THESE TERMS GOVERN YOUR USE OF THIS DOCUMENT

Your use of this Ontario Geological Survey document (the "Content") is governed by the terms set out on this page ("Terms of Use"). By downloading this Content, you (the "User") have accepted, and have agreed to be bound by, the Terms of Use.

Content: This Content is offered by the Province of Ontario's *Ministry of Northern Development and Mines* (MNDM) as a public service, on an "as-is" basis. Recommendations and statements of opinion expressed in the Content are those of the author or authors and are not to be construed as statement of government policy. You are solely responsible for your use of the Content. You should not rely on the Content for legal advice nor as authoritative in your particular circumstances. Users should verify the accuracy and applicability of any Content before acting on it. MNDM does not guarantee, or make any warranty express or implied, that the Content is current, accurate, complete or reliable. MNDM is not responsible for any damage however caused, which results, directly or indirectly, from your use of the Content. MNDM assumes no legal liability or responsibility for the Content whatsoever.

Links to Other Web Sites: This Content may contain links, to Web sites that are not operated by MNDM. Linked Web sites may not be available in French. MNDM neither endorses nor assumes any responsibility for the safety, accuracy or availability of linked Web sites or the information contained on them. The linked Web sites, their operation and content are the responsibility of the person or entity for which they were created or maintained (the "Owner"). Both your use of a linked Web site, and your right to use or reproduce information or materials from a linked Web site, are subject to the terms of use governing that particular Web site. Any comments or inquiries regarding a linked Web site must be directed to its Owner.

Copyright: Canadian and international intellectual property laws protect the Content. Unless otherwise indicated, copyright is held by the Queen's Printer for Ontario.

It is recommended that reference to the Content be made in the following form: <Author's last name>, <Initials> <year of publication>. <Content title>; Ontario Geological Survey, <Content publication series and number>, <total number of pages>p.

Use and Reproduction of Content: The Content may be used and reproduced only in accordance with applicable intellectual property laws. *Non-commercial* use of unsubstantial excerpts of the Content is permitted provided that appropriate credit is given and Crown copyright is acknowledged. Any substantial reproduction of the Content or any *commercial* use of all or part of the Content is prohibited without the prior written permission of MNDM. Substantial reproduction includes the reproduction of any illustration or figure, such as, but not limited to graphs, charts and maps. Commercial use includes commercial distribution of the Content, the reproduction of multiple copies of the Content for any purpose whether or not commercial, use of the Content in commercial publications, and the creation of value-added products using the Content.

Contact:

FOR FURTHER INFORMATION ON	PLEASE CONTACT:	BY TELEPHONE:	BY E-MAIL:
The Reproduction of Content	MNDM Publication Services	Local: (705) 670-5691 Toll Free: 1-888-415-9845, ext. 5691 (inside Canada, United States)	Pubsales@ndm.gov.on.ca
The Purchase of MNDM Publications	MNDM Publication Sales	Local: (705) 670-5691 Toll Free: 1-888-415-9845, ext. 5691 (inside Canada, United States)	Pubsales@ndm.gov.on.ca
Crown Copyright	Queen's Printer	Local: (416) 326-2678 Toll Free: 1-800-668-9938 (inside Canada, United States)	Copyright@gov.on.ca

LES CONDITIONS CI-DESSOUS RÉGISSENT L'UTILISATION DU PRÉSENT DOCUMENT.

Votre utilisation de ce document de la Commission géologique de l'Ontario (le « contenu ») est régie par les conditions décrites sur cette page (« conditions d'utilisation »). En téléchargeant ce contenu, vous (l'« utilisateur ») signifiez que vous avez accepté d'être lié par les présentes conditions d'utilisation.

Contenu : Ce contenu est offert en l'état comme service public par le *ministère du Développement du Nord et des Mines* (MDNM) de la province de l'Ontario. Les recommandations et les opinions exprimées dans le contenu sont celles de l'auteur ou des auteurs et ne doivent pas être interprétées comme des énoncés officiels de politique gouvernementale. Vous êtes entièrement responsable de l'utilisation que vous en faites. Le contenu ne constitue pas une source fiable de conseils juridiques et ne peut en aucun cas faire autorité dans votre situation particulière. Les utilisateurs sont tenus de vérifier l'exactitude et l'applicabilité de tout contenu avant de l'utiliser. Le MDNM n'offre aucune garantie expresse ou implicite relativement à la mise à jour, à l'exactitude, à l'intégralité ou à la fiabilité du contenu. Le MDNM ne peut être tenu responsable de tout dommage, quelle qu'en soit la cause, résultant directement ou indirectement de l'utilisation du contenu. Le MDNM n'assume aucune responsabilité légale de quelque nature que ce soit en ce qui a trait au contenu.

Liens vers d'autres sites Web : Ce contenu peut comporter des liens vers des sites Web qui ne sont pas exploités par le MDNM. Certains de ces sites pourraient ne pas être offerts en français. Le MDNM se dégage de toute responsabilité quant à la sûreté, à l'exactitude ou à la disponibilité des sites Web ainsi reliés ou à l'information qu'ils contiennent. La responsabilité des sites Web ainsi reliés, de leur exploitation et de leur contenu incombe à la personne ou à l'entité pour lesquelles ils ont été créés ou sont entretenus (le « propriétaire »). Votre utilisation de ces sites Web ainsi que votre droit d'utiliser ou de reproduire leur contenu sont assujettis aux conditions d'utilisation propres à chacun de ces sites. Tout commentaire ou toute question concernant l'un de ces sites doivent être adressés au propriétaire du site.

Droits d'auteur : Le contenu est protégé par les lois canadiennes et internationales sur la propriété intellectuelle. Sauf indication contraire, les droits d'auteurs appartiennent à l'Imprimeur de la Reine pour l'Ontario.
Nous recommandons de faire paraître ainsi toute référence au contenu : nom de famille de l'auteur, initiales, année de publication, titre du document, Commission géologique de l'Ontario, série et numéro de publication, nombre de pages.

Utilisation et reproduction du contenu : Le contenu ne peut être utilisé et reproduit qu'en conformité avec les lois sur la propriété intellectuelle applicables. L'utilisation de courts extraits du contenu à des fins *non commerciales* est autorisé, à condition de faire une mention de source appropriée reconnaissant les droits d'auteurs de la Couronne. Toute reproduction importante du contenu ou toute utilisation, en tout ou en partie, du contenu à des fins *commerciales* est interdite sans l'autorisation écrite préalable du MDNM. Une reproduction jugée importante comprend la reproduction de toute illustration ou figure comme les graphiques, les diagrammes, les cartes, etc. L'utilisation commerciale comprend la distribution du contenu à des fins commerciales, la reproduction de copies multiples du contenu à des fins commerciales ou non, l'utilisation du contenu dans des publications commerciales et la création de produits à valeur ajoutée à l'aide du contenu.

Renseignements :

POUR PLUS DE RENSEIGNEMENTS SUR	VEUILLEZ VOUS ADRESSER À :	PAR TÉLÉPHONE :	PAR COURRIEL :
la reproduction du contenu	Services de publication du MDNM	Local : (705) 670-5691 Numéro sans frais : 1 888 415-9845, poste 5691 (au Canada et aux États-Unis)	Pubsales@ndm.gov.on.ca
l'achat des publications du MDNM	Vente de publications du MDNM	Local : (705) 670-5691 Numéro sans frais : 1 888 415-9845, poste 5691 (au Canada et aux États-Unis)	Pubsales@ndm.gov.on.ca
les droits d'auteurs de la Couronne	Imprimeur de la Reine	Local : 416 326-2678 Numéro sans frais : 1 800 668-9938 (au Canada et aux États-Unis)	Copyright@gov.on.ca

ROYAL ONTARIO MUSEUM
OF
MINERALOGY
LIBRARY
ONTARIO DEPARTMENT OF MINES
10347.

REPORT OF

THE BUREAU OF MINES

VOLUME VIII—FIRST PART

1899

CONTENTS

INTRODUCTION - - - - - - - - - - p.	5-8
MINERAL INDUSTRIES OF ONTARIO - -	9-28
THE CONDITION OF ONTARIO MINES - - -	29-48
MINES OF NORTHWESTERN ONTARIO - -	49-99
MICHIPICOTON MINING DIVISION - - -	100-105
NICKEL EXTRACTION BY THE MOND PROCESS	106-120

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

Toronto:
Warwick Bro's & Rutter, Printers, etc., 68 & 70 Front St. W.
1899.

ROYAL ONTARIO MUSEUM
OF
GEOLOGY AND MINERALOGY
622
O

CONTENTS

	PAGE
LETTERS OF TRANSMISSION	1-3
INTRODUCTION	5-8
Transactions in charters and mineral lands	5
Comparative statistics	6
Iron production	6
Gold mining	6
Nickel and Copper mining	7
Amendments of the Mines Act	7
MINERAL INDUSTRIES OF ONTARIO	9-28
Mining Companies incorporated	
Mining Lands sold and leased	10
Table of Mineral Production	11
Building Materials and Clay Products	11
Cements	13
Pottery	14
Petroleum and Natural Gas	14
Calcium Carbide	17
Salt and Gypsum	17
Graphite and Mica	18
Pig iron and Iron ore	18
Copper and Nickel	18
Gold and Silver	21
Mining Accidents	23
At Foley mine	23
At location HW 16	23
At Mikado mine	24
At West Silver Mountain mine	24
At Copper Cliff mine	25
At Sawbill mine	26
At Golden Star mine	26
At location H W 350	27
INSPECTOR DEKALB'S REPORT ON THE CONDITION OF ONTARIO MINES	29-48
Introduction	29
Iron mines	30
Bedford mine	30
Robertsville mine	31
Cook mine	31
St. Charles mine	32
Welch mine	32
Miller mine	32
Lead Mines	32
Hollandia mine	32
Zinc Mines	33
Balfour mine	33
Copper and Nickel Mines	33
Copper Cliff mine	33
Evans mine	34
McArthur shaft No. 1	35
McArthur shaft No. 2	35
ONTARIO MINES.—*Continued.*	
Stobie mine	36
Kirkwood mine	36
Grand Portage mine	37
Bruce mines	38
Gold Mines	39
Deloro mine	39
Belmont mine	40
Diamond mine	41
Hammond Reef mine	41
Sawbill mine	41
Roy mine	42
Tabor mine	42
Location 419 HW	42
Triumph mine	42
Regina mine	43
Sultana mine	43
Mikado mine	44
Cameron Island mine	44
Emperor mine	45
Golden Star mine	45
Olive mine	46
Alice A. mine	46
Independence mine	46
Burley mine	46
Silver Mines	47
East End Silver Mountain	47
West End Silver Mountain	47
Quarries	48
Crookston and Point Ann	48
Gibson's	48
INSPECTOR BOW'S REPORT ON THE MINES OF NORTHWESTERN ONTARIO	49-100
Introduction	49
Modes of travel to the mines	49
State of the mining industry	49
Mines on Lake of the Woods	50
Sultana mine	50
Burley mine	52
Queen Bee location	54
Climax mine	55
Hay Island mine	55
Triumph mine	55
Bad mine	56
Regina mine	56
Lizzie mine	59
Bath Island mine	60
Locations on Camp bay	60
Boulder mine	61
Stella mine	62

PAGE

NORTHWESTERN ONTARIO MINES—*Continued.*

Triggs mine ... 63
Sentinel mine ... 64
Mines on Shoal Lake ... 64
Mikado mine ... 64
Toronto and Western Co. ... 67
Cedar Island mine ... 67
Ontario Limited Co. ... 68
Great Granite Co ... 68
Cameron Island mine ... 68
Locations on Lake Minnietakie ... 69
Harvey syndicate ... 70
John Sykes syndicate ... 71
Locations in the New Klondike ... 72
Watson's mine ... 72
Northwestern Ontario Exploration Co ... 73
Maw and Greening syndicate ... 74
Location HW 460 ... 75
Tabor mine ... 75
Locations on Manitou Lake ... 75
Westerfield mine ... 75
Barker mine ... 76
Quackenbush locations ... 76
Mines of the Lower Seine ... 76
Golden Star mine ... 76
Olive mine ... 79
Alice A. mine ... 81
Independence mine ... 81
Decca mine ... 83
Foley mine ... 84
Ontario Gold Concessions ... 84
Exploration of Block A ... 84
Exploration of Block B ... 86
Mines of the Upper Seine ... 87
Sawbill mine ... 88
Hammond Reef mine ... 89
Toronto and Western Co ... 90

PAGE

NORTHWESTERN ONTARIO MINES—*Continued.*

Big Six mine ... 91
New Golden Twins mine ... 92
Island Falls Region ... 92
Location AL 282 ... 92
Location AL 283 ... 93
Location AL 198 ... 93
Proudfoot's location ... 94
Locations AL 298-9 ... 94
Location WN 5 ... 94
Mines on Lake Superior ... 95
Ursa Major mine ... 95
Empress mine ... 95
Slate Islands ... 95
Silver mining ... 96
Rabbit Mountain mine ... 96
Silver Mountain mines ... 96
Reduction Works ... 98
Rat Portage Works ... 98
Norman Works ... 98
Keewatin Works ... 99

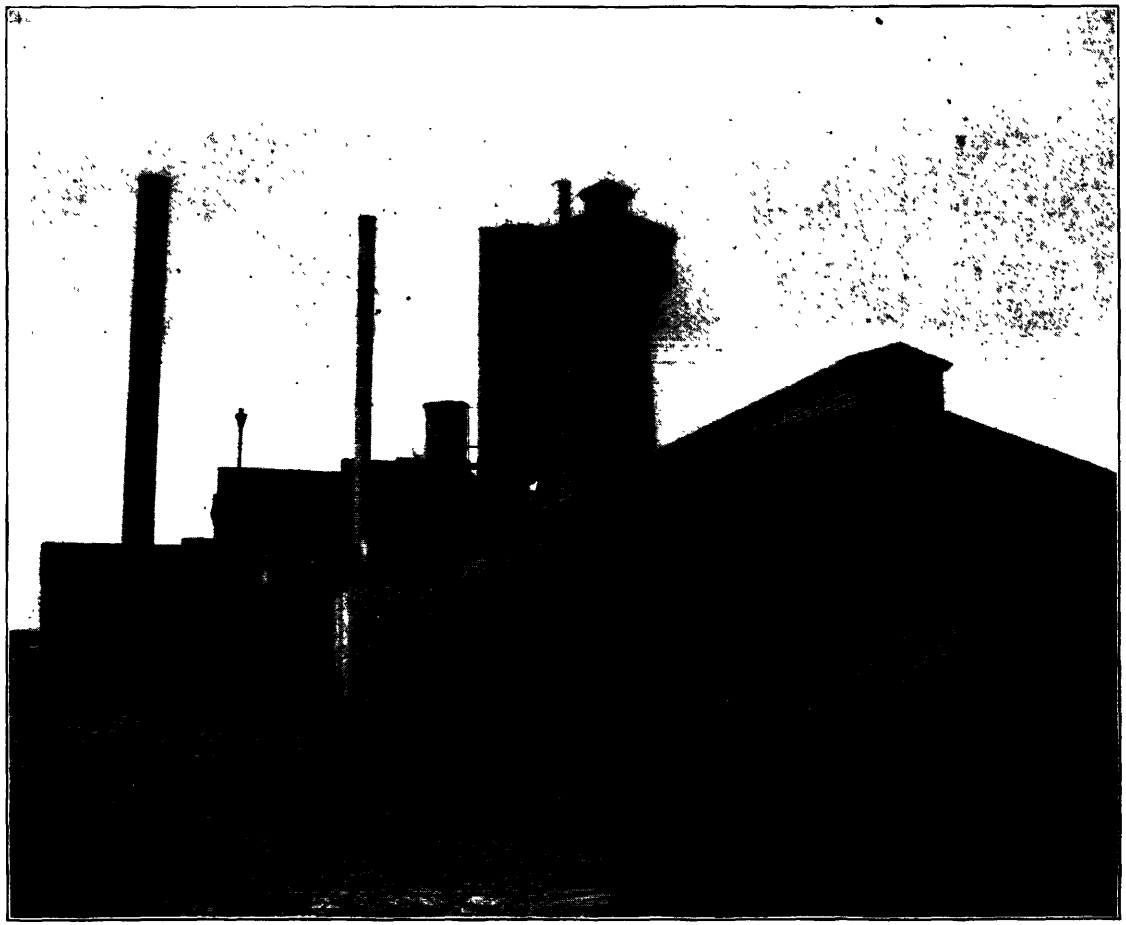
INSPECTOR BOYD'S REPORT ON MICHIPICOTON MINING DIVISION ... 100-105
Progress made in 1898 ... 100
Development work on mining claims ... 100
List of licensees and claims ... 102

NICKEL EXTRACTION BY THE MOND PROCESS ... 106-120
The Sudbury Ore ... 106
History of the Mond Process ... 107
The Smethwick plant ... 108
Description of the working ... 110
A commercial plant ... 114
Value of the process ... 115
Discussion on the process ... 115
Electricity as a refining agent ... 117
Cost of production ... 119

EXPLANATORY NOTE

Owing to the termination of the Government printing contract, earlier publication of the Bureau's Report has been hindered this year, but the delay has permitted of the publication of statistics of metallic minerals for the first six months of 1899, which show a gratifying improvement on the statistics for the corresponding period of 1898.

August 1, 1899. A.B.



Deseronto Blast Furnace Blown in 25 January, 1899

To His Honor SIR OLIVER MOWAT,
Lieutenant-Governor of Ontario.

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

I have the honor to be, Sir,

Your obedient Servant

J. M. GIBSON,
Commissioner of Crown Lands

DEPARTMENT OF CROWN LANDS.
TORONTO, March 29, 1899.

The Honorable JOHN M. GIBSON,
Commissioner of Crown Lands.

SIR,—I beg to submit herewith, for presentation to His Honor the Lieutenant-Governor, the Eighth Report of the Bureau of Mines.

I have the honor to be, Sir,

Your obedient servant,

ARCHIBALD BLUE, Director.

OFFICE OF THE BUREAU OF MINES,
TORONTO, March 29, 1899.

REPORT OF
THE BUREAU OF MINES

Vol VIII 1899 Part I

Introduction

THE RUSH for the incorporation of Mining Companies, which was so marked a feature of operations in 1897, was not maintained in 1898, although the number of charters issued was larger than in any preceding year since the Confederation of the Provinces excepting 1897. Following are the statistics for the first 28 years and for each of the last three years, inclusive of licensed companies:

Year.	No.	Capital.
		$
1868-95	120	46,929,380
1896	26	15 600,000
1897	140	101,531,000
1898	49	30,762,998

The total number organized and licensed in the thirty-one years is 335, and the amount of authorized capital is $194,823,378. Last year's companies make an eighth of the whole in number and a ninth in the amount of authorized capital, which is a good enough showing in spite of the record of the previous year.

The transactions in mining lands are shown in the following tables for the last seven years, being the statistics of lands sold and leased during each year of the period:

1. LOCATIONS SOLD

Year.	No.	Acres.	$
1892	65	6,20	15,273
1893	63	4,37	11,489
1894	40	3,27	7,646
1895	99	7,72	15,868
1896	140	10,73	22,084
1897	472	29,73	59,478
1898	292	19,5	40,469
Totals	1,171	81,61	172,307

2. LOCATIONS LEASED

Year.	No.	Acres.	$
1892	95	13,122	2,314 36
1893	122	13,047	1,933 90
1894	66	7,051	6,488 78
1895	175	15,084	4,924 00
1896	161	13,224	3,497 64
1897	783	86,014	4,821 35
1898	506	48,911	8,063 63
Totals	1,908	196,453	2,043 66

3. RENTAL OF LANDS PREVIOUSLY LEASED

Year.	$
1892	603 00
1893	2,735 86
1894	3,807 78
1895	3,287 16
1896	5,006 50
1897	6,241 11
1898	9,429 62
Totals	31,111 03

The total revenue from sales and rentals in the seven years has been $395,460.66, being a yearly average of $56,494.38, and for last year it has been $97,962.25. For the period ending June 30 of the current year it has reached $109,140, while for the same period of 1898 it was only $44,880.

Classified by products, the mineral statistics of last year are as shown in the following table :

Products.	Value.	Em-pl'yés.	Wages.
	$	No.	$
Stone and Clay products	2,922,379	5,092	1,360,974
Oil, Gas and Carbide	2,328,110	666	311,310
Salt and Gypsum.	282,886	206	62,629
Graphite and Mica	13,500	25	6,300
Metallic products : Iron, Nickel, Copper, Gold and Silver	1,689,002	1,506	723,026
Totals	7,235,877	7,495	2,464,239

The total value of mineral production in 1891 was $4,705,673 ; in 1892, $5,374,139 ; in 1893, $6,120,753; in 1894, $6,086,758; in 1895, $5,170,138, and in 1896, $5,235,003. In 1897 statistics of building materials were not collected, and for that year comparison of total products cannot be made. Last year's product exceeds in value any previous year, it being more than in 1891 by $2,508,668, more than in 1896 by $1,959,338, and more than the average of the six years 1891-6 by $1,765,597. The value of metallic products for each of the eight years 1891-8 and the amount of wages paid for labor are shown in the next table .

Year.	Value.	Wages.
	$	$
1891	388,715	422,479
1892	864,382	366,513
1893	604,762	301,944
1894	842,750	349,751
1895	616,055	266,194
1896	963,288	385,361
1897	749,989	506,192
1898	1,689,002	723,026

The value of last year's product exceeds the average value of the seven preceding years by $970,439 or 135 per cent., and the amount of wages paid for labor last year exceeds the average of the seven years by $351,821 or 95 per cent The wages paid for labor during the eight years is very nearly 50 per cent. of the total value of product.

Three years ago the iron industry of the Province awoke from a long sleep. Early in 1896 the new blast furnace at Hamilton was blown in, and from that time until the end of 1898 it smelted 165,653 tons of ore and 19,847 tons of mill cinder, and produced 100,566 tons of pig iron. The quantity of limestone used for flux during that period was 31,929 tons and of coke for fuel 108,565 tons. Employment was given to an average of 128 workmen, whose aggregate earnings were $148,476, and the total value of pig iron at the furnace was $1,172,697. This Company has been strengthened with the object of establishing steel works in connection with its blast furnace. On January 25 of the present year a new charcoal furnace erected at Deseronto was blown in, and for the first half of the year the two furnaces have produced 30,090 tons of pig iron valued at $409,158, having smelted 14,452 tons Ontario ores, 35,510 tons foreign ores and 5,135 tons mill cinder. The quantity of iron ore mined in the Province during the first half of the present year has been 10,788 tons, valued at its selling price at the mines at $20,604. The Canada Furnace Company, which has been carrying on operations for a number of years at Radnor, Quebec, will soon begin the erection of a charcoal furnace at Midland, in Simcoe county, which will have a capacity of 60 tons per day. The managers of the Company hope to complete it before the close of the year.

Gold mining began in an uncertain way in 1892, and although a number of mines and mills have been worked irregularly since then there are at present only seven which are steady producers of bullion, and three years ago there was only one which was

worked the whole year. During the three years 1892-3-4 the production ranged from $32,776 to $36,900. In 1895 it rose to $50,781, in 1896 to $121,848, in 1897 to $190,244 and in 1898 to $275,078. In the first half of the present year the value of bullion produced is $224,995, and there is a good prospect of the year's production going over $500,000. Last year the number of employés at the producing mines and mills was 580, and the amount of wages paid for labor was $290,919; but of course a large proportion of the cost of labor was for development work. At non-producing mines the number of employés was much greater.

The quantity of nickel and copper ore smelted last year was greater than the average of former years by 56 per cent., and the total estimated quantity of refined metal in the the matte product was 4,567,500 lb. nickel and 8,373.500 lb. copper, worth at the works $782,300. The industry gave employment to an average of 637 men and the amount of wages paid for labor was $315,500. During the first half of the current year the quantity of ore smelted was 88,123 tons yielding 10,741 tons of matte which is estimated to contain 3,224,000 lb. nickel and 3,334,000 lb. copper, and the total value computed at the selling price of matte at the works is $392,093. At the most extensive of the works in operation, those of the Canadian Copper Company, between 700 and 800 men are employed this year and five furnaces are in blast.

After the Toronto meeting of the British Association excursions were arranged so that British and foreign members of the Association might see more or less of the Dominion and become acquainted with its resources. The excursion of the mineralogists and geologists stopped for a day at Sudbury to permit of a visit to the nickel mines and smelting works of the region, the eminent metallurgist, Professor Roberts-Austen, now Sir William Roberts-Austen, accompanying the party to that point. That he was impressed with the extent and importance of our nickel deposits has been proved by his account of them in lectures and papers since his return to England. His paper on the "Extraction of Nickel by the Mond Process" is opportune just now, when the question of refining our nickel in our own Province is under discussion. The Mond process has been known to chemists since 1895, and the interesting experiment of forming a volatile compound with nickel and carbon monoxide from which metallic nickel could be deposited has been repeated in many laboratories; but to adapt the process for use on a commercial scale so as to compete with other methods of refining the metal demanded a large expenditure of time and money. It is very encouraging to see that so distinguished an authority on metallurgical methods as Sir William Roberts-Austen looks on the process as far enough advanced to justify a careful study and description, with the conclusion that it will compete favorably with any now in use. If the cost of the refined nickel can be materially reduced its valuable qualities as a metal and also in its alloy with steel should bring it into great demand, and give a corresponding impetus to one of our most important mining regions. The paper is reproduced in this Report with the kind permission of the author, and it possesses special interest to us in view of the likelihood of Mr. Mond becoming an extensive owner and operator of nickel and copper properties in the Sudbury region.

A number of amendments made to the Mines Act during the last session of the Legislature will, it is hoped, help in a substantial way to advance the mining industries of the Province. The terms of the Iron Mining Fund have been modified to encourage the use of charcoal or peat fuel, by providing for payment of fifty cents per ton on the product of ores not mined in Ontario when such fuel is used solely in smelting ores; but subject to the condition that in the first period of two years not less than twenty per cent. of Ontario ores is reduced at the furnaces claiming aid, and after two years not less than forty per cent., after four years not less than sixty per cent., after six years not less than eighty per cent., and after eight years not less than a hundred per cent.

Payment on the proportional product of Ontario ores, however, is to be on the basis of one dollar per ton of pig metal. A second amendment provides for staking out mining locations in unsurveyed territory which is shown to the satisfaction of the Commissioner of Crown Lands to have no value for pine timber. An explorer who has taken out a license, for which the fee is $10, may stake out in any calendar year two locations of forty acres each, and may hold them, without survey or payment of price or rental, for a period of two years, subject to an expenditure of $3 per acre in the first year and of $7 per acre in the second year for actual mining work. Then, if the development is satisfactory, he may proceed in the usual way to apply for and acquire a location. The advantage of this provision of the Act is, that the prospector is not required to expend money for survey or purchase until he has had an opportunity of proving the mineral worth of the land. A third amendment fixes a new tariff of prices of lands, which is made uniform for all parts of the Province, dependent only upon the lands being in surveyed or unsurveyed territory and their distance from railway communication. In the case of leased lands, the term is limited absolutely to ten years, and if the yearly rental has been paid and if all the covenants and conditions of the lease have been fulfilled, the lessee will be entitled to a patent for his location; or he may obtain a patent at any time upon payment of rent and performance of the covenants and conditions for the full period of the term. In effect, this amendment affords an easy method of purchase by annual payments at a rate which in the aggregate is but little more than the cash price. Some changes have also been made in the provisions of the Act which relate to claims in Mining Divisions, the most important of which are that instead of development work being reckoned at a specified number of days each year it is required to consist of an expenditure of $150 per year, computed at the rate of $2 per man per day, and that when surveys are being made for a patent or lease the boundary lines are to follow the courses of the lines of a claim as originally staked out and recorded, or as they may have subsequently been altered, changed or corrected by the Inspector of the Mining Division. Before a patent or lease can be acquired for a claim, however, the yearly working conditions must be completed for four years on a claim of twenty chains square and for three years on a claim of fifteen chains square or less (or the equivalent of these conditions in a less period of time), and the full performance of the necessary working conditions when certified by the Inspector entitles the holder of the claim to exemption from any further working conditions, renewal fee or miner's license to work the claim with or without a patent or lease for the land.

MINERAL INDUSTRIES OF ONTARIO

Statistics of 1898

Mining Companies

In last year's Report of the Bureau a list was published of all Mining Companies organized under the laws of Ontario for the thirty years ending with 1897, or since the Confederation of the Canadian Provinces. The list which follows gives the name, date of charter and authorized capital of all Mining Companies, Limited, to which charters were granted during the year 1898.[1]

Mining Companies organized

[1] In the case of three of the Companies the Orders in Council (which fix the dates of charters) were passed in December, 1897, but the Gazette notices were not published until 1898.

Mining Companies Incorporated in 1898.

Name of Company.	Date of Charter.	Capital.
The Buffalo Mining and Development of Rat Portage	23 Dec, 1897	$1,500,000
The Buffalo Northwestern Gold Company of Ontario.	9 April, 1898	1,000,000
The British Lion Gold Mining and Development Co. of Ont.	27 April, 1898	80,000
The Bonheur Belle Gold Mining Co. of Northwestern Ontario.	27 April, 1898	500,000
The Bad Vermilion Gold Company of Ontario	23 March, 1898	20,000
The Boerth Mining Company of Ontario	23 Nov., 1898	1,225,000
The Calder Lake Mining Company of Ontario	12 Jan., 1898	100,000
The Cobb Gold Mining Company of Ontario	15 June, 1898	1,500,000
The Decca Mining Company of Ontario	23 March, 1898	975,000
The Duluth Mining Company of Ontario	9 April, 1898	30,000
The Elzevir Mining and Development Company	11 July, 1898	199,000
The Gore Lawn Mining and Development Company	15 Jan., 1898	20,000
The Golden Dredge Mining Company of London, Canada	5 March, 1898	80,000
The Hattie Belle Gold, Copper and Nickel Co. of Parry Sound.	11 July, 1898	400,000
The JO41 Gold Mining Company of Rainy River	8 Jan., 1898	500,000
The Kaladar and Anglesea Mining and Devel't Co of Kingston.	9 March, 1898	400,000
The Leadville Mining Company of Toronto.	16 March, 1898	24,000
The Lake Manitowick Gold Mining and Development Company.	14 Oct, 1898	999,999
The Mountain Mining Company of Ontario	12 Jan., 1898	499,000
The Muskoka Gold Mining and Development Company	10 Jan., 1898	99,000
The Muskoka Beaver Mining Company	5 March, 1898	490,000
The Northern Giant Mining Company	29 Jan., 1898	400,000
The Olive Gold Company of Seine River	13 Dec., 1897	1,000,000
The Onaping Gold Mining Company of Ontario	15 June, 1898	490,000
The Pontiac Mining Company of Ottawa	10 Dec., 1898	490,000
The Sheba Gold Mining and Development Company of Ontario.	23 Dec., 1897	495,000
The Sentinel Consolidated Gold Mining of Ontario	29 April, 1898	250,000
The Snake River Mining Company	5 Oct., 1898	2,500,000
The Seneca Gold, Copper and Nickel Mining Company	31 August, 1898	999,999

Name of Company.	Date of Charter.	Cap tal.
The Triggs Gold Mining Company of Ontario	12 July, 1898	$500,000
The Tycoon Mining and Development Company of Ontario	13 Sept., 1898	150,000
The Voss Mining Company of Ontario	14 Oct., 1898	10,000
The Windsor-Yukon Mining Company	10 March, 1898	45 000
The Wawa Gold Mining Company of Michipicoton	29 April, 1898	199,000
The Wallingford Gold Mining Company	17 Sept., 1898	750,000
The Westminister Mining Company of Ontario	31 May, 1898	195 000
The Wahnapitae Gold Fields Company	9 June, 1898	1,250,000
The Yukon-Klondike Co-operative Mining Company of Ontario.	11 Jan., 1898	300,000
The Zenith Gold Mining Company of Ontario	9 March, 1898	98,000

A comparative Statement

The total number organized and chartered during the year is 41, and the aggregate of their authorized capital is $20,862,998. In the preceding year the number was 136, and the aggregate of their authorized capital $98,356,000. Since Confederation the total number organized has been 327, with an aggregate authorized capital of $184,923,378. Besides those to which charters were granted last year, licenses were issued to the following companies authorizing them to sell stock and other securities in Ontario under the provisions of the Act for the Incorporation and Regulation of Mining Companies, viz.:

The Canadian Minerals Co	$500,000
The Canadian Gold Fields Co	750,000
The Cedar Island Gold Mining Co.	500,000
The Clearwater Gold Mining Co	1,000,000
The Joseph Laduc Gold Mining Co.	5,000,000
The Minnehaha Gold Mining Co	1,000,000
The Ontario Gold Concessions	400,000
The Regina (Canada) Gold Mines	750,000

All are limited companies, with an aggregate capital of $9,900,000. Several of these are operating under foreign charters in British Columbia and the Yukon territory, but the two last named have been working in Ontario.

Mining Lands.

Statistics of lands Sold and Leased.

In 1898 the Crown disposed of 292 mining locations by sale, having a total area of 19,529 acres, and of 506 locations by lease with an area of 48,911 acres. The revenue derived from lands sold in the year was $40,468.87, from lands leased $48,063.63, and from lands leased in the preceding six years $9,429.62, or a total of $97,962.12. For the seven years 1892-8 the number of mining locations sold has been 1,171, with an area of 81,618 acres, and the number leased has been 1,908 with an area of 196,453 acres,—being in all 3,079 locations with an area of 278,071 acres. The revenue derived from lands sold during the seven years has been $172,307, and from the first year's rent of lands leased $192,043.66. Adding rents paid subsequent to the first year of leases ($31,111.03), the total revenue from lands sold and leased has been $395,461.69, which together with miners' licenses, fees, etc., collected in the Michipicoton Mining Division in 1897 8 ($6,244.50) make an aggregate for the seven years of $401,706 06, or an annual average of $57,386 58. The following tables give details by districts of mining lands sold and leased in 1898.

Mining Lands Sold.

District.	Sales.	Acres.	$
Rainy River	255	14,650	30,816
Thunder Bay	9	1,171	2,804
Algoma	1	126	252
Elsewhere	27	3,582	6,597
Totals	292	19,529	40,469

Mining Lands Leased.

District.	Leases.	Acres.	$
Rainy River.	40	40,500	40,534 17
Thunder Bay.	20	3,419	3,419 00
Elsewhere	46	4,992	4,110 46
Totals	506	48,911	48,063 63

Summary of Mineral Production in 1898

Quantity and value of mineral production in 1898, with number of workmen employed and amount of wages paid for labor

Product.	Quantity.	Value.	Employés.	Wages
		$		$
Building stone, rubble, etc		750,000	1,250	520,000
Cement, natural rock... barrels	91,528	74,222	85	23,784
Cement, Portland.. ... "	153,348	302,096	220	104,350
Lime .. ..bushels	2,620,000	308,000	548	127,000
Drain tile .... number	22,668,000	225,000	2,622	456,000
Common brick. . ... "	170,000,000	914,000		
Pressed brick and terra cotta "	8,969,868	100,344	126	42,580
Sewer pipe	.....	93,717	77	26,260
Pottery	.....	155,000	164	61,000
Petroleum. .....imperial gal.	26,978,977	.....	....	....
Illuminating oil..... "	12,281,622	1,243,490	546	263,455
Lubricating oil.. ... "	2,043,226	202,150		
Benzine and naptha. "	1,240,967	121,840		
Gas and fuel oils and tar "	8,047,441	286,705		
Paraffin wax and candles . .lb.	2,616,086	116,349		
Natural gas	....	301,600	85	31,457
Carbide of calcium ..... tons[1]	1,040	55,976	35	16,398
Salt .... "	59,385	278,886	191	60,629
Gypsum .. .. "	3,000	4,000	15	2,000
Graphite..... . .. "	300	6,000	10	1,800
Mica .... "	34	7,500	15	4,500
Iron ore ..... "	27,409	48,875	100	26,700
Pig iron .. . . "	48,253	530,789	130	61,476
Nickel .... "	2,283¾	514,220	637	315,501
Copper. .... "	4,186¾	268,080		
Gold ....oz	16,261	275,078	580	290,919
Silver.... ... . "	86,600	51,960	59	28,430
Totals	.....	7,235,877	7,495	2,464,239

[1] Net tons of 2,000 lb.

Building Materials and Clay Products.

Statistics of building materials were not collected for the year 1897, and for that year the comparative tables which follow for the period 1891-8 are incomplete. The years of depression had seriously affected the building

trade, and production fell off steadily for some time. But with the revival there is a brisker demand for building materials, and it is noticeable also that there is a more generous response to the request for statistics.

The total number of men employed in the production of building materials last year was 4,611, the amount of wages paid for labor was $1,168,240 and the value of materials produced was $2,378,611. In these statistics cement is not included. This industry employed last year 305 men, with wage earnings of $128,134, while the value of the product of their labor was $376,318.

The following table gives the value of the products of stone quarries and the amount of wages paid for labor for each year of the period 1891-8, exclusive of 1897

Statistics of Stone Quarries

Year.	Value.	Wages.
	$	$
1891	1,000,000	520,000
1892	880,000	730,000
1893	721,000	464 000
1894	554 000	336,700
1895	438,000	296,000
1896	394,000	273,000
1898	750 000	520,000

The number of men employed at the quarries last year was 1250, or 480 more than in 1896.

Brick and tile works are correspondingly active, and the output of the yards is but little short of the best year in the decade. Following are the figures of production and value for the seven years, and the amount of wages paid for labor—the quantities of brick and tile being given in millions :

Statistics of Brick and Tile

Year.	Brick M.	Value.	Tile M.	Value	Wages.
		$		$	$
1891	160,000	950,000	7 500	90,000	432,000
1892	175,000	980,000	10.000	100,000	445,000
1893	162,350	932,500	17,300	190,000	451,000
1894	131,500	690,000	25,000	280,000	388,000
1895	126,245	705,000	14 330	157,000	364,000
1896	105,000	577,000	13,200	144 000	306 000
1898	170,000	914,000	22,668	225,000	456,000

The number of workmen employed in brick and tile yards was 2,622, or nearly 800 more than in 1896.

Separate statistics are given for pressed brick and terra cotta, and as will be seen by the following table for the eight years 1891-8 there is little sign of revival in the production of these materials. Two or three of the works had been closed down owing to lack of demand for pressed brick, but work has been resumed at one or two of these and it is likely that the output of this year will show an increase.

Statistics of Pressed Brick and Terra-cotta

Year.	No.	Value.	Wages.
		$	$
1891	13,617,909	156,699	58,000
1892	22,048,000	259,335	88,865
1893	21,634,000	217 373	80,686
1894	25,456,000	286,230	95,400
1895	17 940.867	184,550	69,442
1896	12,201.000	129,845	60,824
1897	8,043,908	99,277	40 084
1898	8,969,868	100.344	42,580

The number of men employed at the works last year was 114, being 29 less than in 1897.

The statistics of lime production show an increase in proportion to those of other building materials, and very nearly approach the highest figures of the decade. They are as follows for seven years of the period :

Statistics of Lime

Year.	Bushels.	Value.	Wages.
		$	$
1891	2,350,000	300,000	116,000
1892	2,600,000	350,000	120,000
1893	2,700,000	364,000	122,000
1894	2,150,000	280,000	108,000
1895	2.090,000	280,000	104,000
1896	1,880,000	220,000	85,000
1898	2,620,000	308,000	127,000

The number of workmen employed last year was 548, or 118 more than in 1896.

The manufacture of sewer pipe last year gave employment to 77 men, whose aggregate wages were $26,260, as compared with 64 men and $19,600 for labor

Statistics of Sewer Pipe

last year. The value of sewer pipe produced was $93,717, or $20,166 more than last year.

Cements.

Portland and Natural Rock Cements.

Very satisfactory progress continues to be made in the production of cement, but especially the Portland variety of it. There has been substantial improvement in the output of the natural rock cement works during the past four years, but values are not so well maintained as is the case with Portland cement, and the rate of increase is considerably lower in the number of workmen employed, in the amount of wages paid for labor and in the quantities produced. The following table gives the statistics of the industry for the last five years :

Schedule.	1894.	1895.	1896.	1897.	1898.
Natural rock cement—					
Number of works .	5	5	5	4	4
Number of workmen...	63	45	56	70	85
Wages for labor . .. $	13,020	14,166	15,200	21,500	23,784
Product .....bbl.	55,323	55,219	60,705	84,670	91,528
Value of product ..... $	48,774	45,145	44,100	76,123	74,222
Portland cement —					
Number of works	3	2	2	2	2
Number of workmen .	105	129	120	161	220
Wages for labor .... . $	31,858	46,000	48,400	67,560	104,350
Product ..... bbl	30,580	58,699	77,760	96,825	153,348
Value of product . $	61,060	114,332	138,230	170,302	302,096

The average rate of wages in natural rock cement works rose from $207 to $315 during the period, and in Portland cement works from $303 to $451, while for both classes of works the aggregate of wages paid for labor grew from $44,878 in the first year to $128,134 in the last, being an increase of 185 per cent. The product of all cement works has grown from 85,903 barrels in 1894, valued at $109,834, to 244,876 barrels in 1898, valued at $376,318, being an increase of 173 per cent. in quantity and of 243 per cent. in value. There has been a slight fall in values per barrel, the average of natural rock being 88 cents in 1894 and 81 cents in 1898, while the average of Portland in 1894 was $2 and in 1898 $1.96. The statistics of Portland cement for 1898, it should be stated, includes 18,400 barrels of Silica Portland, valued at $32,200 which accounts for the apparent fall in value per barrel of Portland.

Imports of Cement

But although the production of cement in Ontario is steadily growing larger, there is no falling off in the quantity of imports for all Canada. The following statistics show for the five years 1894-8 the values of imports entered for consumption from Great Britain, the United States and Other Countries :

Year.	G. B.	U. S.	O. C.	Totals.
1894..	$182,974	$33,263	$68,234	$284,471
1895..	135,693	21,103	95,130	251,926
1896	121,125	25,997	107,907	255 029
1897	111,551	45,2 0	104,081	260 842
1898	106,548	59,855	200,574	366,977

It will be noticed that the trade has undergone a marked change in this short period of four years, the imports from Great Britian having fallen off from 64 to 29 per cent. of the whole, while those from the United States have increased from 12 to 16 per cent. and from all other countries from 24 to 55 per cent. of the whole. Practically all imports, except those from Great Britain and the United States come from Belgium and Germany, the former having last year supplied cement to the value of about $150,000 and the latter to the value of about $50,000. The amount of duty paid was $124,8[illegible]8.65, being $121,968.58 on Portland and $2,900.07 on all other kinds. The total quantity imported last year, including what was not entered for consumption, was 1,153,640 cwt. of Portland and 11,713 cwt. of other kinds.

Pottery.

The pottery works of the Province gave employment last year to an average of 164 men, whose earnings were $61,000. The value of products was $155,000.

Petroleum and Natural Gas.

The total quantity of crude petroleum distilled last year was 26,978,977 imperial gallons, worth at the average price of crude $1,122,801. This was in quantity 1,422,386 gallons and in value $55,753 more than for the previous year. During the first half of the year six refineries were in operation, owned by five separate companies; but during the second half the business was practically in the hands of two companies, viz., the Imperial of Petrolia and the Bushnell of Petrolia and Sarnia, and it is now in one. The following table gives the quantities and values of distilled products for the years 1897 and 1898

Production of 1898

Products	1897.		1898.	
Illuminating oil	gal. 10,891,337	$1,131,083	gal. 12,281,622	$1,243,490
Lubricating oil	" 1,959,810	199,755	" 2,043,226	202,150
Benzine and naptha	" 949,341	77,340	" 1,240,967	121,840
Gas and fuel oils and tar	" 8,021,633	281,035	" 8,047,441	286,705
Paraffin wax and candles	lb 2,139,278	88,378	lb. 2,616,086	116,349

In 1897 the total value of distilled products was $1,777,591, and in 1898 it was $1,970,534. In 1896 the value of distilled products was $832,187 more than the value of crude, being an appreciation by treatment of 74 per cent. In 1897 the appreciation was $710,463, or 67 per cent., and in 1898 it was $847,733, or 75½ per cent. Last year it was supposed that the lower rate of appreciation in 1897 was a result of tariff changes, but this view is not supported by the statistics of 1898. The average rate of wages was lower last year than in either of the previous years, being $482.68 against $540.83 in 1897 and $541.33 in 1896; but no doubt this is a consequence of a closing down of three of the plants in the latter part of last year. The average number of workmen employed at the refineries was 546 and the amount paid for labor $263,516. In 1897 the number was 364 and the amount paid for wages $196,965.70.

Comparative statistics

The proportion of refined products obtained from the crude is shown in the following table for the seven years 1892-98, and indicates in a general way the progress that has been made in the processes of distillation during that period:

Percentages of Products Refined.

Product	1892. p c of crude.	1893 p. c. of crude.	1894. p. c. of crude	1895. p. c. of crude.	1896. p. c. of crude.	1897. p. c. of crude.	1898. p. c. of crude.
Illuminating oil.	38.67	39.12	41 10	43.31	45.08	42.62	45.52
Lubricating oil	12.35	12.45	10.91	9.51	9.07	7.67	7.58
All other oils	27.34	28 14	30.45	28.07	31.09	35.10	34.42
Totals	78.36	79.71	82.46	80.89	85.24	85.39	87.52

In the seven years the increase of all refined products obtained from the crude has been 9.16 per cent, made up of 6.85 per cent. in illuminating oil and 7.08 per cent. in all other oils except lubricating; in the latter there has been a decrease of 4.77 per cent. The wax product last year was larger than in 1897 by 476,808 lb., and larger than in 1896 by 1,084,415 lb. There is perhaps no other industry in the country in which such marked and satisfactory improvement has been made as in the oil industry, and those employed in it deserve great praise for the intelligent methods they have so diligently pursued

A great deal of exploring and developing was carried on during the year for supplies of crude, and the situation was improved in consequence. A small field north of the London road in Sarnia township has been

Exploring and developing New Fields.

added to the producing territory. The southern part of the township of Plympton has also given good results, although in these two localities the oil deposit is not quite so uniform as in the old districts of Petrolia and Enniskillen. It was thought last summer that the township of Brooke gave evidence of a good deposit, and quite a number of wells were drilled there ; but the supply did not prove to be permanent and most of the wells have been abandoned. In the township of Zone, near Thamesville, the same experience was realized ; several wells yielded liberally when first drilled, but the flow did not last. Bothwell is getting its producing limits as an oil field defined, and during the year its yield was little more than 6,000 barrels monthly. Euphemia and Dawn have each a small field, the area of which is being expanded by exploration. In the old territory, which runs from the southern part of the township of Sarnia in a southeasterly direction through Enniskillen by way of Petrolia, wells may be struck at nearly every attempt. Small detached areas in this region not previously explored give good returns, one of the best being near Oil Springs. It takes time, experience and risk of loss to discover these treasures of Nature's storehouse, but it is not improbable that anywhere throughout the counties of Lambton, Kent and Essex a discovery of oil may be made.

A new locality that has recently been attracting attention as an oil field is in the southern part of Dunwich township, in Elgin. Two years ago a show of oil was obtained on lot 15 in the ninth concession, near the shore of lake Erie, by a farmer who was boring for water. A syndicate of Dutton capitalists was formed, and a new well was commenced on lot 15 in the tenth concession. After going through 184 feet of drift to the rock, a surface deposit of oil was struck which for a few days yielded at the rate of two barrels per day. The services of an experienced driller were then procured and drilling was commenced on the north side of the same lot, close to the Talbot road, at an elevation of about 80 feet above lake Erie. The record shows that the drift is composed of 130 feet of blue clay holding many boulders of granite and some limestone, followed by 52 feet of hardpan and gravel. The drilling was continued to a depth of 687 feet, being 505 feet in the rock. A bed of oil-bearing rock 10 feet in thickness was cut through at 332-342 feet, and a second one of the same thickness at 400-410 feet from the surface. From the first of these beds 500 barrels of oil was pumped, and after packing this source of yield the second bed gave one barrel per hour for a test of twenty hours. A small flow of gas was struck at 550 feet, and the rock from 650 to 687 feet yielded a greenish bitter water that flowed over the top of the casing. Cuttings from this well have been examined by Dr. Coleman, who has made the following report on them—the depth of samples being reckoned from the surface of the rock :

Development work in Dunwich.

Dutton Syndicate.

60 ft. Pale yellowish brown limestone, with a fragment or two of dolomite.

111 ft. Pale gray and also white fragments, limestone with some shaly matter.

130 ft. Shaly limestone, yellowish brown.

140-145 ft. Grayish white limestone.

162 ft. Brownish gray, somewhat porous dolomitic limestone, with some sandy particles.

165 ft. Brown limestone with a little sand.

175 ft. Brownish gray limestone.

346 ft. Limestone with some shaly matter, yellowish brown with white particles.

362 ft. Dolomite, grayish white, with what appear to be portions of fossils.

452 ft. Dolomite, bluish gray and also white fragments.

501 ft. Dolomite with gypsum, bluish white.

No. 2 well was drilled on lot 15 in the ninth concession, about 1000 feet north of No. 1. It was put down to a depth of 410 feet, and gave a little showing of gas but no oil. No. 3 was located on the southern part of lot 14 in the tenth, where the surface is about 60 feet below the level of No. 1. The thickness of drift was 140 feet, and the well was drilled to 347 feet. A small show of oil was obtained at 135 to 140 feet in the rock, and about 10 feet of fair cuttings at the bottom. It was pumped ten hours, and then plugged and abandoned. A company known as the Elginfield Company was then organized to continue operations,

Elginfield Company.

and No. 4 well was commenced 300 feet southeast of No. 1, on the same level. The drift had a depth of 190 feet and the rock formations were the same as in No. 1. The oil deposit on the surface of the rock gave two barrels per day. At 410 feet a great flow of salt water was struck and the well was abandoned No. 5 was located on lot 15 in the tenth, 200 feet northwest from No. 1. The drift was 179 feet, and from the bottom of it 500 barrels of oil was pumped. Cuttings of oil rock were obtained from the depths of 150 and 205 feet in the rock, but they were dry. This well was drilled to 415 feet. No. 6 was bored on lot 13 in the eleventh concession, about 30 feet from the west line of the lot. Here the thickness of the drift was found to be 287 feet, consisting of 130 feet clay, 157 feet gravel and sand. Gas was found in the upper bed of gravel, underneath the clay. After drilling through 30 feet of shale and 155 feet of limestone a small flow of oil was struck, which yielded one barrel per day. No. 7 is on the same lot as No. 6, about 500 feet east of it and on the same level. The drift is 260 feet deep, and at 140 feet yielded a strong flow of gas in the gravel. The next eight wells of the Company, all bored last year, are on lot 14 in the tenth concession. Upon the level the drift has a uniform thickness of 205 feet, but some of the wells are located on the side of a hill and there the depth of drift is not so great. Oil was struck in each of the wells at 150 to 160 feet in the rock, the oil cuttings measuring 16 feet, and the average yield of oil is two barrels per day. On the west side of the same lot two wells were drilled during the latter part of the year, on the same general level. The depth of drift was 240 feet, and of limestone to oil-bearing rock 155 feet. The thickness of the oil bed was found to be 20 feet, and while the wells started at 15 to 20 barrels per day they have declined to four barrels.

Henry Hollingshead & Son of Dutton are operating on the west side of lot 15 in the tenth concession, and on the west half of 13 in the same concession. They began boring in September, 1898, in a gully about 40 feet below the level of the ground on the first named lot. No. 1 well was drilled through 131 feet of drift, composed of 80 to 90 feet of clay, and the rest sand and gravel, and then through 160 feet of limestone. Oil was struck at 152 feet in the limestone and the well started at three barrels per 12 hours. In No. 2, which is 400 feet northwest of No. 1, the depth of drift was 129 feet. Oil cuttings were got at 160 feet in the rock, about one foot in thickness. The drilling was continued to a depth of 358 feet, when salt water was struck which flowed to the surface the full capacity of the pipe. This was shut off with difficulty and a pump was put in, but the yield of oil was only one barrel per 12 hours. No. 3 well is 300 feet northwest of No. 2, in the same gully. The drift was 129 feet, and oil was struck at 160 feet in the rock. The drill was continued for 20 feet through alternate bands of oil-rock and dry limestone, when the hole was shot and brackish water broke in under strong pressure. The well has been plugged to the surface. No. 4 is on the west side of lot 13 in the tenth, about 300 feet from the west line and just south of the Talbot road. The surface has a depth of 270 feet, and the drill has gone 178 feet into the limestone. At 161 feet in the rock oil cuttings began to show and they continued for 17 feet. This well was finished on 27 January of the present year, and it has yielded five barrels per 12 hours.

Hollingshead and Son

At the end of January six wells on the Smith farm and two on the Backus farm were worked by the Elginfield company and were yielding 12 barrels per day of 10 hours. All the pumps were driven by one engine with 25 h.p. boiler, and power was also supplied to two pumps of the Hollingshead wells. The total quantity of crude shipped to Petrolia refineries in 1898 was 28 carloads, averaging 105 barrels per car, and selling at $1.40 per barrel. Teaming from the wells to Dutton station costs 15 cents and freight from Dutton to Petrolia six cents per barrel.

Production of the Field

The cost of drilling a well with casing and pump complete ranges from $600 to $700 for a well of 430 to 450 feet deep, and the time occupied is about 250 hours.

The natural gas statistics differ but slightly

from those of 1897. The number of producing wells bored during the year was 14, and of non-producing wells five, but the total number of producing wells only shows an increase of two. An extension of 18¼ miles was made to the length of pipe-lines for distribution of gas, yet the value of gas supplied for consumption was less than in the previous year by nearly $7,000. The amount of wages paid for labor was also less by nearly $11,000, owing, it is probable, to the smaller number of men employed in drilling wells. Following are the statistics of the last six years:

Statistics of Natural Gas.

Schedule.	1893	1894	1895	1896	1897	1898
No. of producing wells..	107	110	123	141	140	142
Miles of gas pipe.	117	183½	248	287¼	297	315¼
Workmen employed ...	59	99	92	87	84	85
Value of gas product...$	238,200	204,179	282,986	276,710	308,448	301,599
Wages for labor .... .."	24,592	53,130	73,328	47,527	42,338	31,457

The number of companies which own natural gas wells is now 15, and nearly all the wells are in the counties of Welland, Haldimand and Essex. There are a number of small wells in Elgin, where the source of supply is in the drift, but their returns are not included in the statistics of the table.

Calcium Carbide.

The Carbide Works at Merritton.

For the thirteen months ending December 31, 1897, the product of the Willson Carbide Works Company at Merritton was 574 tons of calcium carbide, valued at $34,440, the average number of workmen employed being 30 and the amount of wages paid for labor $12,544.62. Last year the product of the works increased to 1,040 tons, valued at $55,976, the average number of men employed was 35 and the amount of wages paid for labor was $16,-397.95. The only interruption to operations during the year was caused by a cyclone which swept over the town and destroyed a number of buildings, among them being one of the power-houses of the Company. The damage to the power-house was quickly repaired, however, and meantime the mill and furnace were run at a reduced capacity.

The demand for calcium carbide continues to be very satisfactory, more indeed than the Merritton factory has been able to supply. But although this is the case the selling price at the works has been reduced by $6 per ton. Further reductions will no doubt be made when larger works are erected and more experience is gained in processes of manufacture. Important advances are likely to be made during the present year as a result of recent methods and tests.

Salt and Gypsum.

Statistics of seven years.

The number of salt works in operation last year was the same as in 1897, namely, six in Huron, one in Bruce, one in Middlesex, two in Lambton and one in Essex. The statistics of the industry for the past seven years are given in the following table:

Schedule.	1892	1893	1894	1895	1896	1897	1898
Tons made	43,387	48,450	35,215	51,009	44,816	54,636	59,385
Value..... ..... $	162,700	149,850	115,551	188,101	204,910	249,880	278,886
Wages.. . ..."	37,800	44,440	43,350	56,496	50,650	58,530	60,629

Excepting for the year 1894 the increase of production has been continuous during the period of seven years, and last year's output was larger than in 1892 by 16,000 tons, or an increase of nearly 37 per cent. The increase in value of production from the first year of the period to the last has been $116,186, or 71 per cent., and the increase in the amount

of wages paid for labor has been $22,829, or 60 per cent. The number of men employed in the industry last year was 191, and their average rate of wages $318.

Salt Production, Importation and Consumption

The total quantity of salt produced in Ontario during the seven years was 336,948 tons, valued at $1,349,878, and in the seven years ending June 30, 1898, there was imported for consumption in Canada 750,090 tons, valued at $2,522,973. The great bulk of the salt imported (about 95 per cent. of the whole) comes in free of duty, and there is enough salt rock underlying one square mile of western Ontario to supply the whole of Canada at the present rate of consumption for 2,400 years.

Statistics of Gypsum

The total quantity of gypsum mined last year was about 3,000 tons. The mines were worked only part time, and gave employment to an average of 15 men; wages $2,000. The value of products, including plaster, alabastine, etc., was $14,600.

Graphite and Mica.

Graphite

The graphite mine in Brougham township was worked during only six months of last year. In that time 300 tons of ore were raised, valued at $6,000. Ten workmen were employed.

Mica.

Mica has been discovered at a number of points during the last few years, chiefly in Muskoka and Frontenac. At most of the properties however operations have not got beyond the development stage, and the returns show that only one of them was a producer last year. The Stoness-Kent mica mine, which is on lot 4 in the thirteenth concession of Bedford township, produced 34 tons of mica, valued at $7,500. From 12 to 18 men were employed. Only small lots were taken out at other locations. Mica for boiler covering is growing actively in demand.

Pig Iron and Iron Ore.

The following table gives the statistics of the Hamilton blast furnace for the three years it has been in operation:

Statistics of three years

Schedule.		1896	1897.	1898.
Ore smelted	tons	51,138	37,492	77,023
Scale and mill cinder	"	5,883	5,350	8,614
Limestone for flux	"	8,657	9,473	13,799
Coke for fuel	"	30,348	27,810	50,407
Pig iron product	"	28,302	24,011	48,253
Value of product	$	353,780	288,128	530,789
Wages for labor	"	47,000	40,000	61,476
Average workmen	No.	125	130	130

The proportion of Ontario ores used in the furnace last year was 27 per cent. of the whole, being 20,968 tons, whereas in 1897 it was only eight per cent. Two mining companies, whose operations were carried on chiefly in Hastings county, raised during the year 27,400 tons, nearly all of which was shipped to Hamilton. Its selling price at the mines is given in the returns as $48,875, or $1.78 per ton. At the furnace the value of Ontario ores smelted was $62,904.81, or $3.00 per ton, which is the same rate as for American ores. The value of mill cinder at the furnace was $17,229.22, of limestone for flux $11,039.44 and of coke for fuel $158,783.22. The total value of raw materials and labor at the furnace was $479,597.64, and the total value of pig iron product $530,789. At the iron mines an average of 100 men were employed whose wage earnings were $26,700, and the value of ore mined, computed at the selling price at the mines, was $48,875.

Copper and Nickel.

Extension of Mining and Prospecting Operations.

There has been a stir in the copper and nickel mines during the past year, and a number of new properties have been developed. Besides the mines in the Sudbury district, several locations north of lake Huron, in the vicinity of Bruce Mines, have been receiving the attention of prospectors and capitalists. The Joseph Powers Syndicate on the Mississaga river has sunk one or two shafts, the old mines at Bruce Mines have been unwatered with a view to the resuming of operations there, and a new company has been opening

up large showings of ore at Rock lake, in Coffin township (now called Aberdeen). This last venture has been acquired by a syndicate now organized as the Rock Lake Mining Company, with an authorized capital of $1,000,000. The locations are situated about 10 miles north of Bruce Mines station, and comprise an area of 1,400 acres. The vein has been traced on the property for a length of three miles, and samples of float ore may be picked up to the south of it a long distance. Work was commenced in April of last year upon an outcropping of ore about 300 feet above the level of Rock lake, and two adits 1,200 feet apart have been driven in from opposite sides of the ridge which holds the vein that prove its thickness to be 16 to 17 feet. A shaft is in course of being sunk, and test pits have been dug at various points which indicate that the vein is well mineralized throughout its whole length. Work has also been resumed on Michipicoton island, where native copper occurs in amygdaloid trap and conglomerate, but although good samples are shown and rich outcroppings have been discovered enough work has not yet been done for a judgment to be formed of their extent and value. In the township of Garson, about ten miles north of Sudbury, a copper-nickel deposit was opened last year, and a furnace to smelt the ore was in course of construction. North of Markstay station also active development work has been carried on and extensive bodies have been exposed, some of which carry gold as well as copper and nickel. The Canadian Copper Company, however, is the principal operator, and several new mines have been developed by this company.

Ore Raised and Smelted in the seven years 1892-98

The following table shows for the seven years 1892-98 the quantities of ore raised and smelted in the Sudbury district, and the per cent. of metallic contents in the ore smelted each year:

Year.	Ore raised, tons.	Ore smelted, tons.	Per cent. of metallic contents in ore smelted.		
			Nickel.	Copper.	Cobalt.
1892	72,349	61,924	3.36	3.19	.1007
1893	64,043	63,944	2.21	2.38	.0800
1894	112,037	87,916	2.92	3.14	.0721
1895	75,439	86,546	2.67	2.73	.....
1896	109,097	73,505	2 67	2.54	.....
1897	93,155	96,093	2.08	2 86	.....
1898	123,920	121,924	2.28	3.43	.....

The total quantity of ore raised in the seven years was 650,040 tons, and the quantity smelted 591,852 tons. Last year's output alike of the mines and smelters was considerably more than in any previous year. It will be noticed that the increase in ore smelted has been almost steadily continuous from year to year, and while last year's record was more than 25 per cent. in excess of the previous year it was nearly 100 cent. more than in 1892. The percentage of nickel contents is fairly well maintained, but the percentage of copper was higher last year than in any one of the seven years.

Statistics of Labor and Wages.

The labor statistics of the mines and works are shown for the same period of seven years in the next table:

Year.	Workers of 15 to 17 years		Workers over 17 years		Total workers.	Total wages.	Average wages.
	above ground.	under ground.	above ground.	under ground.			
						$	$
1892	10	.....	483	197	690	339,821	492.50
1893	10	.....	356	129	495	252,516	510.13
1894	17	.....	395	243	655	311,719	475.90
1895	7	.....	341	96	444	209,960	472.88
1896	8	.....	297	180	485	247,151	509.59
1897	12	.....	379	144	535	253,226	473.32
1898	24	.....	418	195	637	315,501	495.29

The total number of workmen employed last year was larger than in any previous year excepting 1892 and 1894, and the amount of wages paid for labor was larger than in any year excepting the first. The aggregate amount of wages paid for labor in the seven years was $1,929,894, or an average of $489.45 per year; for last year the average was $493.74, which is higher than for any of the other years excepting 1893 and 1896.

Comparative statistics of production in seven years.

Comparative statistics of the industry are given in the following table for the seven years, showing for each year the quantities of ore raised and smelted, the product of matte from the ore smelted, the estimated metallic contents of the matte and the value of the metals, together with the number of men employed at the mines and works and the amount of wages paid for labor:

Schedule.	1892	1893.	1894.	1895	1896.	1897.	1898.
Ore raised .... ..tons	72,349	64,043	112,037	75,439	109,097	93,155	123,920
Ore smelted ..... "	61,924	63,944	87,916	86,546	73,505	96,094	121,924
Ordinary matte ... "	6,278	7,176	10,410	12,525	9,733	13,706	21,101
Bessemerized matte "	1,880	452	1,470	103½	.	328	.....
Nickel contents... "	2,082	1,653	2,570½	2,315¾	1,948½	1,999	2,283¾
Copper contents... "	1,936	1,431	2,748	2,365½	1,868	2,750	4,186¾
Cobalt contents... "	8½	19	3¼	.....	.....	...	...
Value of nickel ... $	590,902	454,702	612,724	404,861	357,000	359,651	514,220
Value of copper... "	232,135	115,200	195,750	160,913	130,660	200,067	268,080
Value of cobalt.... "	3,713	9,400	1,500	.....	.....	...	...
Wages paid..... "	339,821	252,516	311,719	209,966	247,151	253,226	315,501
Men employed.... No.	690	495	655	444	485	535	637

In the seven years the quantity of ore smelted was 591,852 tons, which on being reduced to matte gave 80,929 tons ordinary and 4,233½ bessemerized matte, or in the proportion of 100 to 14.38. The estimated metallic contents of matte product in the seven years are 14,852½ tons or 29,705,000 lb. nickel, 17,285¼ tons or 34,570,500 lb. copper, and 30¾ tons or 61,500 lb. cobalt. At the selling price of matte at the furnaces, which is the form in which it is exported to the refineries, the total value of nickel product for the seven years has been $3,294,060, of copper $1,302,805, and of cobalt $14,613, or a total of $4,611,478. The selling value of last year's product was $782,300, the estimated quantities being 4,567,500 lb. nickel and 8,373,500 lb. copper.

Comparative Values in seven years

Comparative values of the metallic contents of the matte based on the selling price at the works are given for the seven years in the next table:

Year.	Nickel		Copper		Cobalt	
	per ton.	per lb.	per ton.	per lb	per ton.	per lb.
	$	cents.	$	cents.	$	cents.
1892.....	283.81	14.190	119.90	5.995	436.82	21.841
1893.....	275.08	13.754	80 50	4.025	494.73	24.736
1894.....	238.36	11.918	71.23	3.561	461.54	23.077
1895.....	174.83	8.741	68.02	3 401	.....	.....
1896.....	183.22	9.166	69.94	3 497	.... .	.....
1897.....	179.91	8 995	72 75	3 637	.....	.....
1898.....	184.72	9.236	64 02	3 201	.....	.....

These figures show a slight rise in the value of nickel compared with the averages of the previous three years, but a large decrease compared with the first three years of the period. In the case of copper the lowest point of the period was reached last year, although the price of copper had gone up to a point not reached during many years. Obviously the value should be considerably higher than it appears.

Gold and Silver.

Gold was produced last year at 17 locations, but as only four of these have reported an output in excess of $20,000 it will be readily understood that a large majority of them are yet only in the early prospecting stage. The leading ones are the Sultana, the Mikado, the Regina and the Belmont. The Regina however was closed down for five months, during reconstruction of the mill. The Foley was also idle for the greater part of the year, pending a sale of the property in England. In the eastern part of the Province the Belmont and Deloro mines promised well at the beginning of the year, but unfortunately the mill of the Deloro was destroyed by fire early in spring, and a new one erected in its stead was not completed until the close of the year. Both of these mines give assurance of good results for the present year, and in the west the outlook is very hopeful. The following table gives the statistics of gold mines and mills in the Province for the seven years 1892-98:

Statistics of seven years.

Schedule.	1892.	1893.	1894.	1895.	1896.	1897.	1898.
Mines worked .....number	9	15	4	8	8	9	17
Men above ground .. "	85	112	40	126	103	222	296
Men under ground.. "	40	56	52	111	86	216	284
Ore treated ..... tons	3,710	5,560	2,428	6,500	13,292	27,589	57,895
Gold product. ..... oz.	..	1,695	2,022½	3,038	7,154	11,412	16,261
Gold value..... .... $	36,900	32,960	32,776	50,781	121,848	190,244	275,078
Wages paid for labor "	22,750	49,027	38,032	56,234	91,210	217,766	290,919

The total quantity of ore milled during the seven years has been 116,974 tons, and the value of gold product was $740,587, being an average of $6.33 per ton. This is proof of the low grade character of the ore, but as nearly all of it is free milling, it is high enough to earn a good margin of profit when development is sufficiently advanced to provide an ample quantity to keep the mills running steadily. It will then be possible to select the ore, instead of treating all that comes from the mines. Therefore an increase of average may reasonably enough be looked for, unless, as seems likely, some extensive low grade deposits are worked on a large scale. Two of these are the Hammond Reef and the Alice A., where enormous bodies are known to occur, and on which mills of large capacity are likely to be erected soon.

Low grade Ores.

At present the Hammond Reef mill is only equipped with ten stamps, and thirty more will be added this year. As an indication of what may be attained when the enlarged mill is in operation, the following figures are given of the last run made before the mill was closed down in December:

Hammond Reef Mine's record.

Ore treated..... .. tons	396
Time of milling .....hours	437½
Wood burned at mill..... cords	8½
Wood burned at pump ..... "	18
Concentrates produced..... ..lb	6,400
Bullion produced .... oz	89.9
Mint value less express charges and charges of treatment	$1,510.00
Wages and supplies	837.26

The time was about 18¼ days of 24 hours, and although the value of the ore was only $3.81 per ton the net profit after deducting wages and supplies was $672.74, being $1.70 per ton or $36.86 per day. At the same averages a mill of forty stamps working 300 days in the year should produce $99,288 of gold and earn a profit of $44,232. But with the larger mill the cost of production might be very considerably reduced, while a higher average of bullion per ton might be obtained by proper selection of the ore raised from the mine. In this estimate however no allowance has been made for interest of capital invested, or for the wear and tear of machinery.

Statistics having another kind of value have been placed at the disposal of the Bureau by the managers of the Mikado mine. They show the number of days of mill runs, the total quantity

Record of the Mikado Mine.

of ore milled from the commencement of operations in 1896 down to the end of March of the present year, the product of gold in ounces and its mint value. The first item in the table which follows is a total of three runs made at a customs mill in September and December, 1896, and the others are records from the Company's own mill commencing in August, 1897.

Days run.	Tons of 2,000 lb.	Gold, oz.	Value, $.
1896—			
..	297	969	13,395.23
1897—			
16	800	946	14,524.37
10	550	498	7,708.68
..	580	320	4,991 56
18	728	350	5,429.11
18	850	389	5,727.53
1898—			
20	800	463	6,868 44
14	570	462	6,706.50
28	1,200	550	8,342 51
27	1,250	730	10,955.47
24	840	444	6,248.54
17	600	169	2,218.15
20	730	240	3,109.74
21	640	251	3,569,20
21	770	265	3,494.76
17	809	134	1,900.76
21	1,050	227	3,399.13
23	1 150	250	3,563.04
26	1,150	393	5,829.52
23	1,100	407	6,034.09
22	1,000	316	4,717 15
24	1,000	236	3,727.35

The total quantity of ore milled was 18,464 short tons, the weight of gold saved by amalgamation 9,009 ounces, and the value of bullion by mint returns $132,460.83. A cyanide plant for treating tailings was completed early in November of last year, and from that time until the end of March last the quantity treated was 2,099 short tons, which yielded 566 ounces of bullion, with a mint value of $5,072.37. Adding this product to the product obtained by amalgamation the total is 9,575 ounces, worth at the mint $137,533.20, being an average of $7.44 per short ton or $8.34 per long ton of bullion won from all the ore treated.

Mines in Hastings.

Two of the working mines in the county of Hastings are deserving of mention here for the skill and energy with which operations have been carried on.

The Deloro mine, five miles east of the village of Marmora, is one of the oldest gold mines in the Province. The record of the numerous attempts which have been made to treat its refractory arsenical ores is an interesting chapter in the history of metallurgy. After lying idle for a number of years the property was purchased about two years ago by a company known as the Canadian Goldfields, Limited. Since then development work has been carried on vigorously at the mine. The shaft on the main lead is nearly 300 feet deep, and three other veins have been opened up by crosscutting. The new mill is built upon a knoll 500 feet southwest from the shaft, and is thoroughly modern and efficient in its design. The ore is crushed in a ten-stamp battery, and passes over five-stepped plates to two Frue vanners. The tailings from these are sized hydraulically and pass to another set of vanners where a second concentration is effected, after which the tailings are discarded. The concentrates are wheeled to the leaching house and treated in vats by the bromocyanide process under the patents of Messrs. Sulman and Teed. When the extraction is complete the residues are withdrawn and stored in order that the arsenic may be extracted at some future time. A well-equipped laboratory adjoins the mill, and careful control over all the operations is maintained. A building close to the mill contains a 20-drill Rand compressor, which supplies power underground for the drills and pumps.

Ten miles northwest from Marmora lies the Belmont mine, at present the property of the Cordova Exploration Co., Limited. During the last two years great changes have been made here, and the mine can rank with the best in Ontario. At the time of the purchase in 1897 a small shaft represented the development work, and now three shaft houses with their dumps of waste rock give an indication of the activity below. A ten-stamp mill crushes the ore, which is concentrated on Frue vanners, the tailings being treated again on a large gyrating vanner. Every part is of the latest design and appears to work most efficiently. A 20-drill Rand compressor is being installed at a point convenient to the several shafts, and this promises a vigorous

attack upon the ore deposits in the several veins which traverse the location.

The output of these two mines for the first half of 1899 is an indication that they will compare very favorably in amount of production with the mines of the western part of the Province. They are both under excellent management.

During 1898 work was resumed on three of the old silver mines in the townships of Gillies and Lybster, southwest of Port Arthur, which had been closed down since 1893. The following table gives the statistics of the mines for last year:

Silver Statistics.

Ore raised	net tons	6,600
Ore stamped	"	5,600
Bullion product	oz.	86,600
Value of bullion	$	51,960
Wages paid for labor	"	28,430
Average workmen above ground		32
Average workmen underground		27

The value of silver is computed at the average of New York quotations for the last six months of 1898.

Mining Accidents.

Thirteen accidents, involving 15 men, were reported to the Bureau of Mines as having occurred in 1898, five men having been killed and ten more or less severely injured. The number of fatalities is in excess of the average; but at least two of the five, though occurring at mining works, were not of a kind peculiar to mining operations, being rather such as might happen in connection with industries of almost any sort. The five deaths were caused by (1) being caught in the revolving shaft of a stamp mill, (2) falling down an unused mine shaft, (3) being run over by a railway train, (4) falling down a shaft while riding in an ore bucket, and (5) falling down the face of a stope a distance of 22 feet. The other accidents were mainly of the usual type, resulting from premature or unexpected explosions, falls of rock, etc., the injuries in some cases being severe, and in others comparatively trifling. Following are particulars of the several casualties:

Nature of Accidents during the year.

At Location HW16.

A peculiar mishap occurred on mining location HW16 north of Big Sandy lake and east of lake Minnietakie, Rainy River district, on 2nd April, by which Peter Smith had his left hand and the thumb of his right so badly hurt that they had to be amputated, and two other men named James Aitkins and T. Andrews were less seriously hurt. These men were working under the direction of Mr. S. H. Williamson, who had the contract of sinking upon the property. They were employed in one of the shafts, and having broken a drill in a hole they charged the latter with dynamite for the purpose of throwing out the broken steel. This they succeeded in doing without blasting the rock. They then resumed drilling in the same hole, when after working upwards of twenty minutes and dulling one drill an explosion occurred, the force of which took effect upon Smith, who was holding the drill while the others were striking, with the result above stated. Andrews was bruised about the face and breast and Aitkins slightly cut near one eye. Smith was brought down to Dinorwick where his hand and thumb were amputated by Dr. F. A. White of Wabigoon. He was afterwards sent to the hospital at Port Arthur for care and treatment.

Three men injured b an Explosion.

At the Foley Mine.

At the Foley gold mine on 21st January James Shortreed received severe injuries, which ended in his death on the 29th of the same month. The circumstances were as follows: Shortreed, whose duties were to attend the machinery of the stamp mill, was a member of the night crew and shortly after beginning work on the evening in question noticed that the main driving belt of the north battery had become disconnected on account of the wearing out of the lacings. He took it off, relaced it and with a lighted candle in his hand jumped down on the ground from the battery-room floor with the intention of replacing the belt on the pulley, the engine and machinery being in full operation. The loose sleeves of his working blouse caught on the shaft and he was quickly drawn down to and whirled around it. His working mate, Joseph C. Foley,

James Shortreed fatally injured.

junior, ran to the engine, shut off steam and summoned help. Shortreed was disentangled and removed to Mr. J. E. Everett's house, the regular hospital being temporarily occupied by teamsters engaged in filling a wood contract. Dr. D. C. Mackenzie was called and arrived in about an hour and a quarter from Mine Centre. Examination showed that Shortreed's injuries were very severe, consisting of a compound comminuted fracture of the left leg, fracture of the right leg above the knee, and also of the right arm above the elbow. In addition he was hurt internally by the severe compression he had sustained upon the shaft. His wounds, though so serious, were not considered necessarily fatal, but they proved sufficient to end his life in a little over a week's time. There is little room to doubt that Shortreed's own carelessness brought about his death. It is by no means an uncommon thing in factory or mill to throw a driving belt upon a pulley in motion, but there is always danger connected with the practice, and the loose sleeves of the unfortunate workman's jacket were just what was needed to bring about an accident of this particular class, which is always severe and frequently fatal.

At the Mikado Mine.

At the Mikado gold mine on 12th March a miner named John Dunphy, who is described as an old and experienced workman, found himself in darkness after a blast at the 120-foot level. Though warned, as is stated, to carry matches for use in such a contingency, he does not appear to have had any at the time, and began walking about, with the result that he fell down No. 1 shaft a distance of about 45 feet. Fortunately beyond a thorough shaking up he sustained no serious injury, and was able to do surface work again about May 1st. A few weeks later he resumed his duties in the mine.

John Dunphy

At the same mine on 16th July a miner named Joseph Newton while "mucking" in No. 1 shaft of the same mine was injured in the following way: In hoisting after a blast in the shaft, which was 227 feet deep, the bucket caught n the bell wire; the latter being drawn up became entangled around some timbers about 140 feet from the top and wrenched one of them from its fastenings. It dropped down the shaft and touching the bottom rebounded and struck Newton on the forehead. The shaft had been fitted with permanent timbering for about 140 feet down, and below that point temporary lagging had been put in for the construction of a ladderway. The piece which fell had not been "hitched" into the walls of the shaft, but was merely spiked. Newton suffered a slight concussion of the brain, but a few days' treatment in the hospital at Rat Portage restored him to health.

Joseph Newton.

At West Silver Mountain Mine.

Notification was received from Mr. H. Shear, manager of the West End Mine Syndicate, of the death by drowning of one William Montgomery at that mine on Silver Mountain on 13th May. Inspector Bow was directed by telegraph to make an investigation into the circumstances, which he did, and reported as follows under date of 21st May:

William Montgomery

PORT ARTHUR, May 21, 1898.

SIR,—According to your instructions I visited the West End mine at Silver Mountain, and inquired into the circumstances attending the death of W. N. Montgomery, which occurred on the 13th inst. Evidence upon oath was not taken, as such was not specified in your directions. The details of the accident were described to me respectively by H. Shear, superintendent of the mine, Colon Tonkin, mine captain, Mrs. Montgomery, wife of deceased, and John Hayes, engineer (all of whom were present at the time of the accident), and I beg to submit herewith the following report:

The deceased was a man of sixty-one years of age. He was a miner by business, and had been at Silver Mountain for fourteen years. He had been caretaker at the West End mine for eight months, preceding the recent opening of same. Formerly he was employed at the Crown Point mine. At the time of the accident he was not an employé of the present operators, but his wife had a contract to board the employés, and still fills that position.

The scene of the accident was a tunnel which had been driven north into the hillside. I visited the same and made the following notes: The tunnel is four by seven feet in size and 96 feet long. At the end a winze about six by six feet in size had been sunk 22 feet. There is 14 feet of

water in the latter. Forty-eight feet from the entrance some cross pieces, provided with meat hooks, were placed near the roof The hooks were at the east side. On the west side at the same point a small table is provided, which stood in a recess in the wall. The winze is 31 feet from the last meat hook. It was not fenced, but the entrance to the tunnel was secured by a door. The tunnel has been abandoned for some years, and was lately employed for storing meat.

The facts regarding the accident were as follows: On the 13th inst., at a little past 7 p.m., deceased was carrying a quarter of fresh beef up to the tunnel. Finding it heavy, he laid it down a few hundred feet from the latter place, and cut it in two. He carried one half up the tunnel, leaving a small boy to guard the remainder. The boy waited for about three-quarters of an hour, and thinking something was wrong as deceased did not return, he went down to the boarding house and informed Mrs. Montgomery, wife of deceased. Mrs. Montgomery went up to the tunnel and entering a few feet called, but received no answer. She sent a little girl, whom she had with her, for a lantern. Mr. Hayes, the engineer, returned with a lantern and went in as far as the winze with Mrs. Montgomery. A hat was seen floating on the water in the winze, and it was identified as belonging to the deceased. A grappling hook was made and Capt. Tonkin and Mr. Hayes recovered from the bottom of the winze the body of the deceased, and the beef he had carried in. His watch was stopped at 7.14 p.m. It was about 8.15 p.m. that the hat was found, and the body was recovered shortly after. There was a slight bruise on the forehead, which was doubtless caused by his striking against the side of the winze in the fall.

Nobody can account for the affair. It was known that he went in without his candle, as the latter was found near the entrance of the tunnel. It appears that in the darkness he went past the meat hooks and the table without seeing them, but it is not likely that he was observing very closely where he was going, as in passing a person should see the cross-pieces over head, even at that time of day, and the space for passing is also cramped at that point. Deceased must have known of the winze, and its position, as he had taken Mr. Shear in on a previous occasion. He was known to have been a confirmed drinker, but there was no direct evidence to show that he was under the influence of liquor when he went into the tunnel.

The body was buried at Port Arthur on the 16th inst. Mrs. Montgomery has returned to her duties at the mine.

At Copper Cliff Mine.

Ernest Lamarshe.

One Ernest Lamarshe while at work on a roast heap at Copper Cliff mine June 27, using a pick, shovel and wheelbarrow, was caught and injured by some ore falling from the heap. His left leg was broken, and his body bruised, and he sustained a wound on the scalp. He was removed to the hospital at Sudbury and on 11th of July was reported as progressing favorably.

Alexander McKinnon.

Alexander McKinnon, foreman for Mr. D. L. McKinnon, roast yard contractor at the Copper Cliff works, was on 16th August struck by a "jimmy" ore car, weighing about five tons, on the trestle track of No. 2 smelter. He was knocked down and one wheel passed over his back, breaking two ribs on the left side and injuring one of the muscles of his right arm. McKinnon was dumping ore from cars into bins on the trestle track, pushing the cars out of his way as he emptied them. He was in the act of unloading a car when a locomotive which was standing on its crank centres on the same track, having finished taking on water, backed up a little to free its centres preparatory to moving away. In so doing it struck the empty "jimmy" cars and caused them to collide with the one upon which McKinnon was working. The unexpected shock threw him down and brought about the injuries stated above. On 6th September he was reported as being well on the way to recovery.

Thomas Deacon.

At the Canadian Copper Company's McArthur No. 1 mine on 27th September one of the Company's miners, Thomas Deacon, received some painful injuries by reason of his failure to get away from an impending blast in good time. He was wounded severely about the shoulders, arms, thigh and leg, but no bones were broken. He was taken to the Sudbury hospital and on 6th October was reported as convalescent.

Harris, a trainman, fatally hurt.

On 26th September a fatal accident, which was rather a railway than a mining one, befell a man named Harris employed by the Canadian Pacific Railway, engaged on the train running into and out of the Canadian Copper Company's works at Copper Cliff. Harris slipped from a car at the rear end of the train and fell

beneath the wheels, which cut off both his legs, one at the thigh and the other at the knee. The shock resulted in his death shortly afterwards. No inquest was held. While a brakeman on the Canadian Copper Company's train, Harris was employed and paid by the Railway Company.

Jakop Haro, miner, fatally hurt.

The eleventh level of the Copper Cliff mine was on 17th December the scene of a casualty which resulted in the death of a miner named Jakop Haro or Harri, employed as helper on the machine drill. This man was working on a stope and had just climbed up the ladder from the floor of the level with a couple of drill steels. No one saw the occurrence, but it is believed that Haro missed his footing on reaching the platform or on climbing up the stope, and probably disengaged some loose rock which precipitated him to the floor. At any rate he was found lying at the foot of the ladder very severely hurt, his right arm practically severed between the wrist and the elbow, and with multiple fractures of the left arm and a compound fracture of the right thigh. In addition the unfortunate man sustained extensive scalp wounds, though there was no actual fracture of the scalp. The accident happened late in the afternoon, and after his wounds had been dressed at the mine by Dr. R. B. Struthers, Haro was conveyed to the hospital at Sudbury, where he died the following morning between three and four o'clock. On 22nd December an inquest was held by Coroner A. McMurchy, M.D. of North Bay. The foreman in charge of the work deposed that he considered deceased had acted improperly in going up the stope with two steels unassisted. A rope was fastened in the wall at the top of the stope, the lower end being loose, for the purpose of assisting the men in climbing up or down the loose rock forming the face of the stope. Evidence was taken as to the condition of the mine and especially of the eleventh level, the measures adopted for protecting the miners from falls of rock, etc., whereupon the jury found that Jakop Haro came to his death by accidentally falling from the stope to the bottom of the eleventh level of the Copper Cliff mine, a distance of 22 feet, and that no blame could attach to the Canadian Copper Company, as all necessary precautions appear to have been taken.

At the Sawbill Mine.

On 3rd September an engineer named Gordon, employed at the Sawbill gold mine, was holding a drill while a hole was being bored for an anchor bolt for the bed of the hauling engine, when he passed his arm over the drill and received a flesh wound about three inches up from the wrist. He was sent to Port Arthur for treatment and was able to return to work on the 19th of the month, no permanent injury having been inflicted.

At Golden Star Mine.

Fatal accident to James Teppet, miner.

The Golden Star mine on 28th October was the scene of a fatal accident which befel a miner named James Teppet in consequence of his recklessness and disregard of rules. At midnight he with two other miners undertook to ascend from the bottom of the shaft to the surface by means of the ore bucket instead of by the ladderway. The engineer was not aware that anything but ore was coming up, as it was strictly forbidden the men to use this method of ascent. Teppet was standing on the rim of the bucket which stopped on its way up, and wishing to give the signal to proceed he released his hold, lost his footing and falling to the bottom met an instantaneous death. Inspector Bow was directed to make an investigation of the circumstances and to take evidence upon oath, and a copy of his report is appended. It affords another proof of the adage that "familiarity breeds contempt." In some occupations the constant presence of danger seems to lead to a foolhardiness and disregard of all precaution, which men in less dangerous callings rarely show.

RAT PORTAGE, February 1, 1899.

I beg to report herewith the results of the inquiry into the death of James Teppet, which occurred at the Golden Star mine on October 28 last..

I examined under oath John McHugh, Gordon Clarke and R. A. Kerr, the superintendent. Thomas A. Thomas, who rode up in the bucket with McHugh and deceased at the time of the

accident, having left the employ of the company, I was not able to obtain his statement; but the evidence secured was sufficiently clear without further investigation. A summary of the evidence obtained is as follows:

John McHugh: I was employed as a miner, working a night shift at the time of the accident. Tom A. Thomas, Albert Johnson, deceased and myself were hand-drilling at the bottom of the shaft, which was about 40 feet below the fourth level; the latter is 300 feet down. About ten minutes to twelve (midnight) we stopped work as usual to ascend to the surface for lunch. Johnson went up the ladderway, which was in a good condition; thirty feet of rope ladder extended from the bottom to a wall-plate, on the foot wall, from which it was hung, and a wooden ladder reached from there to the fourth level. The remaining three of us started up in the bucket, Thomas inside, and deceased and myself standing on the rim, holding the rope. One bell was rung, the signal to hoist. We ascended until about 40 feet above the second level, when the bucket stopped; no signal had been given and we did not know why it stopped. Deceased then let go the rope, turned around and leaning against the division between the hoisting compartment and manway looked through an aperture in same. He regained his former position on the bucket, and then turned again towards the manway, letting go the rope. While he was in that position the bucket started, after having stopped for what appeared to me a couple of minutes. I don't know whether the bell rope had been pulled or not; the bucket started unexpectedly, not giving deceased a chance to regain himself, and before anything could be done his feet were raised above his head and he fell down the bucket-way. I rang the bell for the bucket to descend to the second level, where Thomas and I got off and went down the ladderway to the third level. There we found deceased hanging on the trap door, quite dead. He had fallen a distance of about 115 feet. We knew it was against orders to ride in the bucket, but it was commonly done in ascending from the third and fourth levels. A notice had been posted up forbidding same. I had come up in the bucket before a couple of times. There was no reason why we should not have used the ladderway on that occasion instead of the bucket.

Gordon Clarke: I was employed in running the hoister at the time of the accident. About ten minutes to twelve I got a signal (1 bell) to hoist, the bucket being at the bottom of the shaft. I brought the bucket up to what I considered would be the second level and stopped. As no work was going on in the first or second levels the bucket was never required to stop there as a rule, and hence there was no mark on the rope to indicate when it was at those stations. The bucket stopped about a minute when I got one bell to hoist again. I raised it about 10 feet when one bell was given to stop, and then four bells to lower. I lowered to the second level and stopped. On learning of the accident the night captain went down, had deceased put in the bucket at the third level; and I brought him to the surface. The men had always been forbidden to ride in the bucket, and a notice was posted up to this effect. But nevertheless they used to get in at the lower levels, ride to the first level, jump off without stopping the bucket and go up the ladderway to the surface, so that they could not be caught. I had never before known them to start from the bottom in the bucket, as the lowest skids were always temporary and loose, and hence not safe for riding purposes. Hence I did not suspect that men were on board. There is no signal to indicate that men are in the bucket.

R. A. Kerr, Superintendent of the mine: "I was awakened about fifteen or twenty minutes after twelve, and told that a man was killed at the mine. I dressed and went up as quickly as I could. When I arrived I found he had been raised to the surface. I inquired how he met with the accident, and was told that he fell off the bucket. As the men were all excited I asked no more questions. I saw that the man was quite dead, with a large gash in his head. On a previous occasion I had spoken to the mine captain about men riding in the bucket, and told him to warn them against it. Notices were posted up at the surface regarding the matter. Deceased, who was of a reckless disposition, had been warned particularly by the captain a short time before the accident."

At Location H W 350.

Nelse Carlson.

An unusual accident occurred on mining location H W 359 (Lower Manitou lake), the property of Messrs. Barker Bros., on 4th October, by which Nelse Carlson suffered severe bodily injury. Blasting was going on in a shaft about 15 feet deep and the last shot for the day was fired at 5.30 p.m. The miners sought cover as usual, and Carlson deemed himself sufficiently protected about 500 feet from the shaft behind a large tree, on a small eminence overlooking the mine. A piece of rock, however, about 25 pounds in weight struck him five inches below the left thigh joint and broke his leg. It is thought the missile must have glanced from one of the trees on Carlson's left, as it seemed an

impossibility for it to have reached him in a direct line from the shaft. Two men were immediately dispatched in a canoe to Gold Rock to bring Dr. Denmark, who arrived at 7.30 a.m. the following day. The doctor set Carlson's leg and had him removed to Gold Rock, where a vacant log house was rented for his accommodation and a man employed to take charge of him. Complications, however, set in and it was deemed advisable to remove Carlson to the hospital at Rat Portage, whither he was taken on 3rd December. On 14th December and again two weeks later Carlson was reported as doing as well as could be looked for.

THE CONDITION OF ONTARIO MINES

By Courtenay De Kalb, Inspector

Introduction.

I BEG to submit the following report upon the results of a tour of inspection of the mines of Ontario, made during the summer and autumn of 1898. Visits were made to all the larger mines in actual operation throughout the entire Province, both east and west. Incidentally a number of smaller mines and prospect workings were visited, but no effort was made to inspect all such properties, the limited time at my disposal precluding any attempt to do so.

After having visited the principal mines in Ontario I have been impressed with the very general desire on the part of mine managers to conform not only to the letter but to the spirit of the laws and the regulations of the Bureau of Mines, relating to matters affecting the health and safety of the miners. In seeking these *desiderata* the more progressive mine managers perceive that they are also achieving economy, which will make a favorable showing on their annual balance sheet. At a number of the larger and more progressive mines it was not uncommon to find local rules enforced which were far in excess of the legal requirements for safety, and it is evident that more stringent regulations in many matters would be welcomed, at least by a large portion of the mining community, since it would tend to the development of a larger body of skilled miners in the Province, which would inure to the benefit of all concerned. The lack of such a body of well-trained miners is a serious drawback to the mining industry in Ontario, and it so happens that the value of such skill is rather discredited among many local mine owners from the circumstance that inefficient stragglers from the camps of the West and South have drifted into the Province from time to time, assuming undue importance, and giving altogether a false impression as to the service which a really skilled miner is capable of rendering.

The status of Mining in Ontario.

The absence of any requirement as to the qualifications for mine foremen is a serious matter, and the growth of a proper *esprit de corps* among the miners, leading to their own improvement, is not to be anticipated until the mine foremen themselves are required to pass examinations and to show a suitable amount of practical experience, to entitle them to a certificate before assuming direction of underground operations.

Qualifications of Foremen.

The inexperience of the miners is shown perhaps most conspicuously in their misuse of dynamite, and their false setting of shots. I have rarely seen a hole drilled in any mine in the Province in such a position as to give the highest efficiency to the blast, and by inquiry I find that the consumption of dynamite per ton of ore extracted is excessive. In many cases powerful explosives are being employed where weaker, slower acting explosives would be far more effective in the practical work of winning ore.

The use of Explosives.

There is a very general tendency at the smaller properties to carelessness in regard to the storage, inspection and handling of dynamite, to thawing dynamite, and to the keeping of fulminates separate from blasting materials. The regulations of the Bureau of Mines might advantageously be revised in so far as they relate to explosives.

Although the steam and compressed air drills are very widely used, it is manifest that hand drilling is necessary in prospect work, upon which just now the future of the mining industry in Ontario

Skill in Hand Drilling.

chiefly depends. Whatever will tend to cheapen this kind of effort will lead to wider operations for the development of outcropping veins discovered by prospectors. Hence the training of miners in the proper use of blasting materials, and the setting of holes, and in the work of single-hand drilling, will render it possible to do far more, I think I might say 50 per cent more, development work than is now done with the same money. I am not aware of more than one mining camp in Ontario where single-hand drilling has been carried on to any extent, and there the interest of the miners has been awakened to such a degree that single-hand drilling matches constitute part of the amusements of the men.

Machinery v. Hand Work

There is still a noticeable tendency on the part of development companies to introduce steam hoists and air compressors, and their accompaniments, before the possibilities of handwork within limits of economy have been exhausted. This is to be deplored, for many a development company uses all its resources on a single vein without learning more than judiciously directed handwork would have revealed at far less cost, and so it ceases to operate, leaving a group of men who might have contributed strength to the mining industry more or less discouraged and disaffected, and consequently unwilling to venture anything again The work of development is necessarily experimental in large part up to a certain limit, but the work of the mining company after proper exploratory work has been done should be upon a sound basis, with the element of chance virtually eliminated. It is unfortunate that too many companies in Ontario are still inclined to start upon mere development work on a scale which indicates that they expect to continue mining permanently.

Hoisting Plant.

The use of kibbles sliding on skidways in inclined shafts is unfortunately very common, the practice apparently being due to false notions of economy. To shallow depths this procedure is not unwise, but in a large number of mines it is persisted in even after it has become the most costly form of hoisting that could be adopted. The danger of hoisting thus from considerable depths is sufficient to warrant its condemnation.

Timbering of Mines.

Fortunately the great majority of the mines of Ontario are in rock so sound that little timbering is required. Where it is used, however, a quite general misunderstanding of the methods of setting it to obtain the full strength of the material seems to prevail, in consequence of which frequent breakages and dislocations of timbers result, with their attendant evil effects upon the progress of mining operations.

In a few of the better conducted mines, on the other hand, the engineering is of an order not excelled in any mining camps in the world.

Iron Mines.

There was considerable activity in the production of iron ores, hematites and magnetites, during the year, occasioned by the demands of the Hamilton blast furnace. The localities where these ores were being mined were confined to the east, along the line of the Kingston and Pembroke Railway, and to the north of Madoc, between that town and El Dorado.

Bedford Mine.

Bedford Iron Mine

The Bedford iron mine lies near Zanesville P. O., about four miles east from Bedford station on the K. and P. Railway. A branch railroad extends up to the mines, the ore being hoisted at one operation from the mine to the cars in which it is shipped. The property belongs to the Kingston and Pembroke Mining Co., with offices in Kingston, but was being worked on contract by William Edgar of Sharbot Lake. The mine is situated on lot 3, second concession of Bedford, Frontenac county. Fifteen workmen were employed, with John Bragg as foreman in charge. The mine itself consisted of an open pit 27 by 25 feet, and 20 feet deep at the time of my visit on November 2, 1898. Hoisting was being done by a derrick and bucket, but a steam hoist and steam pump were just being installed. The ore is magnetite, and apparently of high grade, so far as iron content is concerned, and the results

of analyses were reported to be excellent. The dip of the deposit was very slight, being towards the S.S.E. The footwall was amphibole rock, and a thin layer of the same existed on the hanging wall side, which soon gave way to a highly metamorphosed limestone. Bunches of amphibole and some calcite occur also disseminated through the body of the ore. The vein is a continuation in a southwesterly direction of that which was once mined on a somewhat large scale at the Zanesville (formerly Glendower) mine. Other promising exposures of ore along the strike of the vein have been made for a distance of nearly half a mile southwest.

Robertsville Mine.

The only one of this group of iron mines at present being worked is that known as the Lizzie mine, situated 2½ miles from Clarendon, on a branch from the King-

Robertsville Iron Mine.

ston and Pembroke Railway, on lot 3, ninth concession of Palmerston, Frontenac county. It is owned by the Kingston and Pembroke Mining Co., and operated under lease to William Edgar of Sharbot Lake. The superintendent is David Riddle, with Robert Wilson and Robert Richardson as day and night foremen. Twenty-seven men are employed, 11 on the surface and 16 below ground.

The workings were confined to an open pit, which had once been the first level of the old mine, and had considerable underlie. It measured 85 feet by 24 feet, and was down 125 feet on the incline. Twelve feet above the bottom a drift extends west 67 feet, 11 by 7 feet in cross section, which is used for storage of timbers. There are two old drifts higher up, which are now abandoned. The old second level stopes of the mine were filled with water, but preparations were being made to pump them out. By means of a raft I was able to inspect the roof of the old stopes, which in part was unsound. Orders were given to break down the loose portions of the roof before undertaking to mine beneath it. The first level pit is kept unwatered by a Williams steam pump, 4-inch suction and 3-inch discharge. Hoisting is done on a skip-way, using a ¾-inch steel cable, wound on a 4-foot drum. The hoisting engine is duplex, with 8 by 18-inch cylinders.

Drilling in the mine was done with two Ingersoll-Sargeant drills, and one "Mac" drill, made by A. R. Williams & Co., all using steam. Attention was called to the danger of ice forming on the wall overhanging the pit, from condensing steam and from seepage, and suitable provision for safety to workmen was ordered to be made.

Six hundred feet east of the mine were located two powder magazines in close proximity to each other, one for the storage of quantities of dynamite up to 500 lb., and one for a single box for daily use, the latter being heated by a stove. It was ordered that the larger magazine be removed to a greater distance, and that thawing by direct radiated heat from the stove be discontinued.

The ore is magnetite, in many respects similar in occurrence to that in the Bedford mine.. The dip of the vein is about 35° S.S.W. Other outcrops are abundant in the vicinity, and some mining had been done on the Sheriff pit, a half mile E.N.E. of the Lizzie. My visit to these properties was made on November 4 and 5, 1898.

Cook Mine.

The location of the Cook mine is on lot 15, fifth concession of Madoc, 1½ mile south of El Dorado. The owners are A. W. Coe, of

Cook Iron Mine.

Madoc, Thomas Barnes, *et al.* The mine was being operated under contract by W. J. Comerford, George Duff and James Fox. At the time of my visit, July 28, the contractors were shipping 30 tons of ore per diem, and were employing 22 men in all capacities. The mine was an open pit, 30 feet deep and 25 feet in diameter. Hoisting was being done by a derrick and horse whim. Three pumps were being operated by power derived from a 45 h.p. boiler, two pumps having 3-inch discharge, and one having 2-inch discharge. Drilling was done by hand, charges being fired partly by fuse and partly by battery. Dynamite was properly stored in a magazine far removed from the mine. This mine has since been abandoned owing to the excessive influx of water. The ore is hematite, with a little magnetite and much calcite.

St. Charles Mine.

This mine is situated 2½ miles north of Madoc, and is owned by A. W. Coe. It is operated under contract by George Philipps and John Dunn. It is a new working, being only a pit 30 feet by 60 feet, and 30 feet deep. Hoisting is done by a derrick. The ore is a gray hematite. Men employed, 5. Date of visit, November, 11, 1898.

St Charles Iron Mine.

Welch Mine.

The Welch mine is situated 2¾ miles north of the St. Charles, within sight of it. It is also owned by A. W. Coe, and is operated under contract by John Badgely. The mine is an open pit, with some underlie, 15 feet by 100 feet, and 40 feet deep. The hanging wall was very insecure, and very little protection was afforded by six stulls, which were inadequate to sustain the load that might at any moment be thrown upon them. Instructions were given as to means for cheaply and efficiently sustaining the wall. Hoisting was done by derrick and horse power. Water was also hoisted by barrel in the same manner. Eleven men were employed above and below ground. Drilling was done by hand. Dynamite and black powder were stored in a shop, which was also used as a dressing room, about 150 feet from the mine. Dynamite was thawed by direct heat from a stove. Orders were given to provide a suitable magazine. and to thaw dynamite with a hot water thawer. The ore was a red hematite. Date of visit, November 11, 1898.

Welch Iron Mine

Miller Mine.

The Miller mine is on lot 12, sixth concession of Madoc, two miles south of El Dorado. It is owned by Mrs. Jane A. Wallbridge of Toronto, and is operated under contract by W. J. Comerford. At the time of my visit, November 11, 1898, work was being prosecuted in an open pit 34 feet deep. From the bottom of this pit the old Miller shaft extends 38 feet farther down, with a cross-section of 8 by 10 feet. This shaft was being opened up, and put into condition for operations during the winter. A pump and hoisting plant were about to be installed. Hoisting up to this time had been done by derrick and horse power. The force employed consisted of 13 miners and two surface men. Drilling was done by hand, and blasting by fuse and electricity, according to location. Dynamite was stored in a room adjacent to the blacksmith shop, about 400 feet from the mine, pending the construction of a magazine. Thawing of dynamite was done in a hot water thawer. The ores were red hematite.

Miller Iron Mine.

Lead Mines.

The indications for lead are quite promising in the vicinity of Bannockburn, and more or less prospecting for this metal has been done at various times. The veins are well defined, consisting of galena associated with a gangue of calcite. The galena is non-argentiferous, or practically so. Some years ago a Bleiberg lead furnace had been erected in Bannockburn, but I could not learn that any lead had been smelted in it. Only one mine had been opened up at the time of my visit, and this had hardly progressed further than a "prospect," some 20 tons of cobbed ore having been sacked ready for shipment to Belgium. The location of this mine is on lot A, sixth concession of Madoc, about three miles north of Bannockburn. The owners are Leopold Meyer of Angels Camp, California, and R. C. Van der Meulen of Aix-la-Chapelle, Belgium. The superintendent was G. R. Major, with William Prudhomme as foreman. Five miners were employed, and five boys were engaged as cobbers, their ages ranging from 12 to 15 years. The workings consisted of one large pit, 9 feet by 24 feet, and 15 feet deep, and several small pits and open cuts. Hoisting was being done by derrick in buckets. It was intended to sink a shaft from the bottom of the large pit, and to install a modern hoisting plant. Blasting was done by electricity. A powder magazine was located 500 feet from the pit. The vein was 30 inches wide, strike S. 40° E., dip as yet undetermined. The ore was galena with calcite, carrying small quantities of copper and iron pyrites. Date of visit, July 28, 1898

Galena with a gangue of Calcite

Hollandia Lead Mine

Zinc Mines.

In the vicinity of Chelmsford, Algoma, near Sudbury, are indications of zinc, which may prove to be of some importance. These occurrences seem to have some connection with the graphitic slates, associated with which are also found the deposits of anthraxolite, which have been discussed in former reports of the Bureau of Mines.

Ore in Graphitic Slate.

The location of this property is on lot 7, first concession of Balfour, Algoma, four miles southwest of Chelmsford. It is owned by George Bennett of Toronto, and was being developed on option by J. G. Mills of Chelmsford, and John Dobbie and Leonard J. Lawrence of Niagara Falls, New York. About 300 tons of ore had been extracted, said to show by assay 45 per cent. of zinc, 0.76 oz. of gold, and 9 oz of silver per ton. The workings consisted of a development shaft, 7 feet 8 inches by 9 feet 10 inches cross-section, and 98 feet deep, sloping 75° to the south. It was timbered by a collar with timbers laid "skin to skin" to a depth of 9 feet 9 inches. Below that the walls were sound enough to stand untimbered. Hoisting was done by kibbles on a skidway, with a horse-whim. Objection was made in this case, as in all others, to the use of kibbles on skidway in shafts of any considerable depth. Some minor recommendations were also made regarding platforms at the shaft mouth, and idlers for cable in the shaft. Dynamite was suitably stored at a distance from the shaft. A manway was provided with platforms every 40 feet. It was ordered that the manway should be partitioned off from the hoisting compartment. Date of visit, August 12, 1898.

Balfour Zinc Mine

Copper and Nickel Mines.

Prospecting for nickel and copper ores was active last year in the whole region from the Ottawa river to the Ste. Marie river, and while considerable development work was being carried on over a large area, the fact remains that most of the actual work was confined to the Sudbury region.

Copper Cliff Mine.

There has been no change in the shaft since the inspections of 1897. The shaft starts with an inclination of 43°, which at the third level is turned through an arc of 600 feet radius to an inclination of 77½°, which angle it maintains to the bottom The distances measured down the incline to the different levels are as follows:

Measurements of the Shaft

Surface to 3rd level	273 feet	0 inches.
5th "	374	0
6th "	430	3
7th "	483	10
8th "	576	10
9th "	648	10
10th "	718	10
11th "	783	10
Bottom of shaft	810	10

Hoisting is done at present only from the tenth and eleventh levels. All necessary precautions for safety in the shaft have been taken, except that the signal code was not posted below ground. This was ordered to be done. The old shaft on the 43° angle had been carried down to the seventh level. This is still kept open, and the manway is maintained in a suitable condition to serve as an alternative means of exit. The manway in the new shaft is also kept in excellent condition.

The stopes could not be remeasured without making rather elaborate preparations, and consuming much time. The dimensions according to the former Inspector and according to records in the office of the Company are given in parallel columns.

Stopes of the Mine

Stopes.	From Inspector's book.			From Office records.		
	Length.	Width.	Height.	Length	Width.	Height.
	feet.	feet.	feet	feet.	feet.	feet.
7th level	78	23	50	200	48	.. .
8th "	260	59	60	280	39½	... ..
9th "	123	50	.....	215	31	.....
10th "	200	25	60	144	27	.....
10th "	71	23	32	75	30	45

In the eleventh level stope the "back" or floor arch for the tenth level floor is intact. A winze from the bottom of this stope extends 40 feet downward, and from each end of the stope are drifts, one on a N.W. course 42 feet long, with cross-section 8 by 8 feet, and one on a S.E. course 100 feet long, with the same cross-section Diamond drill holes are carried ahead of the workings as the breasts advance.

The tenth level stope has been carried up to the eighth level through the removal of the intermediate "backs" or floor arches. The walls are nearly vertical, there being but a slight over-lie of the hanging wall. This wall has support from a buttress of rock or ore in place near the middle on the hanging wall side 18 feet thick by 30 feet high. No mining was being done on this level, but the accumulated ore from the broken-down floor arches was being removed. The old cross-cut from the shaft to what was formerly the ninth level stope has been closed by a gate.

The eighth level stope has also been carried up by breaking through floor arches to the third level, but does not constitute part of the stope from the third to the second levels. The floor arch on the eighth level is 40 feet thick, the span being 30 feet. Gates were ordered placed in the cross-cuts from the shaft to the eighth and seventh levels. An arch has been left spanning the stope about six feet below the floor line of the seventh level cross-cut, giving a support at this point for the hanging wall. This arch is 40 feet wide, 18 feet thick, and 30 feet long from wall to wall. A second arch exists about 30 feet S.-E. of this, and 30 feet lower down. Its dimensions are 40′ by 18′ by 25′. Scaling of the walls is done at frequent intervals to avoid rock-falls on the workmen below

The floor arch of the third level stope has been broken through into the lower stope at only one place. There is also a winze from the top of the stope which has been carried up to the surface.

The first level stope has been broken through the surface, so that it now constitutes in part an open pit. At the N.W. end of this pit a drift is being run towards an old prospect shaft 75 feet beyond. This is the only mining now in progress above the eleventh level.

The mine is kept well drained and clean. Only one day's supply of dynamite is kept underground. This is stored in a locked magazine in the old fifth level cross-cut, completely blocking the passage. It is warmed by a steam pipe from the old shaft. Explosives are lowered on the first skip down after the noon hour, before the miners return from dinner, being received by a man specially appointed for this purpose, who is the only person in the mine at the time. Ventilation is excellent, except in the upper part of the manway, which is heated by the air from the lower part of the old shaft in which steam pumps are set.

Condition of the Mine and Works

No changes have been made in the surface plant since the last inspection.

The roast yards are conducted as in the past. Warning notices of danger are conspicuously posted at all approaches, and signals are given by steam whistles before blasting and after all danger is over. Roasting is done on contract by D. L. McKinnon.

The only changes in the smelting plant consist in the erection of an extension eastward of the old furnace sheds to accommodate two new furnaces, making five in all. A new dust chamber and stack have been erected between the new furnace foundations, and also two new blowers with a 50 h. p. engine have been installed. The only advice given beyond that already mentioned was to submit to the Bureau of Mines plans drawn to scale of any proposed work affecting existing arches in stopes before undertaking their removal. Date of inspection, August 8, 1898.

Evans Mine.

The work done at this mine for the past year has consisted chiefly in the removal of floor arches and pillars down to the third level, thereby opening the stopes out to the surface as far down as that level. Stripping was progressing on the floor of the old third level at the time of my visit, and also on the west wall near the bottom. The lower stopes are full of water, so that nothing is known of their present condition. The shaft pillar has

been stripped on the north side next to the stope from a point 40 feet below the surface to the bottom of the third level stope. Hoisting is done in kibbles. At the upper end of the shaft within the remaining portion of the pillar there is a cross-head, working in guides, which serves to guide the kibble up into the shaft house.

A pit was being sunk about 40 feet S.E. from the shaft house, 25 feet in diameter, and 20 feet deep at the date of inspection. This was evidently endangering the shaft pillar, on which rested part of the foundations of the shaft house. Work at this point has been discontinued.

No changes have been made in the surface plant. The trestle from the shaft house to the dump needed repairing, which was done during my visit. It was required that shaft timbering should be carried further down so as to admit of extending the travel of the cross-head nearer to the point of loading the kibble, which was also immediately done. Signal codes were ordered to be posted below ground, and further work affecting floor arches, beyond that then in progress, to be done only after the approval by the Bureau of Mines of plans for so doing. Date of inspection, August 9, 1898.

McArthur Shaft No. 1.

The original shaft has been opened out, forming an open pit 103 feet deep, 70 feet long at the bottom, and eight feet wide. A surface "backing" or arch has been left 30 feet wide and 20 feet deep, to sustain the hanging wall. The dip of the vein averages about 80°. Hoisting is done by derrick and kibble, the cable passing over the rock house below to the winding engine house beyond. Ladders securely fastened to the footwall afford safe and easy passage for miners. One drill was working in the pit, driven by compressed air. Unwatering was done by bailing. A fence was ordered to be placed around the pit. Permanent mining at this point is not contemplated, a better location having been made 1000 feet S. E., where surface stripping has been done preparatory to regular mining. A tramway with three feet gauge and 25 lb. rails has been laid connecting the new location with the McArthur No. 1 rock house. The cars will be operated by cable from the winding engine house before mentioned. Date of inspection, August 9, 1898.

McArthur Shaft No. 2.

Work at this point is wholly new. The location is about 3,000 feet north of the old Copper Cliff shaft. Extensive preparations have been made here for permanent mining operations. The gossan has been stripped down to hard vein capping, and work on the new inclined shaft has begun. The shaft will be located within the country rock on the footwall side, the vein being reached by cross-cuts A rock house, designed similarly to those hitherto employed by the Canadian Copper Co., has been constructed 375 feet S. E. of the location of the shaft mouth, but on a much lower level so that the skipway above ground will incline only five feet in 100 feet to the dumping cradle at the head of a chute near the top of the rock house.

Preparations for permanent Mining.

The hoisting works are located at a still lower level beyond the rock house, and the cable will pass over a sheave on the upper framework of the rock house to reach the shaft. The installation of machinery in the hoisting works consists of two boilers, 100 h. p. each, and two winding drums, five feet in diameter, actuated by engines with 12″ by 15″ cylinders. There is also an air compressor, capable of supplying power for 14 drills.

A standard gauge railroad track has been laid from the roast yards to the rock house, 3,300 feet in length.

In addition to the indicators for showing the positions of the skips during hoisting and lowering, it was advised that a registering apparatus be provided to record the signals transmitted to the engineer, and also to use detaching hooks with the necessary appurtenances to prevent overwinding, and it was recommended that plans of proposed supports for walls in stopes be submitted in advance to the Bureau of Mines as soon as sufficient exploratory work had been done to permit of so doing. Date of inspection, August 8, 1898.

On September 26 a second inspection was made, by which time the new plant was in operation. Surface ore was being drawn to

the rock house, and the shaft was under way. One Blake crusher was in operation, and a second was being installed. A dry house for miners had been fitted up near the shaft, and a suitable magazine for explosives was being built near the base of the hill below the rock house. As an alternative for the detaching hooks it was suggested that an automatic apparatus for shutting off steam from the hoisting engines in hoisting, and putting on brakes to the drum, might be employed.

Stobie Mine.

Extent of operations at the Mine

The shaft has been extended downward on a 60 angle to a fourth level. The depth on the incline from the third to the fourth level is 65 feet; cross-section 7 by 17 feet. A double track for skips extends down to the second level, and the north track has been carried down into the lower level. The shaft lies wholly within country rock on the footwall side of the ore body, 20 feet distant, the several levels being reached by cross-cuts. The cross-cut to the fourth level is on a curve, general direction W. of N., length 23 feet. The fourth level opens out directly as a large stope, 51 feet long, 43 feet wide, and 60 feet high. The stope is worked on two benches, or steps, the upper step being 45 feet above the floor of the level The stope is being extended on ore toward the west and north. On the west side the ore face is being dressed at a point 20 feet from the cross-cut preparatory to leaving a pillar to support the hanging wall. An upraise, seven feet by eight feet, extends from the centre of the stope to the third level, being provided for ventilation.

The third level also opens out as a stope, 78 feet long, 80 feet wide, and 70 feet high. It is likewise worked on two benches, and has an upraise to the second level for air.

The dimensions of the second level stope remain practically as at the last inspection. The lower benches have been stripped back to win ore, and the upper bench has been worked back about 40 feet in a northerly direction, leaving a clean face which is to be cut around to form a pillar for the hanging wall. Access is had to this upper bench both from below and from above through an upraise to the surface, approximately 50 feet vertically. This was adjudged insecure and it was required that the upper part of the upraise must either be cribbed and access cut off, or else it must be timbered down to the stoping chamber and ladders provided at a suitable inclination for ease in ascent, having a guard rail on the side exposed to the open stope. Drainage and ventilation in the mine were excellent. No changes had been made in the surface plant. It was further advised that the signal code should be posted at all loading stages below-ground, and that pillars for hanging wall should have a diameter at bottom of not less than 25 feet and at top of not less than 18 feet. It was also advised that in all cases when the span of a floor arch exceeded 20 feet the minimum thickness of arch should be 12 feet, and in no case should a less thickness than six feet be adopted. Plans drawn to scale were required to be submitted to the Bureau of Mines for approval before stripping of "backs" or floor arches between levels 4 and 3, and 3 and 2 might be permitted. Other recommendations were made concerning blasting, indicators for engineer, and disengaging apparatus to prevent overwinding Date of inspection, August 6, 1898.

Instructions

The Canadian Copper Co. was overhauling the free library at Copper Cliff, and had nearly completed a large public hall for the miners, located near the McArthur No. 2 shaft, which was to be rented until its cost was recovered, when it was to be turned over to the town of Copper Cliff as a free hall.

Free Hall and Library

Kirkwood Mine.

This is a new mine, located on lot 8, third concession of Garson, District of Nipissing, about six miles N. E. of Sudbury in a straight line, and nine miles by road. The discovery was made by G. W. Jackson and Alex. Mennie, and development work on a somewhat large scale was being undertaken by T. N. Kirkwood of Sudbury, under option. The ore body consisted of pyrrhotite and chalcopyrite, carrying nickel, the appearance of the ore being

A property in Garson township

similar to that found in the other copper-nickel mines of the Sudbury region.

The work in progress consisted of three shafts. Shaft No. 1 was 20 feet deep, 12 by 9 feet in cross-section. It is timbered to a depth of 11 feet by hewn timbers set skin-to-skin. Cross-section inside timbers 8'-9" by 6'-9". Shaft walls below timbers well trimmed and sound. Hoisting was done with an iron-bound kibble and windlass, using 1½-inch hemp rope. Water is removed by bailing. Shaft No. 2 had a depth of 38 feet, cross section 13 by 8 ft. 7 in. Timbered to a depth of 11 feet same as shaft No. 1 Cross-section inside timbers 8 ft. 10 in. by 6 ft. Hoisting arrangements the same as at shaft No. 1. At shaft No. 3 sinking had just begun. Shaft No. 2 is 500 feet E.S.E. from No. 1, and No. 3 is 650 feet S.S.E. from No. 1.

The surfact plant consists of a blacksmith shop 100 feet S.W. from shaft No. 2; a magazine for explosives about 400 feet from both No. 1 and 2 shafts, and 300 feet from No. 3 shaft, well built and guarded against danger from bush fires; a rock house on the north side of shaft No. 2, modelled after those in use by the Canadian Copper Co. The dimensions of the rock house at the base are 28 by 28 feet over all, and 50 high to peak of the roof. The pit-head frame for the shaft was being built adjacent to but detached from the rock house. The construction was massive and strong throughout. In addition there was an office, miners' quarters, and stable, all of logs, about 700 feet distant from all workings. Better windlass supports at shaft No. 2 were required, and it was recommended that the pit-head frame be given a broader base than was contemplated, or else that it be framed into the structure of the rock house to insure greater stability. Date of inspection, August 11, 1898.

Grand Portage Mine.

This mine has for some time been an active producer, shipping its output to New York.

Copper property in Gould township.

It constitutes mineral Location No. 1, Gould township, district of Algoma, and is situated by the Grand Portage on the Mississaga river, 22 miles by road N.N.E. from Thessalon. The owner is J. A. Powers of Lansingburg, New York, and the operators were J. A. Powers, F. A. Cheney, et al., the latter being also the resident manager. The ore body consists of a vein carrying mainly chalcocite, with some bornite and chalcopyrite, associated with a quartz gangue. The cobbed ore shipped to New York is said to contain the proper proportions of FeO and SiO_2 to be self fluxing after roasting.

Mine workings.

The mine workings are as follows: A vertical shaft has been sunk 150 feet, cross section seven by nine feet, and six by eight feet inside timbers. Timbering is carried down as a collar to a depth of 18 feet. The walls below this point were sound and well trimmed. A manway was provided in proper form as to length and inclination of ladders, but was not partitioned off from the hoisting compartment. This deficiency was ordered to be made good.

The first level is at a depth of 100 feet, drifting N.W. and S.E. from the shaft; cross-section 6½ by 6½ feet; N.W. drift 100 feet long; S.E. drift 25 feet long.

The second level is at a depth of 150 feet from the shaft mouth. There is only one drift N.W., 75 feet long, cross-section 6½ by 6½ feet.

There is one overhand stope in the 100-foot level, N.W., beginning 43 feet from the shaft; length 44 feet, greatest height 18 feet above the level roof, the width averaging about seven feet. Stulls eight feet long and 18 inches in diameter support "deads" on the first step above the level. These were not properly set, so that breakages of stulls were not uncommon when shooting down the face of the advancing step or slice. Instructions were given as to means for overcoming the difficulty.

One winze had just been started under the middle of the stope downward from the 100-foot level.

Surface plant.

The surface plant consisted of the following: A shaft house, 18 by 24 feet on the foundations, and 48 feet high to the sheave pillow blocks. Height over all, 55 feet. A swinging trap-door closes the hoisting compartment before the kibble

can be dumped. Ore is dumped to a chute leading to a car outside.

The engine and winding drum are in a room adjacent to the shaft house. One 25 h.p. boiler and one 2-drill Rand air compressor are in the same room. The winding drum is 28 inches in diameter, with a $\frac{3}{8}$-inch steel cable. Adjoining the engine room is a machine shop. The office, quarters and stables are in a row by the river, beginning 400 feet from the shaft house. A trestle runs from the shaft house over the waste dump to a picking floor and store house 100 feet distant.

Pumping is done by two duplex steam pumps. The mine is comparatively dry, and the levels are well drained.

The main magazine for explosives is $1\frac{1}{2}$ mile distant. A small magazine, never containing more than 100 lb. dynamite, is located 500 feet from the shaft house. Explosives are sent below ground only when ready to charge holes for blasting. Blasts are set off by electricity from the surface.

The signal code in use was 1 bell, stop or hoist; 2 bells, lower; 3 bells, caution, run slow. This was required to be modified so that 1 bell should always mean stop. The signal code was also ordered to be posted up at all loading and landing stations. Date of inspection, August 15, 1898.

Bruce Mines.

A portion of this old group of copper mines, located in and adjacent to the town of Bruce Mines, has been drained for examination by Lord Douglas of Hawick. The old shafts thus opened to view were the Scott, Mitchell, Rowe and Grenville, owned by W. H. Plummer of Sault Sainte Marie, Ont. The shafts and stopes present almost without exception perfectly sound walls, and in that respect the mines are safe. Weakening of the walls after exposure to the air would, however, almost certainly occur. The timbers, which had been submerged for years, are in a good state of preservation, but here again rapid deterioration must be looked for. The mine stopes had been opened out to the surface, and stulls set across loaded with waste rock as a covering. These have rotted and are in an exceedingly dangerous condition. No fences have been erected around the shafts or open stopes, so that there is much danger from this source, which is enhanced by the fact that the region is a rather thickly populated one. This criticism applies not only to the shafts mentioned, but to all of the abandoned workings in this vicinity, which are numerous. Notification was sent to the owners of the properties to observe the mining law in this respect, but no reply has ever been received. The matter is one which merits attention.

Old Copper Workings unwatered

The Scott shaft has a depth of 225 feet; cross-section 10 by 16 feet. Three levels open S. E. and N. W. into old stopes of great height. The average width of stopes is about seven feet, ranging from four to 15 feet Two parallel lodes have been stoped, connected by cross-cuts, the second or Fire lode, lying about 30 feet S. W. of the main lode. The stopes are nearly vertical, the walls changing position so that no true foot or hanging walls are developed. The S. W. wall, however, for the most part assumes the hanging position. The shaft was sunk on the ore body, and the shaft pillars, if any ever existed, have been removed, except for an arch 20 feet wide and 20 feet deep on the N. W. side at the second level. A Worthington steam pump, 5-inch suction and 4-inch discharge, keeps the mine unwatered. The ladderway is fairly secure.

Scott Shaft

The Grenville shaft lies 300 feet S. E. of the Scott shaft. The old shaft is completely dismantled, so that access to the workings is obtained by a ladderway leading down directly through the stopes. The open stope is 70 feet long by 14 feet wide. It then extends beyond the shaft N. W. to the Scott stope, and is partly filled with débris. A branch W. N. W extends under a rock capping 12 feet thick for a distance of 80 feet. From this a shaft has been run S. E about 200 feet.

Grenville Shaft

The Mitchell shaft is located 300 feet N. W. of the Scott shaft. It has a depth of 190 feet, and on cross-section is 10 by 12 feet, with an inclination 85° toward the S. W. Originally there were four levels. The first level stope has been broken

Mitchell Shaft

through to the surface, so that only three levels are now recognized by the workmen. The stopes are continuous to the old third level, floors being on stulls, loaded with "deads." All main stopes extend S. E. from the shaft except for short prolongations in the opposite direction from the first and third levels. A floor arch has been left in place between the old third and fourth levels. The stopes are about 200 feet long by from four to 12 feet in width.

Rowe Shaft

The Rowe shaft is situated 500 feet N. W. of the Scott shaft. Depth, 235 feet; cross section eight by 10 feet. The timbers and ladderway in the old shaft are very unsafe. A new ladderway has been put in at the S. E. end of the stope, following very nearly the location of another old ladderway which is still used, though unsafe. The stopes are 200 feet long, and continuous from the surface downward. The walls are nearly vertical. A Worthington pump in the bottom keeps this portion of the mines unwatered.

Instructions

Instructions were given regarding the fencing of the workings, removal of dangerous timbering, and better provision for ingress and egress to the mines. Considering the character of the old workings, it was further required that before active mining might begin in them plans of proposed operations should be submitted to the mine inspector or to the Bureau of Mines for approval. Date of inspection, August 17, 1898.

Gold Mines.

The condition of Gold Mining

The condition of gold mining in Ontario is undoubtedly more promising than in the past. Development of veins is progressing steadily in all parts of the Province, both east and west. There is comparatively little excitement, and the period of "booming" seems to have been superseded by efforts undertaken on a sounder basis. A tendency is still observable here and there to install larger plants than the state of development of the veins would warrant, but the lavish expenditures on wholly undeveloped properties, which characterized a considerable part of the operations of previous years, are not being repeated to any great extent. In portions of the Province, particularly in the west, development is somewhat retarded on account of the high cost of supplies, and also by the circumstance that large quantities of water have to be raised after sinking a comparatively short distance, which materially increases the cost of exploratory work. A sufficient supply of skilled miners is also wanting, and this again imposes higher burdens of initial expense than should obtain, and undoubtedly serves as a deterrent to the opening up of new deposits.

Deloro Mine.

Extent of the Workings.

This mine, which is perhaps the most famous of all the gold mines of Ontario, is again being opened out on an extensive scale, after a period of inactivity. The new work in the mine has been as follows: Gatling shaft has been deepened to 192 feet. Tuttle shaft has been deepened to 122 feet. The Air shaft, 360 feet W. N. W. of Gatling shaft, has been carried down to 63 feet. Keswick shaft, 100 feet north of the old mill, has been sunk to a depth of 50 feet. Gatling level No. 2 south has been lengthened 131 feet, making 410 feet in all. Tuttle level No. 2 south has been driven 90 feet. The south level on the Open Cut vein has been driven 122 feet, and the north level on the same vein 88 feet. The north level on Air vein is 21 feet. Gatling cross-cut west has been lengthened from 90 feet to 250 feet; Gatling cross-cut east from 28 feet to 42 feet, and Tuttle cross-cut (new) is 40 feet. The drift known as "West Cross-cut Level," from Gatling level No. 2 north towards the old Red shaft (new) is 40 feet. The winze on the Gatling vein has been deepened from 18 to 65 feet, and the winze on the Tuttle vein from 10 to 21 feet.

Ore won

Ore has been won from stopes as follows: From first Tuttle stope north, 350 tons; from first Gatling stope south, 700 tons; from second Gatling stope south, 1,000 tons; from first Gatling stope north, 200 tons; from second Gatling stope north, 300 tons. Total since last inspection up to July 26, 1898, 2,550 tons.

Shaft pillars are maintained 18 feet wide on each side of the shafts, and a large "horse" remains as a pillar in the first Tuttle stope north. New timbering (stulls) has been set over the level in the second Gatling stope south, with heavy lagging above to sustain ore broken down in future stoping. In the second Gatling stope south the system of rock filling to sustain the hanging wall has been started, and is being well carried out under somewhat difficult conditions. The timbers throughout the mine are in good condition ; drainage is excellent, three pumps actuated by compressed air keeping the mine unwatered, and ventilation is unusually good.

Supports in the Mine.

One day's supply of explosives only is allowed underground, and this is kept securely locked and removed from all lines of traffic or places where active mining is going on. The operations underground are throughout conducted in a most admirable manner.

Explosive material

The head frame of the Gatling shaft has undergone complete reconstruction, arrangements being made to dump from the skip into bins which deliver ore to cars on a 3-rail incline which goes to the new mill.

Surface plant

The new mill is located 680 feet s. w. of the Gatling shaft, on a slight eminence. The ore is delivered at the top of the mill, and works by gravity through all stages of treatment. Ten stamps have been installed, and the tailings are to be treated by the bromocyanide process in a separate extraction plant, 60 by 38 feet, located 20 feet west of the mill. The boiler and engine house is located 40 feet north of the mill, and two 100 h.p. return tubular boilers had been installed at the date of my last visit. A new assay laboratory, admirably equipped in all details, had also been erected 30 feet west of the boiler house.

A new air compressor plant had been installed by the Canadian Rand Drill Co., the compressors (duplex) being 200 h.p. This plant is in a detached brick building, 50 by 75 feet, located 140 feet s. w. from the mouth of Tuttle shaft.

Improvements have also been made in the magazine for storage of explosives, rendering it safe. The General Superintendent is P. Kirkegaard. The total number of men employed above and below ground is 63.

A few recommendations affecting security in minor matters were made on my first visit, which had been attended to at the time of my second inspection. Dates of inspection, July 26 and November 11, 1898.

Belmont Mine.

The Belmont mine is located in the S. E. quarter of lot 21, and east half of lot 20 in Belmont township, Peterborough county. The owner is A. W. Carscallen of Marmora, and the operators under option are the Cordova Exploration Co., Limited, of Cordova, Spain. The general manager is D. G. Kerr. Total number of men employed in all capacities, 57.

The underground workings are carried on through three shafts, a fourth shaft being now abandoned. Shaft No. 1, on lot 20, near the road, 10 by 12 feet cross-section, has a depth of 135 feet ; inclination 75°. Hoisting is done by skip. Shaft No 2, 1,021 feet E. by N. of shaft No. 1, is 7 by 12 feet cross-section ; has a depth of 75 feet ; inclination 75°. Hoisting is done by kibble on a skidway. Shaft No. 3, 1,287 feet S. E. of shaft No. 1, is 8 by 10 feet cross section ; depth, 40 feet. It is abandoned, and securely boarded up. Shaft No. 4, 350 feet S. E. from shaft No. 2, is 10 feet by 12 feet cross section ; depth 32 feet, vertical. It is a mere prospect shaft. A fifth shaft for air has been sunk 230 feet east from shaft No. 2, 10 by 14 feet cross section ; depth, 14 feet.

Underground Workings

In shaft No. 1 the 75 foot level is driven east 45 feet, and west 33 feet ; the 120 foot level, east 80 feet and west 65 feet. The cross section is irregular, but averaging about six by seven feet. In shaft No. 2 the 35 foot level is driven east 230 feet and west 50 feet : the 70 foot level is east 75 feet and west 110 feet.

Levels

In shaft No. 1 the 75 foot level east is carried up to the surface ; the 75 foot level west is 20 feet long and 15 feet high. Stopes in the 120 foot level are just beginning. The walls are sound throughout. In shaft No. 2, 35 foot level east the stope is carried to the surface. The

Stopes.

walls are not sound. Lines of stulls have been set in the stope at two places 15 feet apart vertically, well lagged and loaded with waste rock. All has been done in a workmanlike manner and ample protection insured.

Surface plant

In shaft No. 1 the shaft house is substantially built. The hoisting engine is in full view of the shaft mouth. The sheave is 25 feet above the shaft mouth. There is an automatic dump for the skip, and the cable used in hoisting is three-quarter inch. The tramway from the shaft house to the mill is 264 feet long. Shaft No. 2 has a temporary head frame with a winding engine and boiler in an adjacent shed. Hoisting is by kibble on a skidway. In shaft No. 4 hoisting is by derrick. The old mill is now used as a blacksmith shop and storeroom The location is 57 feet S. E. of shaft No. 1. The new mill is 264 feet S. S. E. of shaft No. 1. The plant consists of a grizzley, Blake crusher, 9 inches by 15 inches, 10 stamps of 850 pounds each, one Frue vanner, six-foot belt, corrugated, one Frue vanner, four-foot belt, plain, and one gyrating vanner, six-foot belt, and three pointed settling boxes in a series for all tailings. Power is derived from a 40 h. p. engine and boiler in adjacent rooms. The tank house for water storage is 495 feet N. of shaft No. 1.

The assay office occupies a brick building 396 feet S. W. of shaft No. 1. The manager's office and quarters is 83 feet W. of the assay office.

State of the Mines.

Steam drills are employed in both mines No. 1 and 2. This is objectionable on account of the high temperature and dampness of the air, in spite of exhausting steam into sumps. Ventilation and drainage are well provided for. No powder is allowed underground until holes are ready for charging. The storage of explosives is in a well-appointed frame building 495 feet N. of shaft No. 1. Recommendations were made to case off manways, post up signal codes, prohibit workmen from ascending or descending the shafts in skips or kibbles, in addition to other matters of less importance. Dates of inspection, July 27 and November 12, 1898.

Diamond Mine.

On July 28 I visited the Diamond mine, on lot 14, in the tenth concession of Madoc. The property is being developed by D. E. K. Stuart of Madoc, under option from William Diamond. An inclined shaft had been sunk 27 feet, at an angle of 75° from the vertical. The cross-section of shaft is six by seven feet. Some trenching had also been done to show the outcrop of the vein.

Hammond Reef Mine.

Extent of the Workings.

The Hammond Reef mine is on locations 337 and 338X, east of Sawbill lake, and 35 miles south of Bonheur on the C. P. R. The owners are the Hammond Gold Reef Mining Co. of Toronto. The recent work by this Company consists of an open cut on the adjoining Folger-Hammond location (316X) 60 feet long by 20 feet wide, and varying from 10 to 20 feet deep. Stripping has also been done for about 200 feet across the outcrop, west of the preceding open cut. On location 338X, north of the mill, a new open cut has been started. Also a few hundred tons of ore have been taken out from the old open cut on location 337X. No underground work is in progress. The tramway from the open cut on location 337X has been removed, and a new tramway, one-fourth of a mile long, has been laid from the mill to the new open cut on location 316X. One steam drill is in operation at the Folger-Hammond open cut The stamp mill remains as at last inspection. The dam above the mill is completed, but the water proving unsuitable it is not used. Water is pumped to the mill from Sawbill lake by a No. 6 Cameron steam pump. It was recommended that the dam above the mill be opened, as in its present condition it would endanger the engine and boiler house at the mill in case of heavy floods. Date of inspection, August 29, 1898.

Sawbill Mine.

Work resumed under new Management.

This mine was idle at the time of my visit, but a new management was just taking charge of the plant. The new operators are a Toronto syndicate, with Archie Hutchinson, Arthur Harvey and F. McPhillips, all of Toro to,

as the executive committee, with J. P. Williams as manager. The only new work done since last inspection was in the main shaft. In the first level the north drift has been lengthened to 182 feet, and in the second level the south drift has been carried to a length of 132 feet.

The stopes are as follows: First level, north, length 91 feet, height above level of the floor 33 feet. width four feet (average). First level south, length 60 feet, height 25 feet, width from four to eight feet. Second level north, length 50 feet, height 14 feet, width three to four feet. Second level south, length 88 feet, height 20 feet, width four feet. At a distance of 66 feet from the shaft in the second level stope north, a raise has been carried up 35 feet. All other underground work is unchanged.

Measurements

Instructions were given to case off the manway in a suitable manner, and to put in platforms in the manway at intervals of 30 feet. Also it was required to post up a signal code at all loading and landing stages, and that further sinking in the shaft without proper skip and skipway must not be done without special permission from the Bureau of Mines. Date of inspection, August 29, 1898.

Instructions.

Roy Mine.

This property, which is in process of development, is situated on locations 298 and 299AL, on Lequerre lake, 2½ miles from Reserve bay. The owners are James Hammond, Napoleon Roy, Jerry Savard, and Adolphe Lequerre, and the operators under option are Mrs. G. A. Sweny, together with the before-mentioned owners. The manager is Roy Sweny. The force employed consists of 13 men. The workings comprise an inclined shaft (85°) 81 feet deep, eight feet square in cross section inside the timbers, and two test pits each 15 feet deep, one being 200 feet east and the other 200 feet west of the shaft. Hoisting is being done by a steam hoist with a ⅝-inch wire cable, wound on a 20-inch drum. Kibbles and skidway are used. Date of inspection, August 30, 1898.

Location AL283.

This is a prospect being developed by what is locally known as the "Railroad Co." It is on location 283AL, about 2½ miles from the Roy mine. The shaft has been sunk 75 feet on a 45° incline. Hoisting is done by hand windlass. Eleven men are employed above and below ground. Date of inspection, August 30, 1898.

Tabor Mine.

This property is in the New Klondike region, on location 258SV, about 25 miles S. S. E. from Wabigoon. The owners are James Tabor, *et al.*, and the operators on option are the Eastern Townships Mining and Development Co., of Sherbrooke, Que. A shaft has been sunk 60 feet on an 80° incline; cross-section inside timbers five feet by eight feet. Hoisting is done by hand windlass. Some stripping on the surface has also been done. The manager in charge is H. B. Aylmer. Date of inspection, September 2, 1898.

Lecation 419HW.

This property is in process of development by the Northwestern Ontario Exploration Co., of 16 Eldon street, London, E.C. It is on location 419HW. The shaft is 100 feet deep, well timbered, vertical. Hoisting is done by steam, with kibble. The manager is S. F. Franc. Date of inspection, September 3, 1898.

Other properties in the New Klondike group which were idle at the time of my visit are the Hale and Lowrey and the Monroe and Kirk mines. Some stripping is being done on the latter (location 416HW), and operations will be recommenced here shortly.

Triumph Mine.

This property lies eight miles S.E. of Rat Portage, and was on the point of being abandoned at the time of inspection. The shaft had been sunk 100 feet, and drifts had been run east and west about 40 feet on the vein. A steam hoist with 24-inch drum and ¾-inch cable was employed. The work had been well done in all details, and the mine was in good condition as to drainage and ventilation. A tendency of the roof in

the drifts to scale was observed, and caution was urged against danger from roof-falls. Date of inspection, August 7, 1898.

Regina Mine.

The staff remained the same as at the last inspection, and 24 miners and 28 surface men were employed. Sinking in the shaft had been discontinued at a depth of 434 feet. The manway is suitably cased off, and provided with platforms and ladders in conformity with the requirements of the Mines Act.

Record of new Work.

The new work consists of the following: Fourth level, north drift 75 feet, south drift, 254 feet; fifth level, north drift, 48 feet, south drift, 178 feet; sixth level, north drift 230 feet, south drift 216 feet; seventh level, north drift 38 feet, south drift 50 feet. A cross-cut in the sixth level, north drift, 145 feet from the shaft, runs 31 feet east, and a cross-cut in the second level, 387 feet from the shaft, runs 13 feet west. In the seventh level, on the east side of the shaft, a chamber has been cut for the pump. At the end of the third level south drift an upraise is carried 60 feet on an incline of 45° to the south, and then vertically 15 feet, connecting with the second level 300 feet from the shaft. Overhand stoping is also being carried on in the south drifts on the fourth, fifth and sixth levels. Very little timbering is required in this mine, and such as is employed is well set. Drainage and ventilation are both satisfactory.

Machinery and the Mill.

Six drills are used underground, being supplied with compressed air from a new 10-drill air compressor put in by the James Cooper Manufacturing Co. of Montreal. A new head frame has been erected over the shaft and a new hoisting engine house has been built adjoining the shaft house. The mill has been radically remodelled and new machinery installed, as follows: One Gates' gyratory crusher, No. 3; one conveyor belt 18 inches wide, carrying ore from the crusher 40 feet to the ore bin, the latter having a storage capacity of 200 tons; seven 2-stamp Tremaine mills, with step-lips and apron plates for amalgamation; two 3-compartment Hartz jigs, size of screens two feet eight inches by one foot four inches, 350 strokes a minute, length of stroke decreasing from ¼-inch in the first compartment to ⅛-inch in the third compartment; two Berdan pans for grinding concentrates, diameter four feet, weight of drag 270lb; six gyrating amalgamating tables, four feet by eight feet; four cyanide leach vats, six feet deep by 13 feet diameter; four solution vats; two new 125 h.p. boilers; two engines, 7-inch by 10-inch cylinders, and 250 revolutions per minute, and one extra engine for emergencies. A new dock has also been constructed on the lake front west of the mill.

Instructions.

Instructions were given to keep all dynamite underground under lock and key, and not to continue sinking in the present shaft without authorization from the Bureau of Mines to do so with the present method of hoisting.

Sultana Mine.

The staff at this mine consisted of M. T. Hunter, superintendent, Albert Johnson, mine captain, James Gale, mill foreman, and C. Garnett Rothwell, chlorinator.

Record of new Work.

The new work done underground since the last inspection is the following: Third level, south drift, stope carried up to the second level; second level south stope working toward the shaft; at a distance of 18 feet below the second level in the S.E. wall of the south drift stope, a chamber had been cut for a diamond drill, and cross-cutting is about to be commenced to run from this point to a new ore body discovered by the diamond drill. In the fifth level, south drift, the stope has been carried to within 18 feet of the fourth level. The direction of the level has changed to the west, and at the angle an arch 30 feet thick and 12 feet wide has been left to sustain the hanging wall. In the sixth level (63 feet below the fifth) drifts have been extended north and south. A sinking pump in the sixth level, a pump in the fifth level and a new Northey pump, 5-inch suction and 4-inch discharge, in the fourth level, south drift, 30 feet from the shaft, serve to keep the mine unwatered. Drainage and ventilation are very satisfactory.

Dynamite is kept in the fourth and fifth levels under conditions of insecurity which led to the requirement that explosives should be kept in lockers, and at a distance of at least 25 feet from lines of traffic.

Instructions

The surface plant remains unchanged. Additional advice and recommendations given were to post up a signal code at all levels below ground where work is in progress ; to prohibit persons from riding up and down the shaft in the skip except in emergency cases ; to shut off the second level S. W. drift, and to introduce some form of detaching hook to prevent overwinding in hoisting, or else that some equivalent safety device be used. Date of inspection, September 8, 1898.

Mikado Mine.

This mine was under the superintendence of Theodore Breidenbach, since resigned, with H. Patterson as assistant superintendent.

No. 1 shaft, depth 240 feet. The manway is not properly cased off below the 120-foot level. The first level is unchanged since last inspection. The second level, north drift, is unchanged ; south drift 310½ feet. The third level (240 feet down) is cross-cut 11 feet east. The stope on the second level south, overhand, No. 1, is 110 feet S. from the end of the crosscut, length 150 feet, height 35 feet, width seven feet on an average. No. 2 stope is 180 feet south, length 50 feet, height 25 feet, width three to 12 feet. No. 2 shaft has a depth of 180 feet. In No. 1 level the south drift is 130 feet, and the north drift 140 feet. No. 2, at the bottom of the shaft, south drift, 31½ feet, north drift 36 feet.

Measurement of Workings

Stopes, first level, north drift, overhand, 25 feet from the shaft, length 60 feet, height 24 feet, width five feet. Ventilation is good and the drainage fair. Explosives are not stored underground, a supply being sent below only when ready for charging holes. The magazine is one-fourth mile from the shafts.

Hoisting in No. 1 shaft is by kibble in the south compartment to the 240-foot level ; by cage in the north compartment to the 120-foot level ; in No. 2 shaft a kibble is used with a 5-pole skidway,

The dressing rooms of No. 1 shaft are well appointed. No. 2 shaft dressing room is in the engine house. Excavations are being made for the foundations of a cyanide plant which was to be installed promptly.

Advice and recommendations were given to post up a signal code at all levels where work is going on in both shafts, and at the shaft mouth ; to fence off the north drift of the 120-foot level, No. 1 shaft, to prevent access of miners thereto ; to hoist by skip instead of kibble if sinking is continued in No. 2 shaft below the 180-foot level ; to provide better facilities as to ladders and platforms in the manway of shaft No. 2 within six months ; to inspect the timbers in No. 1 shaft above the 120-foot level to guard against danger from that source ; and to case off the manway in No. 1 shaft below the 120-foot level. Date of inspection, September 21, 1898.

Cameron Mine.

This is a property in process of development on locations 170 and 172S, both being islands in Shoal lake, an arm of the Lake of the Woods. The mining operations are being conducted on 170S, this island containing about nine acres. The owners are the Cameron Islands Mining and Development Co., Limited, with its head office at 71 Victoria street, Toronto. The president of the company is O. E. Foster, of Buffalo, N Y., and the manager is H. B. Hunt.

The underground work consists of a shaft, 75° incline to the east, 120 feet deep, cross section 12 feet by 7 feet. A properly appointed manway is provided to within 30 feet of the bottom, and hoisting is done by kibbles on a double skidway extending to within 20 feet of the bottom. The shaft is collared 20 feet by well-set timbers, and this collar is carried up four feet above the surface. No. 1 level is 62 feet below the surface ; north drift 38 feet, with a cross-cut west 14 feet long, slanting 20 feet from the shaft ; south drift 42 feet long. Two small shafts have also been sunk, called No. 2 and No. 3. Shaft No. 2 is located 250 feet south of

Measurements

the main shaft on the same vein; depth 10 feet. No. 3 shaft is on No. 4 vein on the west side of the island; depth 10 feet. No. 1 open cut on No. 1 vein, length 20 feet, width three feet, depth three feet. No 2, on No. 2 vein, length 30 feet, width three feet, depth three feet. A tunnel on the east side of the island has a length of 66 feet, direction west.

Drainage in the main shaft is excellent, but the ventilation is poor. Work had been suspended until an air compressor plant could be installed, which would supply needed air as exhaust from the drills.

Surface plant

The surface plant consisted of the following: A well constructed pit-head frame, with sheave 29 feet above the surface; an engine and boiler house adjacent to the head frame, with a 15 h.p. duplex hoist, 16-inch drum, winding a $\frac{5}{8}$-inch wire cable; a tramway 40 feet long from the shaft house to the dump; blacksmith shop, office and quarters for miners; and a wharf on the east side of the island with 30 feet frontage. Changes were suggested in the signal code to avoid misinterpretation of signals, and it was required that the signal code should be posted up in the engine room, at the shaft mouth, and at all loading stages below ground. It was also pointed out that while hoisting by kibbles on skidway is not inadmissable while prospecting, it would not be permitted when permanent mining operations had been begun. Date of inspection, September 20, 1898.

Emperor Mine.

The Emperor mine is in process of development Its location is three miles north of Mine Centre, between Shoal and Bad Vermilion lakes. It is owned by the Standard Gold Mining and Development Co. of Minneapolis, Minn. The manager is J. C. Beebe. A vertical shaft has been sunk 125$\frac{1}{2}$ feet. The first level has been run out at a depth of 75 feet, the north drift being 29 feet long, and the south drift 43 feet long. A cross-cut has been driven 41 feet southwest from the south drift, beginning 16 feet from the shaft. The manway has been carried down in proper form to the first level. Unwatering is accomplished by hoisting in buckets. Ventilation is satisfactory. Hoisting is done by kibble, using a $\frac{5}{8}$-inch wire cable wound on an 18-inch drum of a duplex hoist. Power is supplied by a 30 h.p. upright boiler. Storage and handling of explosives are done in a proper manner. It was required that the signal code should be posted below ground, and that men should not be hoisted or lowered in the kibble. Date of inspection, September 12, 1898.

Golden Star Mine.

This property is situated 4$\frac{1}{2}$ miles N.E. of Mine Centre, near the shore of Bad Vermilion lake, on locations 114 and 116AL. The surface rights of the location 41JO adjoining have also been leased for a site for a stamp mill. The owners are the Golden Star Mining and Exploration Co. of Ontario, Limited, with head office at Duluth, Minn. The president is A. C. Hubbell, and the superintendent is R. A. Kerr.

Measurement of Workings

The shaft is 318$\frac{1}{2}$ feet deep, with a manway cased off to the fourth level. The new work since last inspection consists of the following: Third level, north drift, extended to 110 feet. Fourth level, at a depth of 400 feet; south drift 22$\frac{1}{2}$ feet; north drift 22 feet. All drifts are seven feet high, varying in width from four to 15 feet. A cross-cut has been run 12 feet east from the third level north, beginning 60 feet from the shaft, and another 90 feet from the shaft, five feet west. An upraise has been driven 15 feet in the third level north to connect with a winze above.

Surface Plant and Mill

The additions to the surface plant are a 6-drill Rand air compressor, being set in the new mill, the compressed air to be conducted to the mine through 3,000 feet of 5-inch pipe. The new stamp mill contains the following rooms: battery room 37$\frac{1}{2}$′ by 43′ 8″, vanner room 37$\frac{1}{2}$′ by 40′4,″ engine and compressor room 37$\frac{1}{2}$′ by 36,′ boiler room 30′ by 40′. The plant consists of a No. D Comet crusher, two batteries of 1020 lb. stamps, with Challenge ore feeders, the mortars set on cast iron mortar blocks weigh 14,000 lb. each, two Browne's sizers for pulp, four Frue vanners with 6-foot plain belts, one Corliss engine, 12″ by 36″ cylinder, 96 revolutions, and one 80 h.p. return tubular boiler.

An Otto aerial tramway, 2,700 feet long, will carry the ore to the mill, the carrier cable for loaded buckets being 1⅛-inch diameter, and that for empties being ⅞-inch diameter, and the traction cable ⅝-inch diameter. Fourteen buckets will be used, each having a capacity of 600 lb. The power will be supplied at the mill.

An assay office, manager's office and new boarding camp have also been constructed.

Instructions

The requirements made were to post up signal code at landing and loading stations below ground, to scale the roof in all working drifts and cross-cuts, to make some repairs to the manway, to place a guard rail on the north side of the platform at the winze in the second level, and to install a skipway to replace the existing kibble and skidway, hoisting by kibble to cease on or before January 15, 1899. Date of inspection, September 14, 1898.

Olive Mine.

The Olive mine is situated on the south shore of Little Turtle lake, lower Seine river, on locations 60, 61, and 69G, and 439P, 8½ miles N. E. of Mine Center. The owners are The Olive Gold Co. of Seine River, Limited, with its head office in Winnipeg. The president is Hon. George E. Foster, and the superintendent is W. A. Preston.

Measurements.

The new work in the mine since the last inspection consists of 36 feet of drifting east on the second level. Stoping has also progressed in the first level east, 13 feet from the shaft. Length of stope 78 feet, maximum height 28 feet width averaging three feet. Barren rock is being filled into the stope to permit of safely opening it out to the surface. A steam jet ventilator is used, and drainage is effected by a self-filling bail. A pump is about to be set in a chamber near the shaft on the second level. The management of explosives is excellent.

Requirements

Hoisting is done by kibble on skidway, using a ⅝-inch wire cable wound on the 24-inch drum of a 16 h.p. duplex hoist. No changes have been made since the last inspection in the surface plant. It was required that the signal code must be posted in the engine room, at the shaft mouth, and at all loading stations below ground; that filling in of waste rock must be rigidly adhered to if the cap rock over the upper stopes is to be removed, and that further sinking in the shaft must not be done without installing a skip and skipway without special permission from the Bureau of Mines. Date of inspection, September 15, 1898.

Alice A. Mine.

This property is on the Little Turtle river, about nine miles from its mouth. It is owned by the American and Canadian Gold Mining Co. of West Superior, Wisconsin. The president is J. S. Hillyer, and the superintendent George L. Robbins. The workings consist of shaft No. 1, 46 feet deep, with a cross-cut north 30 feet at a depth of 40 feet, and shaft No. 2, 200 feet east of No. 1, 70 feet deep, with a cross-cut at a depth of 60 feet running 19 feet south. The property was not in operation at the time of my visit. A mill consisting of two 2-stamp Tremaine mills had been ordered. Date of inspection, September 16, 1898.

Independence Mine.

The Independence mine is on the south half of lot 11, third concession, and fractional parts of lots 11 and 12, second concession of Bennett township, 3¾ miles from Seine river, 18 miles above Shoal lake. The owners are the Independence Mining and Development Co. Limited, of Sparta, Wisconsin. The president is T. O. Thorbus, and the manager, A. N. Rice. The shaft on lot 11 in the third concession is 75 feet deep, but has been abandoned. A new shaft is about to be started. A log-railroad serves as a tramway for bringing ore to the mill, one mile distant. A 5-stamp mill was in operation on the shore of a small lake by the mining camp. The additional plant consisted of a six-foot Gates vanner, a vertical 20 h.p. boiler and 15 h.p. engine. Date of inspection, September 13, 1898.

Burley Mine.

Description of the Works

This property was being operated under the superintedence of R. H. Flaherty. At the time of my visit the rock in the lake bottom had just been entered, and a seal against the lake waters had been effected. A coffer dam had been

constructed and forced down inside the former crib, and flat timber had been driven from the inside into the outlying silt around the bottom of the coffer dam, thus filling up the spaces between the lower edge of the coffer dam and the unequal surface of the rock. The silt having been pumped out, sinking was carried on to a depth of 17½ feet below the coffer dam, being 12 feet below the lake bottom on the lower side of the sloping rock. A cement wall was then carried up from this depth to a height of 36 inches above the rock, from which point a clay puddle wall was to be continued to the top of the crib. The cement wall was 36 inches thick, and effected a perfect seal against an influx of water. The shaft as planned was to be six by 12 feet inside timbers. The work was being conducted with great skill, and was apparently secure in all respects. Date of inspection, September 9, 1898.

Silver Mines.

After having been closed down for several years, work was resumed on several of the silver properties in the Lake Superior region last year, but only one was an actual producer at the time of my visit. At the East End Silver Mountain ore previously extracted was being milled in a battery of two Tremaine stamps, but the mine itself was closed.

West End Silver Mountain Mine.

This mine is on locations 55, 56 and 57 R, 40 miles w.s.w. from Port Arthur and one mile from the Silver Mountain station on the P. A. D. & W.R. It is owned by the West End Mining Co. of St. Paul, Minn., and is operated by the West End Mines Syndicate, of Silver Mountain, with Herbert Shear as manager.

The underground workings are the following: Shaft No. 1, said to be 150 feet deep; partly filled with water, and unused.

Underground Workings

Shaft No. 2 is located 540 feet east of No. 1, and inclines 80° toward the north. The depth is reported to be 150 feet. Below the third level it is filled with water. Shaft No. 3 (miscalled a shaft) is a winze in the old adit level. Shaft No. 4, located 800 feet east of shaft No. 2, has been abandoned and little is known of its condition below ground. In shaft No. 2 the first level is 35 feet from the surface; east drift 105 feet; west drift 127 feet. The second level is 60 feet from the surface; east drift 30 feet; west drift 212 feet. The third level is 90 feet from the surface; east drift 200 feet; west drift 380 feet. All underground haulage is done in this level.

Winzes connect the first and second levels west of shaft No. 2; there are similar connections from the end of the third level west to the drift from shaft No. 1; and in the end of the adit in the gulch east of main workings there is a winze 14 feet deep (known as shaft No. 3.)

Adit No. 1 is driven from the south side of No. 2 shaft north to the first level east. No. 2 on the north side of the gulch is 450 feet east of No. 2 shaft, extending north, cross-cutting a series of parallel veins, length 90 feet.

In the second level west, overhand stoping has been begun. In the third level west are three stopes: (*a*) 54 feet long, five feet wide, and for 14 feet of its length it has been opened through into the second level; the remainder of the stope is eight feet high above the stulls. (*b*) 40 feet long, five feet wide, 20 feet high. (*c*) 30 feet long, five feet wide, 18 feet high.

The shaft timbering is secure. The collar is 18 feet deep, planked up inside; the stulls are sound and fairly well set; and the ore chutes are well cribbed up.

Drainage is effected by a No. 5 Cameron steam pump. Ventilation is adequate for present workings. Storage and care of explosives are satisfactory.

Hoisting is done by kibble on an inclined plane made of 6″ by 6″ timbers laid skin to skin on the footwall of the shaft.

Machinery.

The hoisting engine is a 10 h.p. 28-inch drum, single cylinder, and an indicator shows the position of the kibble in hoisting. Steam is derived from a 20 h.p. vertical boiler. A new stamp mill is in process of erection. The plant consists of a Blake crusher, 7″ by 10″ jaws, two batteries of 950 lb. stamps, two Challenge ore feeders, four compartment Browne's hydraulic sizer, three Frue vanners, six-foot belts, one Conway automatic cut-off engine 150 h p., and one 60 h p. return tubular boiler.

A trestle tramway from the mine to the mill, with extension to the dump, aggregates 250 feet in length.

The requirements made were to post up the signal code at all loading stages below ground, to use an additional mark on the cable to show the position of the kibble in hoisting, and to install a skipway and skip if work is continued in the shaft below the present third level. Date of inspection, August 24, 1898

Instructions

Quarries.

Building stone is taken out in various parts of the Province and some of the quarries are extensive, but for lack of time I was only enabled to visit those in Hastings county, north of Belleville.

Crookston and Point Ann Quarries.

These quarries are being operated in Trenton limestone at Crookston, having connection with both the C.P.R. and the G.T.R. The superintendent is H. Quinlan. One hundred men are employed, of whom 35 are quarrymen, 45 stone-cutters, and 20 miscellaneous laborers Six 10-ton derricks are set up, four being in constant use, each derrick having a 70-foot mast and 60-foot boom. There is also one steam derrick of modern type, with three drums, one for hoisting, one for handling the boom, one for swinging the derrick. Two steam drills are employed in addition to hand drilling, A well constructed powder magazine is located one-eighth of a mile from the quarry. The maximum quantity of powder stored at any one time is ten 25-lb. kegs. The drainage and general arrangements of the quarry are excellent.

Gibson's Quarry.

This is adjacent to the Crookston and Point Ann quarry, and has connection with the G.T.R. The superintendent is Patrick Varley. About 84 men are employed, of whom 12 are quarry-men and 60 stone-cutters. Two derricks with 87-foot masts and 75 foot booms, and two with 75-foot masts and 70 foot booms are now in place, and three steam hoists, 24 h.p. each, are being installed. The quarry is worked in four benches, and is well laid out and operated in all details. The powder magazine is a secure building of stone, but is defective in the matter of ventilation, and is also rather dangerously near the dwellings of the workmen. Attention was called to the need of ventilation in warm weather, and to the impropriety of keeping fulminates in the same building with the blasting powder. Three steam drills are in operation in this quarry.

MINES OF NORTHWESTERN ONTARIO

By James A Bow, Inspector

Introduction.

I HAVE the honor to submit herewith my annual report for 1898.

Three trips were made over Western Ontario, during each of which all working mines and most of the properties under development were visited, besides a number of prospects upon which little or no work had been done. The first trip was commenced in the latter part of May. I was accompanied to a large extent by Mr. J. W. Bain, of the School of Practical Science, who was holding prospectors' classes at several of the more important points in the district, besides giving lectures at some of the principal mines. The second tour began on August 20. This was made in company with Prof. Courtenay DeKalb, Inspector of Mines for Eastern Ontario, who made one trip over the whole Province. The final tour was commenced in November, and trips to the various mines were made at convenient opportunities, the work of preparing my annual report being proceeded with during the intervals of my stay at Rat Portage. Usually from six to eight weeks is required to make a complete tour.

Inspections during the Year

Nearly all travelling can now be done by railway, steamboat or stage, although the canoe has yet to be resorted to in a number of cases. The steamboat service is a conspicuous feature of the larger lakes of the district, owing its existence, of course, to a large extent to the mining industry, and being, on the other hand, essential to the latter. There are said to be over sixty steamers of all sizes on Lake of the Woods, having headquarters at Rat Portage. Many of these are owned by mining companies, and others are supported by trade with the mines. A considerable volume of trade is carried by steamers from various points of railway connection, such as Rat Portage and Wabigoon on the C.P.R. and Tower, Minn., on the D. and I. R., to Mine Centre, the headquarters of the Lower Seine river mining industry, forecasting the inevitable impetus which this part of the district (as well as the country all along the route) will receive upon the completion of the Ontario and Rainy River Railway, now under construction. Even for pleasure parties the accommodations from Rat Portage to Mine Centre are very good, and the trip is a delightful one. A steamboat line, with two portages, has been established between Wabigoon and Mine Centre, *via* the Manitou lakes, communicating with all points on the latter where properties are under development. In the winter time all important points at any distance from the railway are reached by stage. Most of the mines of course have their own teams. The only advisable way of travelling to Mine Centre in the winter time is *via* Tower, Minn., from which point it is connected by a stage line, the trip being made in two days, and a stage leaving both ends of the line three times a week. An effort was made to run a regular stage from Wabigoon, but this was given up, although it may be done next winter. Considerable judgment has been exercised in the cutting of Government roads during the year for mining purposes; these have been made just where needed, and have been of great service to those to whose properties they facilitated access. Regular stages run where business demands, with suitable stopping places for travellers.

Modes of travel to the Mines.

Western Ontario has been within the last year suffering to a certain extent a relapse from the mild boom which existed during 1897; but, as the boom was not very extravagant, neither is the relapse very disastrous. And the present

State of the Mining Industry

after all a much more healthful condition of affairs for the laying of the foundation of a large and permanent mining industry, to which this district can, judging by the present rate of progress, look forward to in the not very distant future. Although the history of mining here is scattered over nearly twenty years, the bulk of the industry has grown up within the last two or three years, chiefly under the impetus of the boom of two years ago. But one of the injurious offsets to the benefits of the boom was that all properties were held at such extravagantly high figures that much desirable capital was kept out of the country, owing to the inability of investors to make reasonable terms with property holders; the latter have come to realize their mistake in this respect, but too late to retrieve past opportunities. Another unfortunate circumstance is that many valuable properties are in the hands of parties who have neither the means to develop them properly themselves, nor will accept reasonable terms from those who have; but this seems to be an unavoidable condition of affairs. And lastly, it is a regrettable occurrence for such a comparatively young mining country as ours that large amounts of capital from good sources have been expended in developing and prospecting properties which have not turned out satisfactorily; this, along with the other foregoing facts, resulting in more than one representative of capital having withdrawn from the field altogether. Nevertheless there is plenty of vigor left in our mining industry, which is expanding slowly, but sufficiently fast for those whose interests are locked up in the future welfare of the place. We have now three mines with shafts over 400 feet in depth, one other nearly 400 feet, and three others over 200 feet, besides several between 100 and 200 feet, all working except one. The above does not of course include the many other properties where work is in various stages of progress, two of which have mills working on large deposits which will not require underground development. Since last year the following additional stamps have been put in: In the Lower Seine, 25 gravity stamps, and one Tremaine battery of two stamps; on Lake of the Woods, six Tremaine batteries of two stamps each; in the Manitou, one Tremaine battery of two stamps; in the silver district, west of Port Arthur, 10 gravity stamps. The silver mining industry seems to be reviving again at a fair rate. The West End mine is mining, milling and shipping continuously. The Rabbit Mountain mine has lately been acquired by a new company, and sinking in the shaft has commenced. I am also informed that two others of the old mines have been opened again.

Mines on Lake of the Woods.

A geographical classification is most convenient in giving a description of mines, and I begin with those on and near to Lake of the Woods, which is the oldest of the gold mining regions of Northwestern Ontario.

Sultana Mine.

Plant and Management of the Mine.

No alteration has been made in the surface plant, or in the management or ownership of the Sultana mine, which has been running steadily and smoothly ever since the new 30-stamp mill has been in operation and the new hoisting plant installed. The chlorination plant, which runs only in the summer time—the capacity (seven tons of raw concentrates per day) being sufficient for the treatment of a year's product from the mill in the summer months—was put into operation on May 15, and closed down in the early part of October.

The owner and manager of the mine is John F. Caldwell; agent, M. T. Hunter; chlorinator, C. G. Rothwell; mine captain, Albert Johnson; and mill superintendent, James Gale. The total force is 78 (including 39 working underground) in the summer time, and 65 in the winter when the chlorination plant is not in operation.

Extent of the Ore body as shown by Workings.

The shaft has been sunk to a total depth of 400 ft., and will be continued. Unexpected changes in the ore body have led to important variations in the underground workings. The latest developments appear to show that the ore body is a large irregular chimney extending through all the levels from the second down. It is first encountered at a distance of about 150

feet from the shaft in the second level south, and in each succeeding level is found closer to the shaft, showing that it is pitching in that direction, until it meets the shaft between the fifth and sixth levels.

No further work has been done on the vein in the first level; but the south drift, which is 104 feet in length, has been opened again for tramming purposes. The cross-cut, which is 36 feet in length from the end of the drift to the air shaft, is being extended east to cut a parallel vein. It had been driven 113 feet on November 11, the date of my last visit, and the vein is expected to be cut within the next few days. The vein in question is a narrow quartz lode outcropping along the face of the hill behind the mill. A shaft had been sunk to a depth of 60 feet on it about three years ago, and abandoned.

The first Level

In the second level, which is 127 feet from the surface, the north drift had been driven 54 feet and discontinued for over two years, but is once more being extended to cut an ore body at an estimated distance of 450 feet from the shaft.

The second Level.

The main excavations underground can hardly be described in terms of drifts and stopes, as is usually the case, on account of their want of uniformity in shape and the irregular method of mining necessarily employed in such an uncommon, and, to a large extent, erratic occurrence of ore. Each drift going south from the shaft opens into a large chamber representing excavations in the ore chimney or shoot constituting the main ore body as described previously.

The method of mining consists of running a drift from the shaft to the ore body, and into the same; raising to, or sinking from, the level above for ventilation and from this winze drifting south along the vein at a distance of 15 or 18 feet below the level above, leaving that much rock for a floor to the level. The drift is opened out to the full width of the vein, and the ore underneath removed by underhand stoping, keeping the drift 15 feet in advance of the stope. By this means a firm roof is left as the excavation proceeds, all loose rock being scaled off before stoping below.

The south drift of the second level extends for a distance of 110 feet, with a height of seven feet, and a width of from eight to 12 feet, opening at the end into a large chamber 40 or 50 feet in width, 120 feet in length and from 15 to 30 feet in height, extending also downward to the level below, a distance of 60 feet. Underhand stoping, with removal of the floor between the second and third levels, had been going on during the past summer, and this part of the second level has been abandoned for the present after being properly fenced off. A small drift extends 35 feet south from the large chamber, making the total distance from the shaft 260 feet.

No further work has been done in the third level north, which had been driven 13 feet. South of the shaft a drift seven feet in height and from six to 12 feet in width extends from the shaft to the stope or chamber, a distance of 100 feet. The stope is about 100 feet in length, from 30 to 60 feet in width and has been opened through to the second level. The total distance from the end of the stope to the shaft is 230 feet. Work here has been suspended for the present.

The third Level.

The fourth level, 262 feet from the surface, has been driven north 85 feet, and this drift abandoned. South of the shaft 50 feet of drifting connects the shaft with the stope, which is about 100 feet in length, opened out to the full width of the vein which is from 20 to 30 feet, and extending upward to within 15 feet of the third level. The drift near the roof is kept in advance of the stope, making a total distance from the shaft 185 feet.

The fourth Level.

At the fifth level, 337 feet from the surface, a loading chamber or station has been provided, 18 by 25 feet. A drift seven feet in height by 10 feet in width has been driven north 45 feet, and from the end a cross-cut six by eight feet has been driven west 18 feet, and discontinued. South of the shaft a drift seven feet in height by 10 feet in width has been driven 20 feet, opening in a chamber about 25 feet square roughly, and extending to within 18 feet of the fourth level. A drift near the roof is kept 15 feet in advance of

The fifth Level.

the chamber or stope as in previous cases. The hanging wall here takes a sudden bend to the west, and to support it as the excavation proceeded underneath an arch of rock was left, 30 feet in depth, 12 feet in width and about 10 feet in length, at a height of eight feet above the floor of the level.

The sixth level has been established at a depth of 400 feet, with a loading chamber 18 feet square, which gives plenty of room for handling timber and continuing sinking by independent hoisting machinery with cable extending down the manway from the surface, as described in a previous report. As the shaft passes through a portion of the ore body between this and the level above the ore has been stoped out from the ends of the shaft to a considerable height from the bottom, necessitating the casing off of the south end of the shaft from the stope by a division of substantial timber 18 feet in width and extending to within 30 feet of the fifth level, with sufficient of an opening underneath for carrying on work south of the shaft. The stope is 45 feet in height, 13 feet in length and 18 feet in width. Drifting south has been carried 30 feet altogether. At the end of the drift a cistern eight feet in depth has been excavated. At the time of my last visit work was confined to making an upraise to the fifth level. North of the shaft the ore has been stoped out to a height of 18 feet, for a distance of 16 feet.

The sixth Level

The skipway and ladderway have been carried to the sixth level with substantial timbering. The condition of the shaft is good from the surface to the bottom. A heavily timbered pentice has been constructed underneath the skipway preparatory to the continuation of sinking, for which the arrangements have been about completed.

Condition of the Mine and Works

Satisfactory ventilation is obtained by a winze connection between all the levels (except the sixth) and the air shaft.

For drainage purposes a pump stationed at the sixth level pumps to the fourth, where a new Northey pump with 5-in. suction and 3-in. delivery pipe has been installed, with cistern 20 feet south of the shaft. Water collected at the fifth level is syphoned from the cistern there to the sixth. A considerable quantity of water is coming in through seams in the rock at the sixth level.

The condition of the mine and works as recorded in the Inspector's Book has been satisfactory at each visit; the manager and the captain complying with the Mines Act and following recommendations where required. The necessity of careful scaling of the walls and roofs of stopes and watching the same continually is repeatedly impressed upon the captain of the mine. At the time of Inspector De Kalb's visit instructions were left which will be found in his report.

Burley Mine.

Mention was made in last year's report of the Burley mine, which is on water location D191A adjoining the Sultana, and on the strike of the Sultana vein. The property is owned by the Burley Gold Mining Company of Ottawa, Limited; head office, Ottawa; president, L. Crannel; sec.-treas., A. W. Fraser. As the public are well aware, the title to the property was acquired by the above company after much hard fighting in the courts between them and John F. Caldwell, owner of the Sultana. Work was commenced in the summer of 1897, under the management of J. Burley Smith, and continued on into the winter following, until early in February, when operations were suspended pending the decision of the courts regarding the title. This being in favor of the company work was resumed shortly afterwards under the management of R. H. Flaherty, and has continued without intermission ever since.

The Burley Gold Mining Co of Ottawa

Accompanying sketches (p. 64) will show the relative positions of the Sultana and Burley mines; also the construction of the shaft of the latter. The crib is 111 feet from high water mark at the nearest point on Sultana island. As the Burley company own nothing but water rights, their shaft had to be sunk in the water. The position of it was determined from the result of diamond drilling done the winter previous to the commencement of mining operations, with the drill stationed on the ice and holes bored in the bottom of the lake.

Development of a Water Location

The construction of the crib and shaft, etc., is as follows: There is first a crib containing an outer and an inner shell, the former 60 feet square and the latter 40 feet, leaving 10 feet of space between all around, and making a total area for mining operations of 3,600 feet. The shells are constructed of eight by eight inch timber laid horizontally, skin to skin, with joints properly broken. A similarly constructed bottom has been provided between the shells, and sets of braces connect the latter every 32 inches in depth. The crib, which is 30 feet in height, has been sunk two or three feet into the clay, which is at a depth varying from 18 to 24 feet, according to the rise and fall of the water; the top of the crib having in consequence of the variable water level a variable elevation above the water. On December 22, 1898, this was eight feet, as marked on the sketch. There is from 3½ to 16 feet of clay at the bottom, the variability being due to the sloping rock surface. The outer space of the crib is filled with broken stone. Inside the crib a coffer-dam has been sunk to bed rock. This is 16 by 22 feet in size, and constructed of timber sets 26 inches apart,—the timber being 10 inches square for the first 12 feet from the bottom and eight inches square for the remainder of the distance, which is to the top of the crib. Inside the coffer-dam is the shaft, which is six by 12 feet in size with three compartments, two for hoisting and a manway. For the first 15 feet of depth the shaft is timbered with sets several feet apart; below this, extending to a depth of 16 feet below the rock surface, the timbers are laid skin to skin, forming a neat and substantial cribbing. From the bottom of the cribbing a concrete seal three feet thick has been carried up to a height of three feet above the rock surface; the excavation in the rock being enlarged of course for this distance, and the seal being interposed between the rock and the crib-work. The composition of the seal is as follows: First, four feet from bottom, one part cement, three parts sand; second, four feet, the same number of parts of cement and sand with three parts of broken granite, 1½ in. diameter; the balance has five parts broken granite.

Construction of a Crib

Johnson's Portland cement is used. From the surface of the clay to the water level all the space between the crib and the shaft is filled with clay puddle, and above that to the top of the crib with broken rock. For a casing of matched lumber has been provided to confine the seepage water, of which there is not a great deal under the circumstances. A dam at the bottom of the casing collects this water, and a pipe conducts it to a cistern at the first level.

An account of the progress of the work with all the attendant difficulties, etc., up to the time of getting the crib in place and the work of sinking in the rock well advanced would form an interesting contribution to the literature of mining engineering. As stated in my last report, the crib was built on an island about half a mile from its present site, and towed out by a steamer to the point where mining was to commence. It was then sunk to the bottom by filling the outer space with broken stone, something less than 2,000 tons being required; this was transported in barges. The coffer-dam was then sunk in the centre on the "drop-shaft" principal, that is, the clay was excavated underneath and the timber work allowed to descend. It was at first thought that this clay would be sufficiently fluid to allow of its being pumped out; but the case proved otherwise, and excavation methods with hoisting by bucket, were employed under considerable difficulties, owing to the pressure of the clay from the outside. The experiment was made of driving 3-in. planking all around on the outer side of the crib through the clay, with the intention of sending it through to bed rock, thus shutting off the further encroachments of this clay, and hence relieving the pressure inside; but as the depth of the clay was so great at some points the planking could not be driven through to the rock, and the attempt to facilitate operations by this means was given up. Owing to the same fact, viz., the unevenness of the rock surface underneath the coffer-dam, only a small portion of the latter rested upon the rock, but the clay was effectually shut off by driving in 3-in. planking underneath the timbers, filling in all the space

Difficulties of Crib Construction.

between the latter and the surface of the rock ; excavating the clay of course as the work of driving the planking was continued. A comparatively dry and clear space was thus secured for the building up of the crib work of the shaft, which was commenced from the bottom, and also for the filling in of concrete and cement, which was done concurrently with the timbering. A substantial shaft has thus been secured with comparatively little seepage of water.

Sinking the Shaft

The depth of the shaft below the top of the crib is now (Feb. 14, 1899) 141 feet, and sinking is being continued as fast as possible. At a depth of 110 feet a drift has been driven south 58 feet, and discontinued for the present. The next level will be 75 feet below the first. Instructions were left requiring that sinking below the second level or below the 200-foot point be done under a substantial pentice, preferably of stone. A ladderway 28 inches wide has been provided, but is not in suitable condition for travelling up and down, and instructions were left that it be properly constructed to the 110-foot level, with suitable division between it and the hoisting compartments, and a hanging or temporary ladder provided from the 110-foot level to the bottom of the shaft, so that travelling up and down may be safely effected without the use of the bucket.

The country rock is a massive porphyritic granite similar to that of Sultana island. At a distance of 35 feet from the shaft in the drift a zone of schistose rock heavily impregnated with pyrites, eight feet wide, was passed through, and will be cut again by the shaft as it is dipping towards the latter. At a depth of 60 feet a quartz vein eight feet wide, dipping 75° northwest, was passed through ; but was concealed by the casing under the shaft timbers. Both of these veins are said to carry encouraging values. There is now about 18 or 20 inches of vein matter, mostly quartz, at the bottom of the shaft.

Mining Machinery

A cistern has been excavated in the drift at the first level, and a Northey pump with a capacity of 75 gallons per minute under a 300-foot head installed. There is also a small Worthington sinking pump with 2½-in. suction. Mr. Flaherty imforms me that about 25 gallons per minute were coming in altogether.

Drilling is done by compressed air, two drills being in use. The compressor is a 3-drill Ingersoll-Sargeant, which also supplies compressed air for the sinking pump.

The hoisting machinery consists of a five by eight inch duplex hoist, 1,300 lb. steel bucket and a ⅝-in. crucible steel cable running over a 48-in. sheave. This will be replaced by a larger plant when the next level has been reached. A 85 h.p. horizontal boiler supplies the hoister, the compressor and the pump. There are two pumps on the surface; a boiler feed pump, and a Cameron pump with 3-in. intake for fire purposes. Inclined trap doors have been provided at a distance of 10 feet above the shaft mouth, serving as gates for dumping waste rock and ore separately. Short teamways lead from the shaft to the edge of the crib.

At the manway a flue has been carried 30 feet above the shaft mouth for ventilation purposes, a good draught being thus secured.

There is a total force of 20 men, including nine miners working in three eight-hour shifts.

Buildings of the Mine.

The following buildings have been erected on the crib. Boiler and compressor house, 19 by 40 feet, including dressing room 10 by 10 feet, and woodshed ; hoisting engine house, 12 by 12 feet ; blacksmith shop, 16 by 20 feet, and small store house. A gangway has been constructed for hauling material to top of crib. The boarding camps and office consist of roomy and neatly constructed buildings situated on Chien d'Or island, about a half mile from the crib ; this island as well as the Queen Bee, close to it, belongs to the Queen Bee Gold Mining Company. The powder magazine is situated on an island at a suitable distance from the workings. The manager was instructed not to store powder on the crib ; and to keep any stored underground in a box with a lid.

Queen Bee Location.

On Queen Bee island there are two parallel veins with a strike of N. 20° E., similar to

that of the Sultana vein. The formation is granite. A shaft has been sunk 30 feet on one of these veins, which is evidently the outcropping of a chimney of ore similar to that of the Sultana. Eight or nine feet of quartz is exposed, and sinking will be continued.

Climax Mine.

On August 4 I visited the Climax mine, situated east of Heenan's point, about 10 miles from Rat Portage, with steamboat communication from the latter place. The property consists of location 325 P, containing 256 acres It is owned by the Climax Gold Mining Company of Ontario, Limited. Head office, Winnipeg; capitalization, $1,000,000 in $1 shares; president, W. Redford Mulock; vice-president, Thomas Black; secretary-treasurer, B. E. Chaffey. Mr. Fred. Wagner is manager of the mine; a force of three miners is employed. Work has been going on for about a year.

Climax Gold Mining Co

The formation is hornblende schist and trap in contact with granite. Considerable test-pitting and other surface work had been done on the different veins, etc., on the property, without satisfactory results until within a short period of my visit, when a vein had been discovered crossing the contact; this has been traced for about half a mile by a number of test pits sunk at various intervals, and from all appearances is a deposit worthy of exploitation. The greater part of it occurs in the trap, into which a tongue of felsite extends south from the granite for a few hundred feet, the vein following the felsite. Where the vein extends beyond the felsite it consists of a sheared zone of greenstone and quartz the latter cementing the fragmentary masses of the former. In the granite the vein is a simple quartz body, not very wide nor distinctly traceable for any great distance. The best part of the vein is where it is associated with the felsite. Test pits at intervals of about 100 feet show it to range from three to eight feet in width.

Development work of the Property

Visiting the property on October 11, I found a shaft in process of sinking on the vein, at a distance of about 50 or 60 yards from the contact, in the greenstone; it was 26 feet deep. There was six or seven feet of vein matter at the bottom, consisting of quartz and greenstone intimately mixed. Mr. Wagner later informed me that work ceased on October 18, a depth of 31 feet having been reached.

Hay Island Mine.

I visited the Hay Island mine on August 4, and found that a new shaft house and engine house had been built. Work had ceased, as I learned, months before, and as no one was in charge I could get no information; the doors and other entrances of the shaft house, etc, were securely boarded up to prevent entrance. From casual information I learned that the shaft has been sunk to a depth of 100 feet, with drifting north and south at the bottom, and as results were not satisfactory work was discontinued; steam hoisting and air compressing plants had been installed, but the latter has been removed. The appearance of the dump seemed to justify the statement regarding development work.

Triumph Mine.

The Triumph mine, an account of which is contained in last year's report, was in operation until the latter part of September, 1898, since when work has been suspended. A force of four miners had been employed, with Mr. Joseph Hicks of Rat Portage as manager.

The shaft, which is six by 10 feet in size, had been sunk 226 feet and discontinued. At a depth of 107 feet the first level has been established, with drifting east along the vein 36 feet, and west 42 feet; the drifts being 4 ft. 6 in. by 6 ft. 6 in. in cross section. Both drifts curve sharply to the east until about parallel, forming almost a half circle. At a depth of 182 feet the plat for the second level has been put in, but no work has been going on below the first level on account of the ventilation. A good ladderway has been constructed to the first level, properly cased off from the hoisting compartment and provided with suitable platforms. The surface is properly fenced. A neat shaft and engine house has been built. The hoisting machinery consists of a 15 h.p. duplex hoist, with 24-inch drum, $\frac{3}{4}$-inch steel wire cable and wooden kibbles running on pole

Extent of development Work.

skidway. Steam is supplied by a 25 h.p. locomotive style boiler. The buildings consist of a boarding camp, blacksmith shop, shaft and engine house and an old mill building, not in use.

The property is reached by a road seven miles in length from Rat Portage. The travelling in summer time is bad, especially if the season is wet

Bad Mine.

In the latter part of November I visited the Bad mine, which is situated south of the railway track at Margach, a station ten miles east of Rat Portage. Connection with the railway station is secured by a winter road three-quarters of a mile in length, and by a summer road of one mile. The property consists of location 349P, containing forty acres. It has been bonded to Messrs. Hugh Armstrong, James Hildreth and William Peters of Rat Portage; they paid ten per cent. of the buying price down, with an agreement to complete the payment in a given time, pending results of exploitation and milling. Some work had been done on the property by previous parties, the present operators having commenced on November 1. The total force is 13, including eight miners, working in three eight-hour shifts. William Peters is manager, and James Hildreth foreman

As the ground was covered with snow a satisfactory examination of the formation could not be made; but it appeared to consist of eruptive granite in contact with coarse-grained amphibolite; dikes of felsite cutting the amphibolite near the contact, which extends along the face of a hill about 92 feet high. The vein is an irregular lode, varying from a few inches to three or four feet in width, extending along the contact, and said to be traceable by a series of exposures occurring at intervals for a distance of 200 yards or more.

The Vein and Workings upon it

About 30 feet below the top of the hill a six by 10-foot shaft has been sunk on the vein to a depth of 70 feet, with a dip of 50° southwest. At a distance of 25 feet from the surface a drift has been driven southeast along the vein 36 feet, and one northwest 30 feet. From the end of the latter drift a cross-cut has been driven west 10 feet; and from the same point drifting has been carried east 12 feet, along what is apparently a branch of the main vein. At a depth of 32 feet the shaft is cribbed and covered over. Two test pits, three or four feet in depth each, have been sunk on the vein, one on each side of the shaft, at a distance of 20 or 25 feet from the latter.

At the bottom of the hill a tunnel, 4½ by 6½ feet in cross-section, is being driven southwest to cut the vein near the shaft. At the time of my visit it was in 29 feet, and 100 feet of driving was calculated necessary to reach the vein. I learned later from Mr. Peters that this had been driven the necessary distance and discontinued.

The quartz has a yellowish tint, with a somewhat saccharoidal structure, and is evidently all high grade. In February, 1898, four car loads of 20 tons each were milled at the Keewatin Reduction Works, with results ranging from $22 to $24.25 per ton from the different cars; and in January, 1899, 94 tons milled at the same place gave a return of nearly an ounce per ton. An equal amount was ready for milling in February. At the time of my visit a chute was under construction from the dump to the bottom of the hill, to facilitate loading the ore on sleighs.

Mill tests of the Ore

The buildings consist of boarding camps and blacksmith shop.

Regina Mine.

Mining and development work has been steadily progressing at the Regina mine during the past year. The milling machinery has been entirely renewed and alterations made in the cyanide works, involving on the whole important changes in the method of treating the ore, which will be dealt with later. Henry A. Pringle fulfilled the position of manager until October, 1898, when John F. Mieville, the present manager, assumed these duties. John M. Jones is mine captain, and W. H. Rudd cyanider. There is a total force of 52, including 24 miners.

Progress during the Year

With the exception of a little surface exploitation, operations have been confined entirely to the main shaft workings. Over 100

feet of stripping has been done a few hundred feet south on the main vein, which is small and ragged, corresponding to an uneven line of faulting roughly following irregular tongues of felsite extending from the granite on the north.

The main shaft has been sunk to a depth of 452 feet, and will be continued about 30 feet farther with the present hoisting plant. No drifting has been done in the tunnel or in the first, second or third levels since the former report. At the fourth level, 248 feet from the surface, the north drift has been driven 75 feet altogether, and the south 254 feet, and both discontinued for the present. At the fifth level, 298 feet down, the north drift has been driven 48 feet and the south 178½ feet. At the sixth level, 360 feet down, the north drift has been driven 292 feet and continued (the last 100 feet being directly under the lake), and the south drift 217 feet. At a depth of 420 feet the seventh level has been established, with drifting north 43 feet and south 83 feet.

Geological features of the Region

Previous reports of the Bureau deal with the geological features of the vein, but a repetition to a certain extent may not be uninteresting. It is well known that the main vein is a fissure running north and south, crossing the contact between granite on the north and trap on the south. The contact dips north at an angle of between 50 and 60 degrees, so that the shaft which was commenced in the granite passes through the contact between the third and fourth levels into the trap. The east wall of the vein has been faulted 30 or 40 feet north, leaving a contact zone of that width. A peculiar feature is that this zone represents the narrower and poorer part of the vein, which is in direct opposition to the case of the Mikado, where the ore shoots correspond to the contact zones. Another peculiar feature (mentioned in former reports) is that the vein dips west in the granite and east in the trap, so that the shaft which follows the vein changes its dip from west to east at the fifth level, which is slightly below the contact zone, the skidway being changed from one wall to the other accordingly; and the bottom of the shaft, which runs into the west or foot wall is now vertically under the mouth.

Stoping work in the Mine

Most of the stoping has been done south of the shaft, where a vertical chimney or shoot representing a rich and wide portion of the vein passes through all the levels. From the end of the third level south, which is driven 229 feet, an upraise inclined 45 degrees south has been made to the second level, meeting the latter at a distance of 300 feet from the shaft. Stoping north from this raise has been carried for a distance of 18 feet, with a width of four feet, up to the second level; and at the third level the vein has been stoped out north from the raise for a distance of 50 feet, with a raise of 28 feet above the roof of the drift and a width of four feet. In the fourth level south the length of the stope is 71 feet, the height 48 feet above drift and the width 4½ feet. It will be broken through to the level above as soon as possible for ventilation. In the fifth level south the length of the stope is 60 feet, the height 40 feet and the width three to nine feet, averaging about four feet. In the sixth level south the length of the stope is 52 feet, the height 35 feet and the average width about 4½ feet. The vein continues quite strong to the bottom of the shaft. At the seventh level it is seven feet wide at the shaft, consisting of solid quartz with distinct walls. This, of course, does not represent its width at all points in the level.

Diamond drill Exploration.

It was the intention of the manager to test veins on either side of the main vein, and also the latter itself, by diamond drilling from stations underground in the main workings, and if results were satisfactory to cross-cut and work these veins from the main shaft. One drill station was in the second level south 387 feet from the shaft, and a cross-cut had been driven west 13 feet. Stulls were set along the floor of the level, covering the stope underneath, and a tramway laid. The other station was in the sixth level north, at a distance of 145 feet from the shaft, where a cross-cut has been driven 31 feet east. A bore was to be made to the magazine vein, a parallel lode outcropping down the face of the hill about 200 feet east of the main vein. I learned later that

this diamond drilling has been completed. It was done by the Rat Portage Diamond Drill Co., under the superintendence of Mr. T. E. Smith.

Tramroads are laid in all working drifts. The manway has been suitably constructed down to the seventh level. Guard rails have been placed around the skipway at all levels except the seventh. The ventilation and drainage of the mine is satisfactory. In the seventh level a pump chamber has been provided east of the shaft in the hanging wall and a new Northey pump installed. A smaller pump is also employed at the fourth level.

Protection and Equipment

A new 10-drill air compressing plant from the James Cooper Mfg. Co. of Montreal has been installed, with six drills, of which five are in operation Very little change has been made in the hoisting plant. A substantial head frame has been constructed with chute for dumping on to the grizzly. A new engine house has been built west of and adjoining the shaft house. A new steel wire hoisting cable of $\frac{3}{4}$-inch in diameter and 600 feet in length has been put to duty. At present there are in use two 800-pound steel ore buckets, detachable for conveyance along the drifts on trucks, two 500-pound wooden ore buckets in reserve, and an 800-pound steel water bucket.

With the exception of the renovation of the engine room and some slight alterations and additions in the battery and crushing rooms, no change has been made in the mill building, but the machinery has been entirely renewed, consisting now of the following: A No. 3 Gates crusher, operated by a separate engine with 9 by 10 inch cylinder, which also drives a horizontal conveyor belt 40 feet long and 18 inches wide, extending from the crusher to the ore bin. The latter has a capacity of 200 tons. It is wedge shaped, with one side vertical; the slanting side is six inches in thickness, constructed of two by six inch planks laid edgewise and spiked together; the vertical side is four inches in thickness of two by four inch planks laid flatwise.

Mill building and Machinery

Seven Tremaine steam two-stamp batteries, with a total capacity of 75 tons per 24 hours, have been substituted for the 10 gravity stamps hitherto employed. One of these Tremaine batteries had been running for six months along side the gravity mill for comparison, before deciding upon the change. All amalgamation is outside the batteries, step lips and apron plates, the latter inclined $1\frac{1}{2}$ inches per foot, being employed. The screens are diagonal slot, 40 mesh.

Tremaine stamp Batteries

The material from the batteries after amalgamation goes directly to two three-compartment Hartz jigs; size of screens $2\frac{1}{2}$ by $1\frac{1}{3}$ feet; number of strokes per minute, 450. In the first compartment the stroke is $\frac{1}{8}$-inch, and mesh of screen 1 m.m.; in the second compartment the stroke is $\frac{1}{8}$-inch with $\frac{3}{4}$ m.m mesh; and the third compartment, $\frac{1}{16}$ m. m. plus, with $\frac{3}{4}$ m. m. mesh. The bed consists of galena $1\frac{1}{2}$ to two inches in thickness, with pulp one inch deep on bed The product of the jig is of course an impure concentrate with a considerable pecentage of silica but the capacity is great compared with Frue vanners, and very good results are obtained from them.

Concentration and Treatment of Pulp

The concentrates from the first compartment of each jig are treated in a Berdan pan, of which there are two, four feet in diameter, with 24 revolutions per minute, and 270 lb. drags. The product of the latter, along with the concentrates from the second and third hutches, then go to the cyanide works. These have been reduced to four treatment vats six feet in depth and 13 feet in diameter, with the same number of solution tanks, the tailings not being treated now as formerly. The latter are passed over gyrating amalgam tables, four feet wide by eight feet long (six in number) constructed on the same principal as those of the Keewatin Reduction Works mentioned in the last annual report of the Bureau.

The machinery is all from the Gates Iron Works of Chicago.

Power is furnished by two new 125 h.p. boilers, an old 80 h.p. boiler only kept for emergency, three mill engines (one for emergency) with seven by ten inch cylinders and 250 revolutions per minute.

The works are lighted by incandescent lamps supplied from a small dynamo with a separate vertical engine.

The new buildings consist of a manager's dwelling, store, dressing room, blacksmith shop, new hoisting engine house and additions to the mill.

A new steamboat dock has been built west of the old one.

Condition of the Mine.

The mine has alway been found in a satisfactory condition, with usually no requisitions of importance to be made. The dressing room, which is situated at a convenient distance from the shaft, is roomy, well ventilated and heated satisfacorily by steam. Separate lockers with lock and key are supplied to each miner. Adequate provision is made for drying clothes. Hot and cold water is supplied in abundance, with bath tubs, etc. At the time of Inspector De Kalb's visit instructions were left which will be found in his report.

Communication with Rat Portage

The steamer Shamrock, owned by C. W. Fraser of Rat Portage, runs regularly twice a week between Rat Portage and the mine in the summer time, and a stage line over the ice makes the connection during the winter. A half-way house has been built at Yellow Girl point, so that the trip in winter can be made in a day. The steamer Squaw still belongs to the mine, but she has been laid up during the latter part of the season.

During the summer several test shafts have been sunk on locations south of and adjoining the Regina mine, under the superintendence of Mr. T. A R. Purchas, representing English capital; but the results were not very satisfactory, I learned, and work has been discontinued.

Lizzie Mine.

East of Whitefish bay.

Considerable interest has been taken during the latter part of the summer in a new section of the country which has been brought prominently before the public by the reports of excellent discoveries made therein. This is situated east of Whitefish bay, in the vicinity of Sturgeon and other lakes farther north. Most prominent among the finds is the Lizzie mine, situated on a small body of water known as Elizabeth lake, west of Sturgeon lake. It is reached from Rat Portage by 55 miles of steamboat voyage on the Lake of the Woods to Whitefish portage east of Regina bay, one-third of a mile of portage into Whitefish lake, four miles on the latter to Dog Paw rapids (which may either be run, or a 100 yards portage made into Sturgeon lake), 11 miles on this lake to Elizabeth lake, and a half mile across the latter to the mine landing. The voyage from Whitefish portage to Elizabeth lake is made by a small naptha launch belonging to the mine, 20 feet in length and five feet beam, capable of carrying 2400 lb. It makes a speed of seven miles per hour and costs five cents per mile for gasoline It is assisted up Dog Paw rapids by two men with a tow line on each shore. A good deal of surveying has been done by different parties in the vicinity of this mine, and farther north, and some valuable finds have been reported; and it is expected in consequence that connection with the railway will be established by way of Eagle lake, which lies to the north, instead of by Lake of the Woods to Rat Portage, as the former will be very much shorter, although the work of finding the most accessible route and cutting it out has yet to be done. A stage runs from Rat Portage in the winter time.

Locations of the Lizzie Mine.

The property of the Lizzie mine consists of locations FM73A, 74, 81, 82, 83, 86 and 87, aggregating 345½ acres. It is owned and operated by the Virginia Mining Company of Ontario, Limited; capitalization, $100,000 in $1 shares. The head office is Toronto. President, Edward W. Stifel; secretary-treasurer and general manager of the mine, S. H. Brochunier, both residents of Virginia, U.S. Mr. Thomas Paris is superintendent of the mine. The total force is 14, including six miners, working day and night shifts.

The discoveries on the property were made in May, 1898, and development work commenced in June following. The workings are confined to location FM73A, which comprises a point of land 33 acres in extent, jutting out into Elizabeth lake, a body of water 66 acres in area. The ground rises

gradually all around to a maximum elevation of about 150 feet above the water.

Rock formation and Veinage.

The formation consists of a hard, fine-grained, light-colored schist—the nature of which has not been determined –in contact with a coarse-grained greenstone, containing large porphyritic crystals of hornblende over a quarter of an inch across, with a few small isolated patches showing marked ophitic structure. This rock is fine grained near the contacts. Dikes consisting of siliceous porphyritic rock, of a lighter color than the schist run through the latter at various points on the location. The geology can be fairly well studied where the ground is elevated, although the main contacts occur in the muskegs

The veins are confined to the schist. The main vein has a strike of north 30° east, parallel to the strike of the schists, and traceable for 700 or 800 feet, outcropping at three or four places along its course. It varies in width from a few inches to three or four feet, and in some places breaks up into a number of small scattered stringers. What are believed to be a couple of branches are traceable by "float" quartz to the main vein, a distance of about 300 feet away.

At the northeast end the main vein outcrops down the face of the hill at the water's edge; the outcropping is traceable there for about 70 feet, taking a sudden bend eastward due to the disturbance of the schists. At an elevation of 41 feet above the lake an open cut has been made six feet wide, from one to 15 feet deep, and 39 feet along the vein, and from the end of this a drift has been driven south 33 feet along the vein. A shaft six by eight feet in cross-section had been sunk five feet at the time of my visit, October 15, and on February 8, 1899, Mr. Paris informed me that it had been sunk 68 feet. It was commenced in the open cut near the entrance to the drift. A very rich pocket containing a number of magnificent free gold specimens was struck where the sinking of the shaft commenced. The quartz has a bluish tint, is translucent, and contains copper and iron pyrites. Manganese is quite plentiful in the rock associated with the quartz.

There is an excellent mill site on the lake close to the workings, and at a distance of 1500 feet on a small river is a waterfall 11 feet in height which is calculated to be able to furnish all necessary power for hoisting and milling when such machinery is installed.

The following buildings have been erected: Cooking and sleeping camps, office, blacksmith shop and store house.

I learned in February from Mr. Paris that a steam hoisting plant has been installed.

Bath Island Mine.

Resumption of Work.

Work has been resumed at the Bath Island mine, under the management of Mr. J. F. Mieville of the Regina. Mr. C. W. Fraser of Rat Portage, who is doing the work by contract, kindly allowed his steamer, the Shamrock, to call at the island on the return trip from the Regina mine to Rat Portage. We arrived about six p.m., just after blasting, and hence I could not go under ground, as the steamer could not be kept waiting until the mine cleared; but I got the following information from the foreman:

The shaft is 100 feet deep. At the bottom drifting has been carried 16 feet in each direction on the vein. And a cross-cut has been made north to cut No. 2 vein. It had been driven 58 feet on November 9, the time of my visit, and the vein would be reached within the next few feet. A ladderway had been constructed according to the requirements of the Mines Act, with suitable division to the bottom of the shaft. There was a total force of 12 men, of whom eight were miners.

An account of this mine is contained in last year's report of the Bureau. No change has been made in the ownership, or in the officers of the company.

Locations on Camp Bay.

Bully Boy Mine

No work has been going on at the Bully Boy, in Camp bay, during the year, negotiations for a sale having been pending. Mr. Charles Stirling, a part owner of the mine, informed me that the shaft had been sunk 113 feet, with 16 or 20 feet of drifting at a depth of 60 feet. I visited the shaft, but water prevented ingress.

About a mile and a half north of Camp bay, on an extension of the road running to the Bully Boy mine, is situated a property which was being worked by the Combined Gold Mines Company of Ontario, Limited, with head office at Niagara Falls, Ont. The capitalization is $1,000,000. President, Robert Humphreys, Lanes Mill, Penn.; secretary, M. P. Hatch, Buffalo, N.Y. The place was visited on July 9. Work had been going on since November 1, 1897, with a force of four miners under the management of Mr. A. Patterson. The formation is massive greenstone (altered diabase), with numerous porphyry dikes cutting it, due to the proximity of the granite on the east. The location on which most work has been done is S79. What is known as the Patterson vein is traceable for half a mile with a strike of nearly north and south. Two test pits have been sunk on it 40 feet apart; one to a depth of 10 feet, showing the vein to dip 30 to 35 degrees east, with an exposure of from four to five feet of quartz. Both walls are distinct, containing a few inches of oxidized schistose matter.

Location S79

No. 1 vein is traceable for 500 or 600 feet on elevated ground, with a strike of a little east of north, and a dip of 65 degrees east. In width it varies from two to three feet, consisting of solid quartz. A shaft has been sunk on the vein to a depth of 58 feet, now full of water. The shaft was sunk on the footwall, and a cross-cut at the bottom showed the vein to have widened. Assays averaged $11.

No. 7 vein, said to be traceable for over half a mile, is apparently a contact between trap and porphyry, a dike of which 15 or 20 feet wide is found here. A shaft has been sunk 24 feet on the vein, but was full of water. It is said that from two to four feet of quartz is exposed in the latter.

A peculiar deposit, which may properly be called a vein, was being tested at the time of my visit. This was a body of quartz four or five feet in thickness lying perfectly flat, covering an area several hundred feet in length by from 40 to 100 feet in width, and gradually dipping into the trap on the west side. It was apparently a vein which gradually flattened near the surface, with the upper or hanging wall removed, exposing the naked quartz for a considerable distance. Two cross-cuts 40 to 50 feet in length were made about 200 feet apart, revealing the above state of affairs. Shafts were sunk through the trap under which the vein dipped, showing the dip to get gradually steeper. One shaft was sunk 25 feet, cutting the vein, but was abandoned owing to the excessive amount of water. A test pit west of the northerly cross-cut showed the vein to exist under three feet of country rock, which consisted of felsite and trap mixed. A few feet farther west another test pit is being sunk which has not cut the vein at a depth of 15 feet. As soon as the dip of the vein can be satisfactorily established a working shaft for development purposes will be sunk at a suitable point. Satisfactory showings of gold were obtained from the vein.

At another point on the property a vein of quartz five or six feet wide, mixed with country rock, and forming a ridge, was tested by a few shots, without satisfactory results and given up.

The buildings on the property consist of cooking and sleeping camps, and several blacksmith shops situated at different points.

Boulder Mine.

About two miles south of Camp bay, on the main shore, is situated the Boulder mine, the property consisting of locations S141, FM45 and E281 and 282, aggregating nearly 400 acres. It is owned by the Ontario Boulder Mining Company of Ontario Limited, with head office at Minneapolis; president, E. T. Le Clair. The first work was done in the fall of 1897, consisting of a little test pitting in the northern part of the property. Operations were discontinued during the winter, and resumed in the spring, under the management of Mr. J. R. Gifford. At the time of my visit, July 9, there was a force of 25 men, including nine miners, working in three eight-hour shifts.

Locations under development

The formation is hornblende schist and trap in contact with Laurentian granite; the strike being roughly north and south, with an irregular line of contact.

The vein has a strike of northeast and southwest, crossing the contact, it is said, two or three times, and is traceable for over half a mile. At the shaft it outcrops on elevated ground for a distance of about 100 feet, running into low ground in each direction and outcropping or becoming exposed again where the ground rises.

About 200 yards from the lake and 100 feet above the water level, on location E281, a 4½ by 8½ foot shaft has been sunk in the vein to a depth of 30 feet, and is being continued. Sinking was progressing at the rate of 11 feet per week with single-hand drillers working in three eight-hour shifts, with three men per shift.

There is 11 feet of quartz at the surface and quartz on three sides in the shaft.

The buildings consist of cooking and sleeping camps and stable. A manager's dwelling is being built also. All buildings are roomy, comfortable and neatly built.

A dock is being constructed in a small, conveniently situated inlet at the lake. The steamer Pearl, with 42 feet keel, belonging to the mine, runs between there and Rat Portage, a distance of 55 miles.

There is a very good mill site at the lake, with excellent opportunities for the transportation of ore by gravity.

On October 22 I met Mr. Gifford in Rat Portage, and was informed that mining operations had been suspended for some time, pending the installation of hoisting and air-compressing plants. These consist of the following machinery: An 8 by 12 inch duplex hoister; a six-drill Rand duplex compressor, with three No. 3 drills; a 4 by 12 foot receiver; two 45 horse-power boilers; a 30 horse-power saw mill engine, and a boiler of the same capacity and two duplex Snow pumps.

The saw mill, which has a capacity of 10,000 feet per day, is in running order. The saw mill is an almost essential feature of any mine which is situated at a considerable distance from a railway, as usually a large quantity of lumber is needed, and the expense of transportation is considerable. The locations are well wooded with fairly heavy timber, consisting of Norway pine, spruce, poplar, etc.

The following mining work has been done: No. 1 shaft, depth 90 feet; No. 2 shaft, 1,000 feet east of No. 1 on the same vein, depth 70 feet.

A new vein with favorable assay values had been discovered 30 feet east of the main vein while cutting out the foundation for the hoisting engine house.

Some additional buildings have also been erected.

Stella Mine.

Considerable development work has been done at the Stella mine during the year, and much information obtained regarding the character of the ore bodies. What was believed last year to be one vein has proven upon clearing and stripping to be the exposures of several parallel veins crossing the property close together. Work has been done on three or four of these.

Extent of development Work

On No. 1 vein the shaft has been sunk to a depth of 60 feet, and temporarily discontinued, after being properly fenced. The vein, which is similar to all the other veins, consists of a zone of quartz and green schist mixed, with rather indefinite walls. Assays range from $4 to $14. A mill test of two tons gave a return of $3.75 free milling. There is a large quantity of concentrates, chiefly copper and iron pyrites. It is the intention to sink the shaft to a depth of 100 feet, and cross-cut to the hanging wall, the foot only being exposed.

On No. 2 vein the shaft has been sunk 65 feet, and discontinued for the present, being properly secured at the surface to prevent accident. The vein changed its dip rapidly at a short distance from the surface; at a depth of 25 feet the shaft went into the foot wall. At the bottom a drift was carried west 15 feet, and from the end a cross-cut driven south 40 feet, cutting the vein at a distance of 35 feet. Drifting was done on the vein for a distance of 10 feet west, the vein consisting of a zone of quartz and schist five or six feet wide. The shaft was full of water, but I got this information from Mr. Neil Campbell, the manager. A small shaft house has been built. Several open cuts have also been made on this vein, these being five or six feet in depth, and the vein varying from

a few inches to two feet in width in them. Twenty tons of ore from one cut gave a $406 gold brick, and 800 pounds from the same vein gave a return of $134 per ton at the Keewatin Reduction Works.

On No. 3 vein a shaft has been sunk 40 feet. The vein averages about two feet in the shaft, and is 18 inches wide at the surface. Operations have been discontinued here also, and the shaft allowed to fill with water. At the surface it has been properly fenced.

The main or Stella vein was the only one being worked at the time of my visit, July 11. The tunnel, mentioned in last year's report, has been driven 104 feet and discontinued. The vein ranges from two to four feet in width, averaging about 3½ feet. Close to the tunnel a shaft was being sunk on the vein; it was then 51 feet deep, dipping 57 degrees south. The vein ranges from four to 4½ feet in width, consisting of quartz and schist mixed. The manager states that assays run from $7 upwards, and he believes that it will average over $20 per ton. A suitable collar has been provided to a depth of 16 feet. A neat head frame has been constructed, and hoisting is done by horse power.

Twenty feet east of this shaft a test pit had been sunk on the vein 15 feet, but filled up again with broken rock.

The buildings consist of sleeping camp to accommodate 15 or 20 men, dining camp, stable, ice house and blacksmith shop.

There is a total force of 10 men, seven of whom are miners working day and night shifts.

A wagon road has recently been cut direct to the mine, branching off from the main road which runs to Andrew bay.

Meeting Mr. Campbell in Rat Portage on November 28, I learned that the shaft had been sunk on the Stella vein to a depth of 127 feet, and work stopped on the first of the month. It is probable that operations will be suspended until steam hoisting machinery is installed.

Triggs Mine.

On the same belt as the Stella, with similar formation and ore bodies, is the Triggs mine, situated east of Witch bay on a fairly good wagon road about 2½ miles in length extending from a small lake which is crossed by canoe shortly after leaving the landing at Witch bay. The property consists of three locations, McA56, 129 and 148, aggregating 113 acres. It is owned and operated by the Triggs Gold Mining Company of Ontario, Limited. President, F. D. Sargeant, St. Paul, Minn.; vice-president, J. W. Millar, Rat Portage; secretary and treasurer, J. H Triggs, Rat Portage. I visited the place in August. Work has been going on since October, 1897, under the management of J. H. Triggs, secretary of the company.

Triggs Mining Company.

The workings are confined to an elevated portion of ground 40 or 50 feet in height, about 150 feet in width and from 700 to 800 feet in length, surrounded by low, swampy ground. The formation is fine grained trap. The richest ore is confined to veins, and consists of zones of quartz and greenstone mixed, extending along the top of the hill with a strike of nearly east and west. There are two of these veins, one on the north and the other on the south side of the hill, about 150 feet apart: but the manager has made repeated tests, resulting in the conclusion that gold is contained to a sufficient extent and sufficiently diffused to warrant treatment of the whole mass between the veins. The quartz in the veins assays exceptionally high, and the greenstone between gives promising returns.

No. 1 vein, on the south side, has been exposed by a number of small test pits two or three feet in depth, sunk at frequent intervals, extending over a distance of several hundred feet. Oxidized material is revealed in most cases, with from a few inches to two feet of quartz. A shaft has been sunk on the vein to a depth of 80 feet, but was not in operation and was partially full of water at the time of my visit, preventing ingress. At a depth of 40 feet a drift has been driven eight feet west along the vein. Mr. Triggs informed me that the shaft followed a very rich pay streak for the greater part of the distance, but this dipped so flatly near the bottom that sinking was continued in the foot wall. Several hundred tons of rich ore have been dumped separately at the surface, awaiting the erection of a mill. A neat collar and a ladderway have been provided, and a temporary shaft house built.

On No. 2 vein, which is traceable for from 500 to 800 feet along the north side of the hill, two test pits have been sunk; one 10 feet deep revealed four feet of vein matter consisting of quartz and greenstone, charged with pyrites and said to assay well. The other, 70 or 80 feet west, was six feet in depth and 14 feet in length, exposing about 10 feet of vein matter; the vein branched here, the branches aggregating about five feet in width. Iron and copper pyrites were abundant and assays were satisfactory.

Near the foot of the hill, on the north side, a tunnel was commenced which was intended to be driven through to the south side, cutting both veins. I learned later from Mr Triggs that this had been driven 40 feet, and work at the mine suspended, with the intention of commencing again during the winter.

The force consisted of three miners and a cook. Boarding camps, a stable and a blacksmith shop had been built.

Sentinel Mine.

On the south shore of Labyrinth bay is a property consisting of locations WA7, 8 and 9, owned by the Corondo Gold Mining Company, Limited; it is being tested under option at present by the Sentinel Consolidated Gold Mining Company of Ontario, Limited, with head office at Toronto. President, Dr. Edmund E. King; manager of company and mine, N. B. Eagen. Work has been going on since the summer of 1898. Two shafts have been sunk on WA7, one 40 feet deep and the other 106 feet; the latter one is being continued. I did not visit the property, but got the foregoing information from Mr. John McAree, O.L.S., engineer of the mine, and Mr. Hamilton Proudlock, foreman of the work. A mill run of 60 tons was made at the Rat Portage Reduction Works in February, 1898, with reported satisfactory results.

Locations WA7, 8, 9

Mines on Shoal Lake.

Although Shoal lake is connected with Lake of the Woods, it deserves to be dealt with as a distinct mining region on account of the character of the rock formation which composes the greater part of the area that is mineral bearing. The eruptive granite here is found to be fissured in many places, and a number of the veins are proven to carry gold ore that promises to make rich mines.

Mikado Mine.

The Mikado mine has been in steady operation during the year, with Theodore Breidenbach as general manager, H. Patterson assistant manager and engineer, and Mr. McMillan business manager. F. C. Pengilly is superintendent of the new cyanide works, completed on October 24, 1898 A total force of about 80 men, including from 26 to 30 miners, is continually employed.

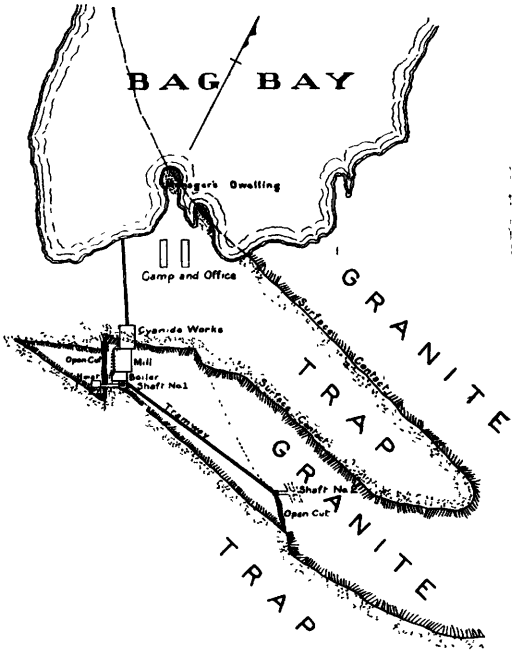
Staff and Force of the Mine.

Prospecting, sinking of test shafts and diamond drilling have been done at various points on the property, together with a study of the geology of the main veins, which has led to a systematic method of underground development in which each drift or cross-cut is driven with the calculation of striking an ore body or workable portion of the vein at an estimated distance.

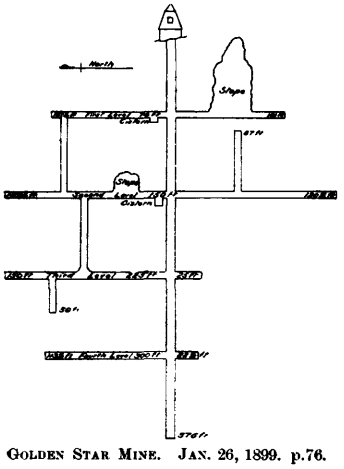
Systematic method of development

Previous reports of the Bureau of Mines contain descriptions by Dr. Coleman of the rocks constituting the formation, as well as accounts of the property in general. The formation consists of altered trap with areas of intrusive granite occurring on the northern part of the property. A dike or tongue of the granite, varying from 150 to 300 feet in width, extends for a distance of about a quarter of a mile west from the main body into the trap, crossing the two main veins which are 400 feet apart, and parallel with a strike of north 30° west, outcropping for a short distance each near the shore of Bag bay. This tongue of granite dips 30 degrees south, as revealed by underground workings. The portion between the veins has been faulted or thrown 4[illegible] feet to the north, the veins representing the lines of displacement. This is shown at both veins, but best at No. 1, the west vein, and establishes beyond doubt their dynamic origin. In all the workings the continuity of the fault is evident, although generally in the trap the effect of subsequent agencies of vein formation has not been so great as in the granite, consisting for the most part of a small but

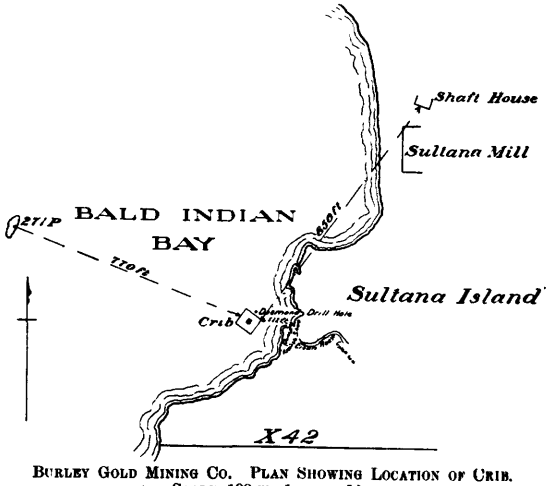
Evidence of Faulting



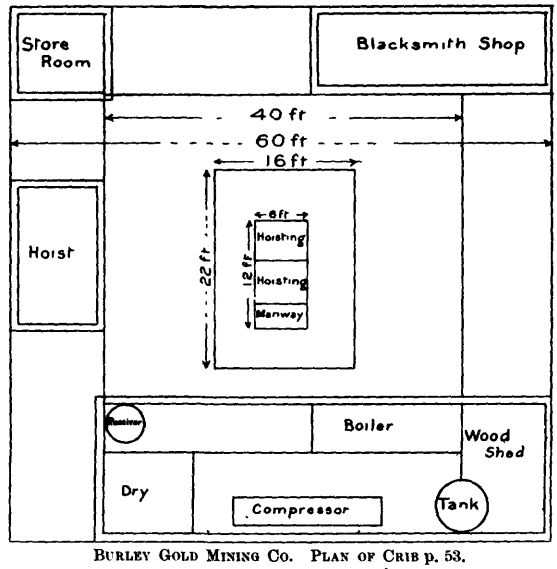
MIKADO MINE. PLAN OF SURFACE WORKS, SHOWING VEINS, CONTACTS, DISLOCATION, ETC. SCALE, 80 FT. 1 IN. p. 64.



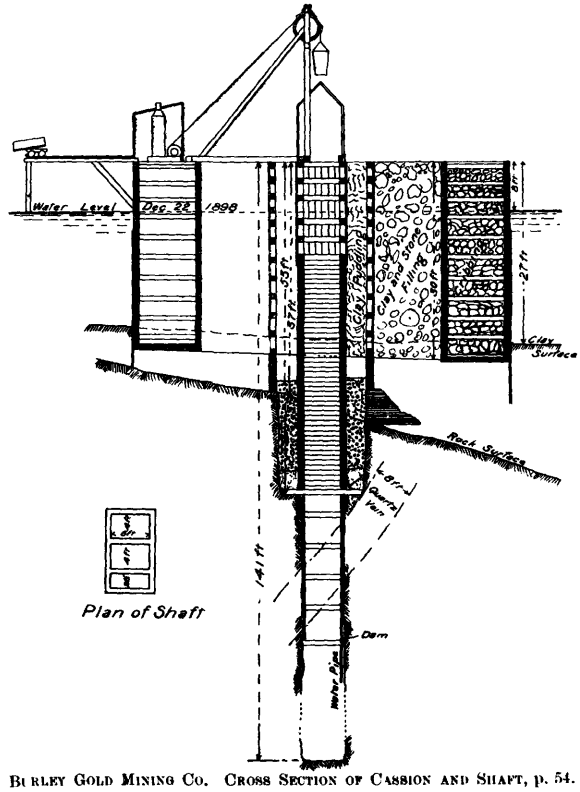
GOLDEN STAR MINE. JAN. 26, 1899. p.76.



BURLEY GOLD MINING CO. PLAN SHOWING LOCATION OF CRIB. SCALE, 100 FT. 1 IN. p. 52.



BURLEY GOLD MINING CO. PLAN OF CRIB p. 53.



BURLEY GOLD MINING CO. CROSS SECTION OF CASSION AND SHAFT, p. 54.

persistent seam of calcite with a zone of fracture several feet in width on each side. In the granite the vein opens out into a good quartz body, several feet in width, charged with pyrites and bismuthinite, and all rich enough to be workable. This applies particularly to No. 1 vein, wherein the best ore occurs in a shoot following the tongue of granite previously mentioned; although even in the trap the vein is sometimes good. In No. 2 vein the nature of the wall rock does not appear to be so influential a factor in determining the quality or width of the ore body; the workable part of the vein consisting principally of a zone of fractured felsite and trap, altered and silicified by circulating waters. Felsite occurs in both veins and is always considered a favorable indication.

Extent of the Workings.

At No. 1 vein a vertical shaft has been sunk in the hanging wall to a depth of 250 feet, cutting the vein, which dips east, at 180 feet. It was commenced in the granite dike, but the latter, dipping to the south, left the shaft, which was continued in the trap. The cross-section is 6 by 12 feet inside the timbers, with a double hoisting compartment and a manway for a depth of 127 feet, and 6 by 8 feet with a single hoisting compartment and manway for the remainder of the distance. Levels have been established with cross cuts to and drifting on the vein at depths of 60, 120 and 240 feet. The north drift in the first level has been driven 190 feet and abandoned. At a distance of 136 feet from the entrance a cross-cut has been driven northeast 21 feet. The south drift has been driven 189 feet, passing through the granite dike, and discontinued. The ore shoot following the granite has been nearly all stoped out to the surface, leaving a pillar 10 feet in diameter to support the hanging wall. The dimensions of the stoped out space are as follows: In the south drift the length is 107 feet and height above the level floor 30 feet. North of this the ore has been stoped out to the surface for a distance of 60 feet, leaving a pillar in the centre. In the north drift the length is 36 feet and the average height above the floor about 17 feet; the average width of the stoped out portion is about 10 feet.

The north drift at the second or 120 foot level has been driven 154½ feet and abandoned. The south drift has been driven 380 feet, passing through the granite, and is continued, as the vein is still good, at a distance of 120 feet past the ore-shoot. The first, or what is called No. 6, stope has been carried up to the first level with an average width of about four feet and an average length of 90 feet. The second or No. 5 stope is 92 feet in length, with an average raise of about 15 feet and average width of about five feet. At a distance of 190 feet from the entrance of the drift a rise has been made 25 feet above the roof of the drift, and will be continued to the level above. Suitable stulls, supported by posts in the centre where necessary, have been placed along the roof of the drift and farther upward in the stope, for retaining the broken ore which is discharged through mill-holes into cars below, tramways being provided in all working drifts.

At the third or 240-foot level a cross-cut 20 feet east cuts the vein, along which drifting has been done north 126 feet and south 69 feet. This work is all in the trap, and hence the vein is not so good, but drifting will be continued in both directions with the calculation of striking bodies of ore at estimated distances. In the south drift a stope has been made 34 feet in length, seven feet in height above drift, and three feet in width.

An intermediate pump station had been provided at a depth of 180 feet, where a chamber, dammed to hold water, has been excavated on the south end of the shaft. But the pump is now stationed in a chamber near the shaft at the 240-foot level, with 10 feet of sump to pump from.

No change has been made in the hoisting plant, with the exception that only a single cage-way exists from the second level down, as stated previously.

A suitable ladderway has been constructed to the bottom of the shaft. It was in a dangerous condition on account of ice formed by the freezing of the dropping water between the surface and the 120-foot level, and instructions were left to keep it chopped out as well as possible. The ventilation is satisfactory.

On No. 2 vein a shaft, inclined 65 degrees east, has been sunk to a depth of 180 feet.

Levels have been established at depths of 120 and 180 feet. In the first level, which is abandoned, the north drift is 140 feet in length, and the south 130 feet. The floors of the drifts are 10 feet above the floor of the loading chamber. In the north drift, 25 feet from the shaft, a stope 60 feet in length, 24 feet in height and five feet in width has been made.

At the 180-foot level both drifts are 169 feet in length, and are being continued. At a distance of 100 feet north of the shaft an overhand stope has been made 60 feet in length, seven feet above the drift, with an average width of three feet. In the south drift, at a distance of 150 feet from the shaft, a very rich pocket was struck, from which was obtained nearly 1,000 lb. of ore which contained much visible gold, a special report on which was sent to the Bureau of Mines. An overhand stope has been made 13 feet in length, about five feet in height and six feet in width, and is being continued.

A Northey pump with a capacity of 300 gallons per minute has been installed. The

Equipment of the Mine

hoisting plant consists of a 12 h.p. double drum hoist with a 30 h.p. horizontal boiler, formerly at No. 1 shaft, and a kibble sliding on pole skidway. The ore is trammed on the surface to No. 1 shaft and raised to the crusher floor. A new 40 h.p. horizontal boiler has been substituted at No. 1 for the one removed, and connected with two 70 h.p. boilers already there. Drilling in both shafts is done by compressed air, supplied by an eight-drill Rand compressor, with six No. 2 drills in use, and three receivers; one 4½ feet in diameter and nine feet in length on the surface, and one three feet in diameter by four feet in height under ground in each shaft.

Two other shafts have been sunk at some distance to the south of the main ones. One, called No. 3, is six by nine feet in size and 80 feet deep. It has been abandoned and allowed to fill with water. The other, No. 4, on the strike of the main vein, is five by eight feet in size and 65 feet deep. This has also been abandoned and allowed to fill. Instructions were given to have both shafts fenced.

No change has been made in the mill, which has been running steadily with the exception of 19 days in June, when it was stopped through the breaking of the crusher, which was a Comet. A Blake, with 8 by 12-inch opening, has been substituted. The erection of the cyanide works was commenced on September 17, and completed on October 24, following; they were put into operation about a month later. All the product of the mill is treated after amalgamation, the work of the cyanide plant consisting of extracting the very fine free gold, of which a considerable quantity is carried off as float, and the gold in the sulphides, which are not concentrated as is usually the case, the amount, ½ per cent., being too small to warrant the installation and operation of the necessary concentrating machinery. The mode of treatment consists in what is known as the "double treatment process," that is to say: settling tanks are first subjected to the cyanide solution; the material is then dumped into a second series of tanks called the "treatment" tanks, and cyanide solution added a second time; all leaching being done in the latter. The plant is capable of treating 1,600 tons per month, giving it five days of actual treatment. The works consist of three settling tanks, 12½ feet in diameter and eight feet deep, three treatment tanks, 13½ feet in diameter and eight feet deep, three extraction boxes and three solution sumps; also test room and accommodation for the men; the whole covered by a roof 50 by 60 feet in size. An elevator in the mill raises the tailings from the discharge there to the top of the cyanide works. A large percentage of the slimes is eliminated by slime separators in filling the first tanks. Although there is a considerable percentage of copper in the ore, by proper manipulation of the solutions a good extraction is secured without much loss of cyanide.

The Mill and the Cyanide Works.

Mr. Pengilly, who superintended the erection of the plant, and now superintends the working of it, is highly pleased with the success achieved so far in the cost and percentage of extraction; and thinks that this method of treatment is the solution to the problem of the profitable treatment of even the low grade ores of the Lake of the Woods.

Pennsylvania coal is used in all the boilers; it is much more convenient to handle, and the cost not much greater than the wood which grows in the vicinity. The chief difficulty is the transportation from Rat Portage on account of the low water at Ash rapids, but this has been remedied by the Government to a considerable extent by the deepening of the channel, and stop logs are being put in the dam on Winnipeg river, which will enable a uniformity of water level to be maintained in future.

Coal for Fuel.

New buildings at the mine consist of an engine house at No. 2 shaft, dressing room at No. 1, men's sitting room, cyanide building and a number of private dwellings. A new steamboat dock and a coal dock have also been constructed.

Buildings.

The following instructions were left in the Inspector's Book: 1. Fence the open cut west of mill and also shafts No. 3 and 4. These have been complied with. 2. If work is continued at the 120-foot level in No. 2 shaft, a shield must be provided overhead to afford protection to miners from material falling down the shaft. Work has been suspended in this level. 3. The ladderway in No. 1 shaft must be kept clear of ice as well as possible.

Instructions.

Inspector DeKalb left instructions which will be found in his report.

On a small island north of the Mikado mine in Bag bay diamond drilling had been done by a new company, with the object of testing for an extension of the Mikado vein. It is reported that very satisfactory results were obtained and that development work will be commenced in consequence.

Toronto and Western Company.

The Shoal lake property of the Toronto and Western Mines Development Company, Limited, consisting of D410, adjoining the Mikado on the east, was visited on December 27. The manager is Mr. John T. Moore, and the foreman Mr. H. F. Downing. There was a total force of 12 men, including eight miners working day and night shifts.

The Location and its Development.

The formation is granite, a part of the same body which occurs on the Mikado property. The vein consists of a zone of altered granite about four feet wide, impregnated with quartz and pyrites. Its origin is no doubt similar to that of the Mikado veins, viz., a fault in the country rock; it is parallel to the latter veins, having a strike of north 30° west.

At a distance of about a quarter of a mile from Bag bay, with an elevation of 55 feet above the water, a shaft 7 by 11 feet in size has been sunk on the vein to a depth of 120 feet, and is being continued. The foot wall is quite plain and well defined. The dip varies from 60 to 80 degrees east. A suitable collar has been constructed to a depth of 11 feet. A neat and roomy manway with suitable ladders and platforms has been constructed to within 40 feet of the bottom, properly cased off from the hoisting compartment. It is the intention to drift at a depth of 100 feet. Blasting is done by electricity.

Well constructed shaft and engine houses have been built; the former 20 feet square and 25 feet high, and the latter 23 feet square, adjoining.

The hoisting plant consists of a 25 h.p. duplex hoist, with steam brakes, 17-inch drum, $\frac{7}{8}$-inch steel wire cable running over $4\frac{3}{4}$-foot sheaves, a 750-pound wooden kibble sliding on a four-pole skidway and a 25 h.p. locomotive style boiler.

Ventilation is secured by a blower driven by a five h.p. engine.

Another shaft 200 feet distant has been sunk on a parallel vein to a depth of 57 feet, but work was suspended in it at the time of my visit.

The buildings on the property consist of boarding house, warehouse, ice house, barn, blacksmith shop, engine house, shaft house and powder house.

Cedar Island Mine.

The only work done at the Cedar Island, or better known as the Cornucopia mine, consists of diamond drilling, done by the Rat Portage Diamond Drill Company, H. W. Kennedy manager, and T. E. Smith superintendent. In all four holes were bored on the different veins, on the island and on the mainland, aggregating 869 feet. Mr. Smith informed me that the Rat Portage Diamond Drill

Diamond drill Exploration.

Company have done in the neighborhood of 3,000 feet of boring on the various properties in the district this year (1898).

Ontario Limited Company.

On July 1 I visited the Ontario Limited property, and found that all work had ceased.

Exploration and Development work

Walking over the property I found that several shafts had been sunk to considerable depths, and were partially full of water. As no information could be obtained I did not remain. While in Rat Portage Mr. C. W. Engledue, the manager, gave me the following notes on shaft sinking and diamond drilling up to the time of the suspension of operations.

On No. 1 vein, bore No. 1 started 76 feet north of the vein, at a dip of 79 degrees; depth of bore 220 feet on the incline, cutting the vein at a depth of 204 feet vertically. A five by nine-foot shaft had been sunk to a depth of 55 feet the first 30 feet being vertical, and the remainder dipping 45 degrees north. On the south end of the vein a shaft, No. 1 A, $4\frac{1}{4}$ by $7\frac{3}{4}$ feet in size, had been sunk 44 feet.

On the junction of veins No. 5, 6 and 7, No. 2 bore commenced 50 feet north of junction; sunk 197 feet on incline at a dip of 75 degrees north. A shaft was sunk on the junction to a depth of 65 feet.

On No. 4 vein, shaft 5 by 10 feet in size, 75 feet in depth; vertical for 40 feet, and dipping 60 degrees north for remainder of the distance. At a depth of 70 feet a drift was made 20 feet south.

The foreman of the work was James Emmons, subsequently employed at the Burley mine in Bald Indian bay. The diamond drilling was done by the Rat Portage Diamond Drill Company.

Mr. Engledue also informed me that 50 tons of ore from the open cut near the shaft of the Gold Coin mine, of which he had charge, were milled at the Keewatin Reduction Works, without very satisfactory results.

Great Granite Company.

Since July 21, 1898, prospecting work has been in progress on the property of the Great Granite Gold Mining and Development Company of Ontario, Limited. The capitalization of the company is $5,000,000; its president, General James E. Curtiss; its vice-president and general manager, Thomas W. Gleason; its secretary, D. D'E. Potter. Five thousand acres in one block, situated south of Echo bay, are owned by the company. On a few locations prospecting work has been carried on; four test pits, two 15 feet and two 10 feet deep, have been sunk on as many different veins on 248E; and on 272E a shaft is now being sunk which has reached a depth of $18\frac{1}{2}$ feet. The work is in charge of Mr. B. Leonard Thorne, who supplied me with the foregoing information.

Cameron Island Mine.

The Cameron Island mine, mentioned in last year's report, is on a small island of 16 acres, surveyed as mining location 170S, situated about six miles west of the Mikado, in Shoal lake. The property is now owned and operated by the Cameron Island Mining and Development Company, Limited, with head office at 71 Victoria St., Toronto. President, O. E. Foster, and secretary John R. Allan. Mr. William Caldwell was manager of the mine until the present summer, when Mr. William James became mine foreman and Mr. H. B. Hunt manager. At the time of my first visit, July 1, there was a total force of 20, including 15 miners, working in two shifts. A number of these were laid off later in the season, as the work in the shaft was suspended on account of poor ventilation, it being the intention to continue therein as soon as an air-compressing plant was installed. The manager informed me since that the mine was closed down until the spring of 1899, work having ceased October 1.

Operations of the Season.

The formation of this island is exceptional, consisting of coarse-grained amphibolite, or probably the augitic extreme of gabbro (altered no doubt to hornblende as is the case with most rocks of this nature in Western Ontario). At several points where the rock is exposed distinct, isolated segregations of coarsely crystallized felspar occur, covering areas of a few square feet or square yards, merging gradually around the edges into the hornblende; the felspar in the zones of mergence com-

Formation of the Island

monly occurring in large ophitic crystals distinctly visible to the naked eye even without close inspection. As only a limited amount of the rock is exposed, there is yet much to be learned as to the relative quantities of felspar and hornblende; but the nature of the formation is evident from what is already visible.

The ore bodies, or veins as they are called, are a series of parallel dikes of felsite extending across the island with a strike of north 30 degrees east. Descriptions of these can be found in the report for 1897. The main vein reveals an interesting feature which is worthy of note. The main portion consists of light colored felsite, containing a considerable percentage of quartz, and heavily charged with iron pyrites, the whole possessing a schistose structure. Where it is exposed on the north shore it shows a width of 16 feet, which is probably the average width of the dike all over. Near the centre of this dike, running parallel with it, there occurs a small dike about two feet wide of harder and darker colored felsite, which is a later eruption, as is evident from the fact of its being enclosed in the large dike, and not being altered or silicified like the latter. This forms the foot wall of the shaft.

Extent of the Workings.

A 7 by 12-foot shaft has been sunk on the dike or main vein to a depth of 120 feet, dipping 75 to 80 degrees west. At a depth of 62 feet a level has been established, with a five by seven-foot drift south on the vein for a distance of 42 feet, and one north 38 feet, of the same cross-section. Twenty feet from the shaft in the south drift a cross-cut has been driven west 14 feet, exposing from 11 to 13 feet of vein matter. A neat collar has been constructed to a depth of 20 feet, extending four feet above the surface. A manway with ladders and platforms suitably arranged has been cased off from the hoisting compartment to within 30 feet of the bottom. A three-pole skidway for bucket extends to within 20 feet of the bottom, with trap door at the first level. A substantially constructed shaft house, framed of 12 inches square timber, has been built.

The hoisting machinery consists of a 15 horse-power duplex hoist, with 16-inch drum, $\frac{5}{8}$-inch steel wire cable, iron kibble, and a 25 horse-power locomotive style boiler. Forty feet of tramway extends from the shaft house to the dump, with one Woodside Bros. iron dump car. No provision is made for pumping water, as the shaft is quite dry even at the bottom.

At a distance of 250 feet north of No. 1 shaft, on the same vein, a test pit was being sunk at the time of my second visit; it had reached a depth of 10 feet.

On the east side of the island, near the water level, a tunnel has been driven west 66 feet, cutting No. 1 vein and a branch of No. 2. These are both felsite bodies.

The following buildings have been erected: Engine house, blacksmith shop, shaft house, sleeping camp, boarding camp and office.

A steamboat dock, with a frontage of 30 feet, has been built on the east side of the island. The steamer Ethel, belonging to the mine, runs between there and Rat Portage.

Cordwood is supplied from a neigboring island, 172S, the property of the company.

The company are talking about erecting a 40-stamp mill in 1899.

On September 20, the date of Inspector DeKalb's visit, an Inspector's Book was left, with instructions, etc., which will be found in Mr. DeKalb's report.

Locations on Lake Minnietakie.

Activity on Lake Minnietakie.

During the past year the country around lake Minnietakie has been the scene of a fair amount of prospecting activity. Quite a number of locations have been surveyed, and on a few of these test shafts have been sunk, open cuts made, and other surface exploitation work done at various places on the lake and in the vicinity. A few days, beginning June 15, were spent in examination of some of these locations.

Entry into the Region.

Access to lake Minnietakie is obtained by means of a good wagon road nine miles in length from Dinorwic on the Canadian Pacific Railway to Sandy lake, a voyage of six miles by canoe across the latter and a 15-chain portage from there to lake Minnietakie, the entry into which is at the southern extremity of a long narrow bay, extending river-like in a southwesterly direction from the main body for a distance of

about 20 miles. An effort is being made to have communication improved by continuing the road around the eastern side of Sandy lake, where it is claimed a first class summer road only 20 miles in length can be constructed directly to lake Minnietakie, thereby avoiding the necessity of transhipping at Sandy lake. A Government road 27 miles in length has been cut from Wabigoon to lake Minnietakie, meeting it at a point a few miles north of the Sandy lake portage.

Formation of the Country

The formation of the country consists of a wide belt of green schists and trap, with quartz and felspar porphyries, altered felsite, gabbro, etc., scattered throughout, and Laurentian granite on the north and the south. The strike of the formation is northeast and southwest. The northern boundary, or the contact with the granite, occurs at some distance north of lake Minnietakie, and the southern contact crosses the southern part of the lake.

Harvey Syndicate.

Burnt Island location.

Mr. E. E. Harvey of Winnipeg, representing capital from that place, has been sinking on several properties during last winter and the following summer. Burnt island, where work was in progress at the time of my visit, was the first place examined. It is situated near the northwestern shore of the lake, about 40 miles from the railroad, and has an area of a few hundred acres. The eastern portion has been surveyed into a mining location. The island is fairly well wooded for mining purposes, although a portion of it has been burnt over. The formation consists of hornblende schist and quartz and felspar porphyry. The eastern part of the location is composed of an eruptive mass of the latter. A band of hornblende schist over 100 feet in width crosses the location with a strike of northeast through the porphyry. On the contacts between these rocks the veins occur. Two have been exposed so far. The main vein is on the easterly contact and can be traced almost across the island, a distance of about a quarter of a mile. It outcrops on elevated ground all along, and stripping consists for the most part in merely removing a few trees and a little moss. The other contacts are on lower ground, covered with several feet of earth, except at the shores where the rock is exposed. The main vein is exposed distinctly on the north shore, with a width of three or four feet. It has been stripped at several places along its strike, maintaining about the same width. The vein matter consists of quartz and porphyry mixed with a little green schist. About 200 feet from the shore, and 60 or 70 feet above the water level, a 7 by 9 foot shaft has been sunk on the vein to a depth of 48 feet, and is being continued. It is the intention to sink 60 feet and cross-cut east, as the east wall of the vein is not exposed in the shaft. There is an average of about three feet of quartz, with at least 4½ feet at the bottom, mixed slightly with schist. The quartz is white, semi-translucent, containing plenty of iron and copper pyrites and galena. A few nice specimens containing visible gold from the shaft were shown me. The force consists of three miners and a foreman, A. Johnson. A log boarding camp comprises the building accommodation.

Location BJ12.

On a parallel arm of the lake, and at a distance of 10 or 15 miles south, is another location BJ12, belonging to the same parties, where a shaft had been sunk the previous summer, and work suspended since. The vein is a contact between fine grained, massive greenstone and eruptive granite, the latter extending along in a bluff about 40 feet in height and from 50 to 100 feet back from the water. The vein dips northwest into the bluff, about half way up the face of the same. The shaft, which is vertical and was started on the hanging wall side, is said to be 35 feet in depth, but is now full of water. It is said to have been sunk to the foot wall, cutting through 26 feet of quartz. The cross-section is 6 by 8 feet, and a collar extends for 18 feet down. The vein on the surface is exposed for only a few feet at the shaft, showing a width of five or six feet. A few hundred feet south another exposure for a distance of 30 or 40 feet occurs, where it is entirely in the granite, and has a width of from two to three feet. The quartz is similar to that of the previous property, with small remnants of greenstone scattered all through. Galena is quite plentiful, also copper and iron pyrites.

Harvey's first camp, a few miles south of Burnt island, was the first place reached. Two locations, BJ17 and 20, had been surveyed, and I was informed a couple of small test pits had been sunk, but I did not visit them.

John Sykes Syndicate.

My trip to the Minnietakie country was made in company with Messrs. Fulton B. Jewell and G. H. Fanning, who with Joe Greenwood were prospecting and testing properties during the past year in this district for the John Sykes syndicate of Glen Williams, Ontario. They had surveyed a number of locations on different parts of the lake, and had done considerable prospecting work on them. Most of these were visited and examined with more or less minuteness.

The first were locations SV106 and 107, aggregating a little over 80 acres, on Neepawa island. The formation is hornblende schist and trap, with eruptive granite in the interior. The ore body is a porphyry dike three or four feet wide and traceable for at least a quarter of a mile, following the strike of the schist, which is northeast, and dipping nearly 90 degrees west. The island is pretty well timbered and moss-covered, rendering prospecting difficult. In fact all the country around this part is fairly well supplied with timber. An examination of the shore at another part of the island showed the rock to be altered felsite.

Locations SV106 and 107.

Location SV104, containing nearly 60 acres, and situated on a point about one mile south of Neepawa island, at the outlet of Twin lake, was next examined. The formation is similar to the preceding, being hornblende schist and trap, with a strike nearly east and west. Following a foot trail for a distance of a few hundred feet from the shore we came to the vein, which appeared to be a contact from one and a-half to three feet in width and traceable for 70 or 80 feet, curving around the base of a small hummock consisting of porphyry, and extending into the schist, across the strike of same. A few shots had been put in and a few square yards of stripping done. The vein appeared to lie pretty flat. It consisted of white quartz with little or no concentrates.

Location SV104.

A few miles further up Twin lake we came to SV105, on which the greatest amount of work had been done. The formation is hornblende schist, with a strike of north 20 degrees east. An ore body consisting of a mixture of quartz, schist and felsite, the whole possessing a schistose structure, and much altered on the surface, traverses the location with the strike of the schist. A seven by nine foot shaft was sunk on the hanging wall of the vein the previous winter, and although operations have been suspended for a while they will be resumed shortly. At the bottom a cross-cut has been driven 15 feet east. As the vein dips west the hanging wall is not exposed, but at least 16 feet of vein matter has been cross-cut, consisting of schist and quartz, about 25 per cent. being the latter, occurring in small lenticular masses and stringers. On the surface the vein has been stripped across in a couple of places about 150 yards south of the shaft. A couple of small felsite dikes full of quartz stringers were exposed, with considerable decomposed schist on both sides. A log cabin and a blacksmith shop have been built. I hear that a 10-stamp mill was being taken in here in January, 1899.

Location SV105.

Ruby Island, or location SV103, was next visited, and proved to be an interesting property geologically. The island is roughly dumb-bell shaped, a low lying isthmus with a beautiful sand beach —a number of sand beaches occur at different points on the lake—on each side connects the two main portions, only one of which, containing 30 or 40 acres, was examined. It was thickly timbered and the rock deeply moss covered, but by following the shore around where the rock was exposed a fair idea of the nature of the formation could be obtained. An examination showed that the latter consisted of a series of parallel bands of different kinds of rock, conforming with the general strike of the country. The principal of these is a band of hard, light-colored schistose felsite, containing small stringers of quartz. This was about 70 feet in width, and crossed the main portion of the island. On each side of this was a siliceous green schist varying from coarse to fine grained, and next to this a coarse grained amphibolite, which

Location SV103.

was exposed only on the west side. A small dike of coarse grained gabbro about eight inches in width in the green schist led to an examination of the main shore about two miles distant, where the formation proved to be gabbro.

Another island property, SV107, was visited on the return trip. A dike of porphyry over 100 feet in width, with hornblende schist on each side, crosses the island. In some places the porphyry is full of quartz stringers, usually a few inches in width, and running without any regularity or persistency. Iron pyrites is plentiful, and it is said that copper pyrites and galena also have been found. Two or three shots have been put in.

Location SV107.

The last places examined were SV109 and 110, aggregating 80 acres, on the long narrow peninsula extending northeast in the southwestern part of the lake. The country rock is green schist and trap. A felsite dike 12 to 20 feet in width, containing small stringers of quartz, crosses both locations. A shot has been put in at one place. On SV110 a small parallel dike from one to three feet in width traverses the location south of the larger one. A little stripping and blasting work has been done on it. At one point a quartz vein 12 inches wide is exposed on one wall of the dike, where a shot had been put in and some stripping done.

Locations SV109 and 110.

One or two other parties were working at different places on the lake, but I did not think it necessary to visit any more properties during this trip, as nothing more than prospecting work was being done.

Locations in the New Klondike.

During the greater part of the year three or four properties in the New Klondike have been steadily worked and the place bids fair to become an important mining centre. A new flag station named Dyment, with a half mile of side-track, has been established on the Canadian Pacific Railway, where Bear creek crosses the track, a distance of 20 miles east of Wabigoon, and the town site of Dyment surveyed. Mr. D. A. Larson, who was instrumental in securing this station, has built a hotel there, with first-class accommodation, and this is now the most convenient point of entry to the mining country to the south. A wagon road nine miles in length leads to the New Klondike. This was originally cut out by Walker and Brown and others who are principally interested there, and the Government has widened and improved it for a distance of six miles. The country being comparatively level and the timber light, very fair roads can be cut at no great expense. The New Klondike is also reached from Wabigoon or Dinorwic by a steamer which runs up Little Wabigoon river to within three miles of the mines, and a road has been cut out in order to establish connection with the railway by this route. Other roads from place to place have been cut out where necessary by those operating in this section. Thomas Hogan, who has done most of the development work here by contract, has been very energetic in road cutting, having spent, he informed me, $500 in this work

The New Klondike Country

Watson's Mine.

What is apparently one of the best properties in the New Klondike is HW416, a location of 40 acres, owned by the Hon. Robert Watson, Minister of Public Works for Manitoba, and John M. Monroe, of Dinorwic. Mention was made of this property in last year's report. On no property in this part of Ontario are finer surface showings evident. Whether the results of development work will fulfil the expectations of the owners is an interesting question to all who are operating in the vicinity. The formation is felsite and felspar porphyry. Fire has run over a considerable part of the location, which had been covered with a dense growth of small evergreens; and about 6½ acres have been cleared. Large masses of dark blue quartz outcrop irregularly on the higher ground where the rock is exposed, suggesting the likelihood of immense ore bodies underneath. As the greater part of the location is either muskeggy or the rock soil covered, the work of stripping is expensive, necessitating the removal of considerable earth, loose rock, moss and trees, and although a great deal of this work has been

Location HW416

done, with very favorable results, there is still much to be learned from what is yet hidden under the surface covering. The largest outcropping of quartz is about 150 feet in length, with a jog of 20 feet near the centre. It ranges in width from one to 22 feet, averaging 10 or 15 feet. Being apparently more resistant to glacial action than the country rock, it stands out to a height of several feet. A trench 170 feet long, two to three feet wide and three to five feet deep, has been made along the south wall of the ore body, and near the south end an open cross-cut five to eight feet deep and 75 feet long has been made, cutting through 22 feet of quartz.

Another body of quartz three feet wide is cut by the cross-cut at a distance of fifty feet from the large body. Other outcrops occur to the south, on the strike of the large vein, but their connection with the latter has not yet been determined. Farther west bodies of quartz several feet in width have been uncovered for a short distance in three or four places. A costean six or seven feet deep and about 17 feet long has been made on a vein crossing from HW477 on the southern part of the location. The principal vein is traceable with a continuous outcropping for about 150 yards, varying in width from one to seven feet, and averaging about three feet. It has a strike of northeast and a dip of about 80 degrees east. About 250 feet of the vein has been stripped. At the northeast end a junction occurs with a large vein six or seven feet wide which comes in from the south, and is traceable for seventy or eighty feet with stripping for most of the distance. A six by eight foot shaft, dipping about 80 degrees east, has been sunk on the vein to a depth of 90 feet, and is being continued. The work is done by Thomas Hogan, who has contracted to sink 150 feet with 200 feet of drifting at the 100 foot level. The vein is not so strong in the shaft as on the surface, the variation in width being considerable. There is a comparatively large quantity of copper pyrites and zincblende present, along with the usual per cent. of iron pyrites and a little galena. The hoisting plant consists of a 10 h.p. hoister, a 9 h.p. upright boiler and 750 lb. ore buckets, sliding on a skidway extending to the bottom of the shaft. A head frame 22 feet in height has been constructed. A suitable ladderway has been provided to within 30 feet of the bottom, the ladders below this being movable. The force consists of seven miners, working in day and night shifts. There are on the property a boarding camp, a hoisting engine house and a stable.

Northwestern Ontario Exploration Co.

Location HW 418.

A number of locations had been taken up by Walker and Brown, the first prospectors in the New Klondike. An offer was made of any one of their locations to whoever would sink a 250 foot shaft upon it. This offer was taken by the Northwestern Ontario Exploration Company, with head office in London, England. Managing director of the company, J. Scott Smith, and superintendent of mines, S. F. Franco. HW418 was first chosen. What appeared to be the outcrop of an immense body of quartz 40 or 50 feet in width, forming a small hill, proved upon sinking a 12 foot test pit to be nothing more than the upper side of a flat lying vein two or three feet in thickness. This however dipped at an angle of 20 degrees into a bluff 70 or 80 feet away, and a shaft was sunk there to a depth of 78 feet, 34 feet vertically in the hanging wall, cutting the vein, and 44 feet on the incline. This shaft, I was informed, revealed three feet of pure quartz and about 12 feet of a mixture of quartz and greenstone. But as values were not satisfactory it was abandoned entirely, after being properly fenced to prevent accident.

Location HW419

The same company are now sinking on HW419, an adjoining location of 40 acres. Work was commenced under the previous agreement, but an absolute title to the property has since been acquired. A shaft seven by nine feet inside the timbers has been sunk to a depth of 142 feet, with sinking continued. It is sunk on a very small but extremely rich vein, from four to six inches in width on the surface and said to be traceable for 1000 feet. It has a strike of slightly north of west, and a dip of nearly 90 degrees west. The vein at a short distance down pinched out altogether,

leaving a mere seam which continued persistently for a distance of 30 feet, and gradually widened into a vein again, until at a depth of 74 feet it was five feet wide. It then pinched out suddenly and left no traces of a vein whatever. Sinking was continued through the barren rock to a depth of 97½ feet from the surface, when quartz again appeared. This proved to be the vein again, which continued very persistently and clearly defined, with a width of from three to 10 inches to the bottom. I have been told that since I last visited the place the vein has widened out to two feet at a short distance farther down. The quartz varies from white to blue at different depths. It is slightly mixed with country rock and heavily charged with copper pyrites, with a fair quantity of zincblende and pyrrhotite. Strange to say, iron pyrites is rare. Considerable visible gold has been found. This mineralization applies to the upper portion of the vein, before it disappeared at a depth of 75 or 80 feet. The lower portion differs in that the zincblende has entirely disappeared, none having been found since the vein appeared the second time. This and the slightly different appearance of the quartz along with other considertions would lead to the surmise that the two portions of the vein had very little connection. The country rock next to the vein is massive and dark colored, with a felsitic structure, and is perhaps felsite. There is not sufficient surface exposure of the rock to make the geological surroundings of the vein intelligible, but an examination of the shaft near the bottom shows the vein to be included in a dike of this hard felsitic rock three or four feet in width, with softer schistose rock on each side. The mouth of the shaft is at an elevation of about 100 feet above a small lake close by. It has been securely timbered for a depth of 100 feet, with a ladderway for the same distance, and instructions were left to continue the ladderway to the bottom. The hoisting plant consists of a 20 h.p. hoister, with a 12 h.p upright boiler, a head frame 18 feet in height and a skidway for bucket extending to the bottom of the shaft, the first 70 feet being vertical. Blasting is done by electricity. A force of six miners is employed. The work is done by Thomas Hogan, who has contracted to sink to 200 feet. The usual building accommodation, such as boarding camps, etc., is provided. Roads have been cut through, communicating with adjoining locations and with the railroad.

On the same location a tunnel has been driven 50 feet on a vein which outcrops down the face of a hill and is said to be traceable for 600 feet along the top of the same. The dip of the vein is 55 degrees. It varies from two inches to two feet in thickness. Although rich at the entrance the vein was poor in the tunnel, hence the abandonment of it.

On HW417 two test pits several feet in depth have been sunk 40 feet apart, on a vein of white quartz from two to seven feet in width.

Maw and Greening Syndicate.

Messrs. John Maw and S. O. Greening, of the B. Greening Wire Co., of Hamilton, Ont., have together secured a half interest in (and I believe have since secured a complete title to) five 40-acre locations, viz., HW455, 476, 477, 478 and 479, from C. W. Hale and Captain H. Lowry of the New Klondike. Two or three of these have been under development all summer with the following results :

Location HW479.

On HW479 a four by seven foot shaft has been sunk to a depth of 40 feet on a small vein averaging two feet in width, and traceable for about 250 feet, with stripping for the greater part of the distance. It has a strike of north 60 degrees west and a dip of nearly 90 degrees north. The width of the vein in the shaft remains about the same as on the surface. The quartz is dark blue, well charged with copper and iron pyrites and pyrrhotite. The shaft is provided with a neat and substantial collar to a depth of 10 feet, and a ladderway 18 inches in width, securely boarded off from the hoisting compartment for a suitable depth. The work is done under the superintendence of C. W. Hale.

Location HW477.

On HW477, which adjoins HW416, mentioned previously, a number of outcrops occur suggesting the possibility of definite and fair sized veins underneath. The country rock is felspar porphyry and fine grained diorite. Some of these outcroppings, which average about two feet in

width and range from three or four to 10 or 12 feet in length, are roughly arranged so as to represent the outcroppings of probably continuous veins, while other exposures are isolated or branch off irregularly, making the whole a complex puzzle. In one instance a test pit was commenced on a small exposure of quartz which proved, upon the results of a few shots, to be quite a large sized quartz body capped by two feet of porphyry. Considerable test pitting and stripping has been done with satisfactory results. The quartz with its mineralization is similar to that of adjoining properties. It would be superfluous to mention all the veins examined, as the foregoing is fairly well representative of this part of the country.

An interesting geological phenomenon was shown me by Captain Lowry on locations HW456 and 457, where the contacts occurred among biotite granite, felsite, and a dark colored schistose rock of felsitic structure of an earlier age than the felsite. In fact the felsite was the latest of the three. Its contact with the granite was very sharply defined and quite interesting. Numerous small stringers of blue quartz occurred in the granite, and some in the felsite also.

Contacts on HW456 and 457.

Veins in Coarse Gabbro.

An occasion was taken advantage of to visit HW460, a location belonging to Thomas Hogan, which proved specially interesting on account of the formation, which was gabbro, of a rather coarse texture. Extending up the sloping face of a hill about 200 feet in height, several small veins were observed, ranging in width from several inches to two feet, and traceable for from 25 to 100 feet, and said to be found also on the other side of the hill. A little stripping and blasting had been done, but assay values were too low to warrant any great expenditure. The quartz is blue, with no visible concentrates. Inclusions of green schist were found associated with one of the veins. At another place on the location several hundred yards distant, a band of this schistose rock 10 to 15 feet in width extended through the gabbro, and contained some splashes of white quartz well charged with pyrites. Some blasting had been done, but assays were low and work was discontinued.

Location HW460

Tabor Mine.

The Tabor mine was visited on November 2nd. This was reached by steamer, which ran from Wabigoon to a landing up Little Wabigoon river, 25 miles from the railway. A foot trail of a mile in length led to the mine. The property consists of SV258, owned by James Tabor and James Stephenson of Wabigoon, and operated under bond by the Eastern Townships Mining and Development Company of Sherbrooke, Que. A small quartz vein averaging a foot or so in width and traceable for several hundred feet, has been sunk upon by a five by eight foot shaft to a depth of 50 feet, the shaft having an inclination of 80 degrees with the horizontal. The manager of the mine is H. B. Aylmer, and the foreman Thomas Armstrong.

Location SV258.

Locations on Manitou Lake.

In the latter part of June I made a trip through the Manitou region and visited a couple of properties which were the only places under development at that time.

Westerfield Mine.

The first place visited was situated between the Upper and Lower Manitou lakes, near the narrows. The steamboat landing was connected with a small body of water named Charlton lake by a foot trail of about a mile in length ; a canoe trip of about half a mile across Charlton lake completed the connection with the property. This consisted of locations HP355, 386 and 387 and G31 ; containing 40 acres each. Operations have been carried on by the Manitou Lake Gold Mining Company, Limited ; the head office, St. Paul. President, F. M. Joslin ; vice-president, Cyrus Wellington ; secretary, F. E. Draper ; general manager of the mine, N. C. Westerfield. The company own the first two locations and hold the last two under bond. Work has been going on since April 12. A force of seven miners was employed at the time of my visit, June 21. The formation consists of green schist. An irregular quartz vein two or 2½ feet in width, apparently breaking into

Locations HP355, 386 and 387 and G31.

branches in one or two places, is traceable by several out-croppings for over 1000 feet. A band of schistose felsite about two feet in width is associated with the vein for a considerable part of its length.

Three shafts have been sunk; the first, or No. 1, to a depth of 43 feet; the second, or No. 2, at a distance of 180 feet from No. 1, 22½ feet, and the third or No. 3, at a farther distance of 700 feet, to a depth of 40 feet, with 20 feet of drifting in each direction at the bottom. The first two shafts were not in operation and were partially full of water at the time of my visit. No. 3 shaft is about a quarter of a mile from Charlton lake, to which a tramway could be conveniently constructed with a drop of 70 or 80 feet towards the water, if it were desired to build a mill. Mr. Westerfield gets very satisfactory assays from the quartz resulting from development work. All the quartz taken from the shafts is carefuly sampled and assayed weekly on the premises.

Barker Mine.

I learned later on in the season that operations had been commenced on a property known as Barker Bros. mine on the southern part of the Lower Manitou lake. I did not visit the property, but Mr. Forbes, the business manager, informed me that a shaft had been sunk about 50 feet, with a considerable amount of stoping between the bottom and the surface. A 2-stamp Tremaine mill has been installed and has been in operation for some months.

Quackenbush Locations.

On my return trip to Wabigoon I visited HP375, a property under operation by Mr. V. Quackenbush. Two shafts have been sunk 50 feet and 66 feet respectively, (the former having 18 feet of cross-cutting at the bottom where the vein is very wide) on a small bedded vein of quartz in a green schist formation. These shafts were not in operation at the time of my visit; the figures regarding depth, etc., having been obtained from Mr. Glass, the manager of the work. But sinking had been commenced on a felsite dike full of quartz stringers, which crosses from an adjoining location and has the appearance of a promising ore body.

Mines of the Lower Seine.

The region of the Lower Seine is developing well. It has two mines that are producing gold, and a number of properties are in course of development that in a short time, it is confidently hoped, will be equipped with mills of large capacity to treat their extensive ore bodies.

Golden Star Mine.

The Golden Star mine has made rapid progress since the commencement of operations.

Organization of the Company.

The property, consisting of locations AL114 and 116, situated about 4½ miles north of Mine Centre, was originally owned by the Seine River and Rainy Lake Exploration Company, but has since been acquired by the Golden Star Mining and Exploration Company of Ontario, Limited. Head offices, Duluth, Minn., and Port Arthur, Ont. President, A. C. Hubbell; vice-president, Thomas A. Merritt; secretary-treasurer, A. E. McManus. Capitalization of the Company, $1,000,000, in $1 shares.

Development work has been advanced as fast as possible since the shaft was started.

Extent of development Work

The following are the underground measurements up to January 26th, 1899, the date of my last visit: Depth of shaft, 376 feet. First level, depth, 74 feet; north drift, 107½ feet; south drift, 101 feet. Second level, depth 150 feet; north drift, 149½ feet; south drift, 120⅜ feet. Third level, depth, 225 feet; north drift, 150 feet; south drift, 25 feet. Fourth level, depth, 300 feet; north drift, 113½ feet; south drift, 22½ feet. Height of drifts, seven feet; width, four to 15 feet. Winzes and upraises: 100 feet north of the shaft is a winze between first and second levels; 80 feet north of shaft, winze between second and third levels; 110 feet north of shaft, in third level, winze 30 feet deep; 60 feet from shaft, in second level south, upraise 57 feet above floor of drift. Stoping: First level south, length 40 feet; height above floor, 70 feet; width, three to seven feet. Second level, north, length, 30 feet; height, 31 feet. Third level, north, overhand stoping commenced at

winze.[1] The ore is shot down on a row of stulls placed under the stopes along the roof of drifts, and sent through mill holes to cars below.

Equipment of the Mine.

A No. 7 Cameron pump is employed for draining the mine. A six-drill Rand compound air-compressor has been installed, with four Little Giant drills in operation. Three thousand feet of five-inch conductor pipe extends from the shaft to the mill where the compressor is situated, with four-inch pipe down the shaft. Two receivers, 10 feet in length by 30 inches in diameter, are in use. Tramways are laid in all working drifts, with tramcars in first and second levels. Hoisting has hitherto been done by bucket, but a skipway was in course of construction at the time of my last visit, having been completed and in operation to the second level. A 2,000 pound steel skip has been installed, with steel railway and suitable back stringers to prevent the skip from leaving the rails. A self-dumping arrangement is provided at the surface, with chute. The hoister is a duplex with 8½ by 12-inch cylinder and 42-inch drum, made by M. C. Bullock of Chicago. A 65 h. p. boiler furnishes steam. A 40 light dynamo has been installed at the mine, with incandescent lights at the loading stations underground as well as on the surface. An Otto aerial tramway, 2,700 feet in length, conveys the ore from the shaft to the mill. The discharge terminal is 10 feet lower than the loading

[1] NOTE ON THE GOLDEN STAR MINE.
July 18, 1898.

Apart from the fact that it is producing the largest amount of gold in the Seine River district, the Golden Star, like the Sultana, is interesting as an ore deposit. This is in a measure due to its situation.

As is well known, a mass of that variety of granite commonly known as protogine has forced its way to the present surface through the green Huronian rocks between Shoal and Bad Vermilion lakes, and in this intrusive material are found at a number of points well defined fissure veins, and more rarely small bodies of auriferous felsite. Deposits of the former class were being worked at the Foley, Ferguson, AD2, Lucky Coon and Emperor mines, while an opening on the felsitic material may be seen at the vein close to the mill on the Ferguson property.

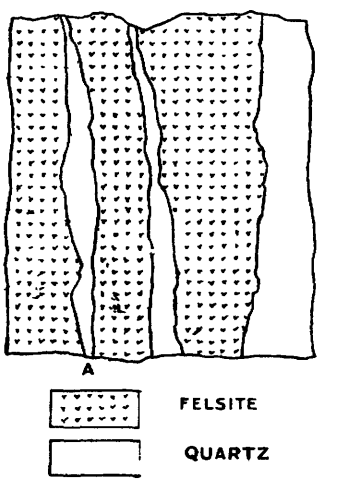
At the Golden Star, however, there is a change. Instead of lying wholly within, the mine is situated in Huronian rocks to the north of the area of granite, distant only a few hundred yards from the edge. The shaft has been sunk on a broad ledge on the face of a hill, which to the south slopes gently up to a height of about 100 feet, and on the north descends a short distance to a small ravine.

Starting from the shaft to walk in a southerly direction, a shallow pit is met with almost immediately; in the walls and bottom can be seen portions of a dike of yellowish-green felsite, with streaks of quartz. There is an opportunity afforded here of examining both horizontal and vertical sections of these quartz bodies; they are distinctly lenticular in form, and are irregularly distributed through the felsite. This is shown in the accompanying sketch.

The horizontal section as seen in the bottom of the body marked A is an almost symmetrical lense in shape, terminating sharply at one end.

Proceeding southwards up the hill, the dike may be traced for some distance with an average width of 10 to 12 feet; time did not permit a further examination in this direction. North of the shaft it could not be traced for debris, and plunging into the little ravine it is lost beneath heavy soil.

From a surface examination it was seen that no definite continuous vein was traceable, but that parallel lenticular bodies of quartz traversed the



Scale—1 inch=2 feet.
Face of south side of pit just south of shaft.

dike somewhat irregularly. It was impossible to determine, on account of the soil, whether these were branches from one vein or separate masses arranged along parallel lines of fissure, and indeed it matters little to the working of the mine which of these ideas is correct, although the inclination is to give preference to the latter. Some further evidence may be gathered from the underground workings.

The shaft at this time had reached a depth of 290 feet, and three levels had been run at intervals of about 80 feet.

The first level north showed a fair amount of quartz in the dike near the shaft; as the breast was approached the felsite diminished in quantity and finally disappeared, while a 10 inch vein of quartz continued its course through the greenstone

terminal, which difference of elevation, owing to the ups and downs of the cable way, is not sufficient to admit of transportation by gravity, an additional four horse-power, applied at the mill, being required for the purpose. No curves are necessitated. The carrier cable for loaded buckets is 1⅛-inch in diameter, and for empties ⅞-inch; the traction cable is ⅝-inch in diameter, and has a speed of four feet per second. Fifteen standards, constructed of six by six inch timbers and situated at various distances apart, support the cables. Nine steel buckets of 600-lb capacity each are in use, with three in reserve.

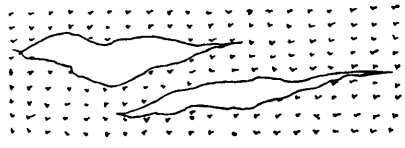
Stamp mill on Bad Vermilion lake.

A stamp mill has been erected on Bad Vermilion lake at a distance of half a mile from the mine. It is situated on JO41, a location adjoining the Golden Star property and belonging to the JO41 Gold Mining Company, with the surface rights leased to the Golden Star Company. The mill has an excellent site on bare rock which has a convenient slope towards the water, of which there is a suitable depth. The building is substantially and neatly constructed of material supplied by a saw mill on the property. The following are the dimensions: Battery room, 37 feet 5 inches by 43 feet 8 inches; vanner room, 37 feet 5 inches by 40 feet 8 inches; engine and compressor room, 37 feet 6 inches by 36 feet; boiler room, 30 feet by 40 feet. The machinery consists of the following: Comet D crusher—the buckets dump directly into the crusher without intermediation of grizzly—100-ton ore bin, two Challenge ore feeders, two batteries of five stamps each, two Browne's two-compartment hydrometric sizers and four Frue vanners with six-foot smooth belts. The machinery is all from Fraser & Chalmers. Power is supplied by the following: A 12 by 36-inch Fraser & Chalmers Corliss engine, with 96

---

country rock. Driving had been discontinued when this latter was reached on account of the poverty of the ore. In the south portion of the same level the felsite was present in large quantity and no greenstone was visible. The quartz as seen in the roof commenced at the shaft with a width of two feet, which rapidly increased to eight feet in a few yards. There was here a large body of ore, eight feet broad and 15 feet long; after this was passed the quartz shrank very much in size, and at a distance of about 40 feet from the entrance separated into two divergent branches, six inches and 10 inches wide respectively. At this point work had ceased.

On the second level north, a niche had been cut for a pump in the east wall a few feet from the shaft. In the face of this enlargement could be seen an irregular body of quartz, 14 feet across, but cut down suddenly by a mass of felsite to about half the width. Because of the irregularity, it was impossible to judge the size of this body of ore with any accuracy; it probably extended upwards for a fair distance, while maintaining its width, and this would imply a mass of considerable size. As in the level above, the felsite thinned out gradually as the face was approached, leaving only the quartz to traverse the greenstone. In the roof of this could be seen some typical lenses of quartz; they are represented roughly in the sketch.



The third level south had been driven 25 feet in felsite with an average exposure of quartz 10 inches in width; the latter had at this point some of the features of a continuous vein.

In the north drift felsite can be seen all along the walls, although the width is not more than six feet as shown by a cross-cut near the breast 70 feet from the shaft. The quartz as usual varies in amount; there is a fair quantity near the entrance, but only four inches at the breast.

At the bottom of the shaft three feet of quartz can be seen on the hanging wall, and this extends for some distance up; the appearance of this portion of the deposit was very encouraging.

It is impossible to give any information as to the value of the different portions of the lode; but no better evidence could be desired than that offered by the treatment of the ore on a large scale. The results of the mill tests are too well known to require quotation. I was informed by Mr. Merritt, at that time superintendent, that the felsite carried sufficient gold to rank as a low grade ore, and although I had no definite information as to the tenor of the quartz, it is probable that the values are fairly large. If the felsite is as rich as was stated, the amount of deadwork in the mine will be small, and the lenses of quartz will represent bonanzas instead of constituting the ore necessary for the economical operation of the mine.

From its physical characteristics it is more than probable that the felsite extends in the form of a dike to a considerable depth, and with this encouraging hope it might be possible to tide over any season of poverty during the exploitation of the lode.

A good deal of work has been done since these notes were made however, and the deposit has doubtless been explored with some thoroughness. At that time there was abundant promise of a prosperous future in ore reserves which had been blocked out, and in the appearance of the ore body in the shaft and lowest level. Unless some radical change has taken place there is no reason for resigning this hopeful view of affairs, which would place the Golden Star among the foremost of our mines in Western Ontario.

J. Watson Bain.

revolutions per minute, a Fraser & Chalmers return tubular 80 h.p. boiler and a Rand Drill Co. boiler of the same type and power. The mill is lighted by a 60-light dynamo, driven by a 16 h.p. engine. The mill has been in operation since November 9, 1898. The machinery is well constructed and substantial, and works very satisfactorily.

The foundation of the batteries was prepared by excavating in the solid rock to a depth of four feet, filling with concrete carried to a height of four feet above the surface, making a depth of eight feet of concrete altogether. On this are placed the solid cast iron anvil mortar blocks, 30 inches in height and weighing 14,000 lb each. The mortars, which weigh 6,300 lb each, are placed on these.

Mill Practice

The following details of mill practice, etc., will be interesting: Number of stamps, 10; weight of each, 1,020 lb; capacity of mill, variable, average 35 tons per 24 hours (although 41 tons have been crushed in that time); height of drop, six to seven inches; speed, 97 drops per minute; material of shoes and dies, forged steel; cams (Blanton), tappets and heads, cast steel; depth of discharge, five inches when dies are new, not maintained constant; screens, diagonal slot, 40 mesh; no inside amalgamation; apron plates, 12 feet long by 54 inches wide; double with 1½-inch drop in centre; slope, 1⅞-inch per foot. The amount of mercury added to the batteries varies with the quality of the ore. About five gallons of water per minute are used to each battery. Plates are dressed every three hours. There is about one per cent. of concentrates, which assay very high—from $150 to $200 per ton.

A dock has been constructed close to the mill, and a small steamer owned by the company runs on Bad Vermilion lake between the mine and the portage on the small river which empties into the Seine.

Buildings and Employes.

There are about 25 buildings on the property, including mill building, tramway terminals, shaft-house, dry, blacksmith shop, hoisting engine house, office, assay office, powder magazine, stables, boarding camps, a number of private dwellings and a saw mill: the latter has a capacity of 10,000 feet per day.

There is a total force of 35 on an average; of these 16 are miners and six are employed in the mill. The general superintendent is Robert A. Kerr, and the engineer C. J. Stone.

Condition of the Works.

The mill machinery is all in a satisfactory condition. The ventilation and drainage of the mine is satisfactory. A manway has been constructed to the required depth, with ladders and platform provided, but not well arranged in some places. The bucketway is properly fenced at the shaft-mouth. The following recommendations, etc., have been left in the Inspector's Book on the occasion of my last visit: 1. Attention is directed to the requisition regarding signal code in previous entry. 2. Several rungs in the ladderway were found weak and broken; more care should be taken to prevent this state of affairs. 3. Below the fourth level arrange the ladderway so that the man-hole will be on the foot wall side of the platform, and the foot of the ladder on the hanging wall side. 4. Provide a suitable guard rail around the skipway at the second level and at all others below. 5. Scale carefully the walls in stopes, as they (the hanging particularly) are not very sound. 6. The stulls in some cases are not well placed, considering the softness of the hanging wall; they should be set at an angle between the normal and the vertical. 7. Do not allow riding on the aerial tramway. Inspector DeKalb left instructions which will be found in his report.

A fatal accident occurred in the shaft on October 28, 1898, and a special report on the same was made to the Bureau.

Olive Mine.

Organization of the Company.

Development work has been steadily progressing at the Olive mine, with installation of new milling and mining machinery. This property originally belonged to the Preston Gold Mining Company of Ontario, Limited, but as this corporation was formed for exploration and development purposes only, a subsidiary company, the Olive Gold Company of Seine River, Limited, was formed to take over the mine after a certain stage of development work had been reached. The officers of the

latter company are as follows: President, Hon George E. Foster; vice-president, William Blackwood; secretary, C. B. Deacon, Winnipeg, Man. The company is capitalized at $1 000,000 in $1 shares. W. A. Preston is superintendent of mines; address, Olive Mine, Mine Centre, Ontario. A. E. Doidge is mine captain and engineer. A variable force has been employed throughout the year, averaging about 35.

Measurements of the Mine

Mining operations have been almost exclusively confined to the main shaft; a little test pitting, etc., having been done at other points on the property. On G60 a test pit has been sunk 25 feet on what was believed to be an extension of the main vein, but is discontinued and properly fenced. The following were the underground measurements in the main shaft on the date of my last visit, January 25, 1899. Depth of shaft, 223 feet. First level, depth, 60 feet; east drift, 70 feet; west drift, 127 feet; cross-section, 4 by 6 feet. Second level, depth, 135 feet; east drift, 90 feet; west drift, 19 feet; cross-section 5 by 6½ feet; air shaft, 60 feet east of main shaft, and connected by drift with the latter; depth, 60 feet. Stoping: In the first level east, all ore is stoped out overhead between main and air shafts, leaving a shaft pillar from 10 to 25 feet in length at the main shaft, extending from the first level to a height of 36 feet, with filling of broken ore above, and five by five feet shaft pillar at the air shaft near surface, with broken ore filling each side of the shaft supported by stulls and lagging extending up each side and along the roof of the drift. Stoping east of air shaft: Length, 42 feet; average height, about 18 feet; width of total stoped out space east of main shaft, about three feet. In west drift: Length of stope, 31 feet; average raise above drift, 4½ feet, and width, 2½ feet

Equipment of the Mine

East of the shaft at the second level a pump chamber has been excavated in the foot wall and a cistern sunk, a No. 7 Cameron pump being employed for drainage. A ladderway has been constructed to the second level, with temporary ladders below. A six-drill Rand air compressor has been installed with five No. 2 drills in use, and two receivers 10 feet in length by 30 inches diameter. The shaft had been vertical for the first 12 feet of depth, but has been recently straightened to correspond with the inclination of the remaining portion. The shaft house has been moved accordingly.

No important change has been made in the hoisting machinery, which consists of a small steam hoist and bucket with ⅝-inch wire cable. The shaft house has been partially boarded in and chutes constructed for dumping ore and waste rock separately.

Milling Machinery

The old two-stamp battery has been supplanted by a larger one, and other additions made to the milling machinery, which was expected to be in operation early in February. The new machinery consists of the following: Two batteries of five stamps each, with 10-foot apron plates, two Challenge ore feeders, a three-compartment hydraulic classifier, two extra six-foot smooth belt Frue vanners — there being already one in use—and a Comet crusher. All the machinery is from Fraser & Chalmers. There are also two new 45 h.p. locomotive style boilers, connected with the old boiler, and a 35 h. p. engine, with pumps, tank, heater, etc. The old building is used, with an addition to the vanner room of 16 by 20 feet, and a new boiler room addition of 30 by 40 feet.

Buildings

The following buildings are on the property: Mill building, shaft house, hoisting engine house, dry, blacksmith shop, assay office, office, store house, stables, general dining and sleeping camps and private dwellings.

State of the Mine

Before the compressor was installed the work had been suspended altogether below the first level during part of the summer, owing to the poor ventilation, but the compressed air removed this difficulty. B. shaft and the new test pit have been properly fenced. The main shaft is provided with suitable guard rail with the exception of on the north side, where a chain is employed. Instructions were left to have a rail substituted for the chain. Convenient loading stations have been provided at both levels; the excavation in the hanging wall furnishing a safe passage way from one drift to another. The following recommendations, etc., were left in the Inspector's Book on the

occasion of my last visit: 1. The man-holes in the first two platforms of the manway should be reduced in size. 2. A shield should be provided over the ladderway at the first level to prevent material falling down the shaft from entering the man-hole there. 3. Keep ice cut away at the first level, and also keep ladder rungs clear of ice. 4. The ladders below the second level are not safely hung; they should be made more secure.

Alice A. Mine.

American and Canadian Gold Mining Co

The Alice A. property consists of K191, a location of 80 acres. It is reached by a 3½-mile foot trail from Wild Potatoe lake. But perhaps the most convenient means of access is by way of Little Turtle river, to the mouth of which a Government road extends from Mine Centre; a voyage of eight or nine miles up the river and a trail of three-quarters of a mile complete the route to the mine. It may also of course be reached from the Olive mine, which is on Little Turtle lake. A winter road 10 miles in length connects the mine with Mine Centre. The owners are the American and Canadian Gold Mining Company, with head office at West Superior, Wis. President, J. S. Hillyer, West Superior; vice-president, George H. Hillyer, West Superior; secretary, J. M. Gray, Duluth, Minn. The manager of the mine is George L. Robbins, and the foreman, T. G. Prideaux.

The Property and its Development.

At the time of my visit, July 26th, there was a force of nine men, including three miners. The formation has been described in previous reports, and a repetition is not necessary. The latest developments appear to show that the country rock for a width of hundreds of feet carries gold in paying quantities, and that it is therefore a large, low grade proposition. But, like the Hammond Reef, it will doubtless be some time before an estimate of its value can be safely ventured.

Near the centre of the location two shafts have been sunk 300 feet apart on a slightly elevated area of bare rock, and a number of small test pits two or three feet in depth have been sunk at different points for test purposes. One of the shafts is 35 feet deep, but full of water. An open cross-cut 18 feet deep has been made north from the shaft, cutting altogether, including the shaft, 35 feet of the ore body. It is intended that open mining shall commence at this cross-cut by working westward, removing the ore in slices or benches as in underhand stoping. The other shaft has been sunk 70 feet, and sinking discontinued for the present, with the intention of resuming again in the winter. At a depth of 60 feet a 5-by 7-foot cross-cut has been driven north 12 feet, and will be continued to about 200 feet, all this underground work being for test purposes only. A suitable ladderway has been constructed in the shaft, but it is not properly divided off from the hoisting compartment. The necessity of having this done was pointed out. Hoisting is done by horse and bucket. The bucketway is properly fenced at the surface. A stove on the surface, with pipe extending down the shaft, is employed for ventilation purposes.

Mill run of the Ore.

A mill run of 10 tons from the dumps of both shafts gave $11.38 per ton; the milling being done at the Olive mill in February, 1898. Mr. Hillyer, the president, informed me in January, 1899, that a two-stamp Tremaine mill had been installed on the property, and that very satisfactory results have been obtained so far. A 50-stamp mill is in contemplation.

There are seven neatly constructed buildings on the property, including office, boarding camp, blacksmith shop, etc.

Independence Mine.

Independence Mining and Development Co.

The Independence mine, situated near Sturgeon Falls on Seine river, was visited twice; on July 26 and on September 13, 1898. The property consists of the south half of lot 11 in the third and fractional parts of lots 11 and 12 in the second concession, township of Bennett, aggregating 613 acres. It is owned by the Independence Mining and Development Company, Limited; head office, Sparta, Wis., U. S. A.; President, T. O. Thorbus; secretary-treasurer, H. M. Newton The following is the route from Mine Centre: A steamboat voyage of 15 miles up Seine

river to a landing about a quarter of a mile below Sturgeon Falls on the north side of the river, a three-mile Government road to Cedar lake (giving a view of the mill on the opposite side) and a voyage of about three-quarters of a mile across the lake. The above company have been carrying on work on the property since September, 1896. A variable force averaging probably eight or ten, including miners and mill men, have been employed during the past year, with Mr. A. N. Rice as manager.

Formation of Sericite and Felsite Schists.

The formation consists mainly of sericite and felsite schists, similar to that of the Olive or of the Alice A. The two latter and this mine are all three situated in almost a straight line on a narrow belt of felsite and sericite schists which are shown on the Dominion geological map as continuous, extending for over 20 miles with a strike of about east and west. At the Olive mine, the most westerly of the three, the formation is sericite schist. The best ore consists of small but persistent bedded veins of quartz from a few inches to two or three feet in width extending through the schists, and carrying exceptionally high gold values. A certain amount of the country rock adjacent to the quartz carries sufficient quantities of free milling gold to pay for mining and milling, about $7 per ton being obtained on an average from this kind of ore. And it might prove when more has been learned of the matter that a larger quantity than is expected of the country rock carries remunerative quantities of gold, possibly sufficient to bring it into the category of large low grade propositions, aside from the existence of the small high grade bodies of ore which it contains. The Alice A, which is situated about centrally between the Olive and the Independence, is claimed by the owners to be a large low grade proposition hundreds of feet in width. The formation, or ore, is felsite schist, closely resembling that of the Olive; and like the latter it contains small bedded stringers of high grade quartz, which, however, instead of forming continuous bodies as in the case of the Olive, exists as numerous small independent lenses or kidneys scattered more or less throughout the schists, not in any case large enough or sufficiently segregated to be workable independently of the schist. The Independence mine, which is situated about 20 miles east of the Olive, on this belt of schists, contains small but very rich pay streaks of quartz, similar to those of the latter mine, although apparently not so persistent. A test of an average sample of the country rock or schist taken over a limited area adjacent to but outside of the pay streak gave $7.35 per ton. Of course it is hardly to be expected that any great quantity of the schist would average so high as this, but not sufficient is known about the matter to admit of any statement concerning it being very reliable. An examination and comparison of the three properties nevertheless gives a forcible impression of the resemblance among them in the respects mentioned, and the question is suggested: If one proves to be a large body of low grade ore, why not all three? And also, Why not any number or all of the properties between, situated on the same body of schists, if they are continuous, as the geological map indicates?

Workings of the Mine

The main workings of the mine are on lot 11 on the third concession, where a shaft six by eight feet in cross-section has been sunk 75 feet. As this was only for prospecting purposes, it will likely be abandoned and a working shaft sunk at a more convenient point close by on the strike of the same pay streak. The latter, on which the shaft is sunk, is a body of quartz heavily mineralized with copper and iron pyrites, from six to 24 inches in width and traceable for 50 or 60 feet on the surface. The vein dipped south, leaving the shaft at a depth of a few feet, but the latter was continued vertical. As the lower workings were full of water I could not go down, but the manager informed me that at a depth of 45 feet a cross-cut had been driven 10 feet south cutting the vein, and a drift had been driven 20 feet upon it. A cross-cut had also been driven three feet north from the shaft, making, with the width of the shaft, 19 feet of cross-cutting altogether. An average sample taken along this, excluding the pay streak, gave $7.35 per ton. The pay streak averages $145. A mill run of the dump, consisting of the material from the cross-cuts, including the pay

streak, gave $19.42 per ton. A couple of test pits had been sunk near the shaft, one 15 feet and the other six feet. About 40 feet of open-cutting four or five feet in depth had been done along the outcropping of the vein east of the shaft.

The main shaft is provided with a collar 12 feet deep. A ladderway has been constructed to the first level, but is not in a safe condition. Instructions were left to have it remedied if work is continued there. For ventilation a centrifugal pump was converted into a blower by the addition of a number of blades. It was operated by man power, and an iron pipe conducted the air down the shaft. It was said to work very satisfactorily, clearing the shaft in five minutes after blasting. The hoisting machinery consists of a bucket and wire rope, with rough bead frame. Power is supplied by a horse.

Equipment of the Mine.

A pole road slightly over a mile in length extends from the shaft to the mill on Cedar lake. The shaft is about 40 feet above the lake, admitting of gravity transportation of ore if necessary, as the grade is all downward towards the mill. One two-ton tramcar is employed, drawn by a horse.

On the south side of the property on the shore of Cedar lake a tunnel has been driven 16 feet north, cross-cutting a very siliceous altered schist, but the assays were low.

The mill, which was put into operation on April 1, 1898, consists of the following: One five-stamp battery, a Challenge ore feeder, a Gates vanner after the Frue pattern with six-foot plane belt, rotary mill pump, 20 horse power horizontal boiler and a 15 horse power engine. The milling machinery is from the Gates Iron Works of Chicago. The stamps weigh 850 pounds each, and drop seven inches, at a rate of 95 drops per minute. The shoes and dies are of forged steel. Inside front and back and apron plates are employed. The sieve is 40 mesh, diagonal slot.

Stamp Mill.

The buildings on the property consist of a mill building, blacksmith shop and boarding camps.

Decca Mine.

The property of the Decca mine consists of K222, a location of 40 acres, situated about three miles north of Mine Centre. It is owned by the Decca Mining Company of Montreal, Limited. Capitalization, $950,000 in $1 shares; head office, Montreal. President, Wm. F. Borland; vice-president, C. C. Corneille; secretary-treasurer, Bannell Sawyer. The manager of the mine is F. C. Fisk. A force of from six to eight miners, along with miscellaneous employes, have been at work since June 15, 1898.

Location K222.

The formation is protogine. A number of quartz veins of variable width cross the location. Development work is in progress on two veins, or more strictly speaking, on two branches of the same vein, although nearly on the same line of strike. These veins range from a few inches to six or seven feet in width, and like all the veins in the protogine area are true fissures, and quite persistent as regards continuity. Two shafts have been sunk about 1,200 feet apart on these veins. No. 1 shaft, which is six by eight feet in size, has been put down to a depth of 55 feet, and No. 2 shaft, of the same cross-section, to a depth of 105 feet. In No. 1 a neat collar has been provided 14 feet deep, with suitable guard rail and trap door. A neat head frame has also been constructed. This shaft was full of water at the time of my last visit, Jan. 26, work being in progress in No. 2 only; but it was to have been opened again within a few days. The vein is two or three feet in width at the surface. Drifting has been commenced in No. 2 shaft at a depth of 100 feet. A collar 23 feet deep is provided. The vein ranges from five to seven feet in width in this shaft, and is practically vertical. Hoisting is done by horse power with single pulley block, sheave and hemp rope. Blasting is done by electricity.

Development work on the Property.

The buildings consist of an office, blacksmith shop, boarding camps and shaft house at No. 2.

On January 26, 1899, I visited K231, known as the Bush Winning Property, which adjoins the Decca. Four miners were working by contract, sinking a shaft on a wide quartz vein in the protogine. A depth of 27 feet had been reached, the contract being for 100 feet.

Location K231.

Emperor Mine.

About three miles north of Mine Centre is situated the Emperor mine, consisting of location 656P, containing 37 acres. It is owned and operated by the Standard Gold Mining and Development Company of Minneapolis. President, John Watson; secretary and manager of mine, James C. Beebe. This is also one of the numerous locations on the protogine area. A number of small quartz stringers and veins of variable width extend with more or less continuity across the property, with a general strike of northeast and southwest. One of these having a width of about six inches, and traceable for about a quarter of a mile, was under development during the summer. A six by eight foot shaft has been sunk on the vein (which is vertical) to a depth of 125½ feet. At a depth of 75 feet a drift has been driven northwest 29 feet, and one southeast 43 feet. At a distance of 16½ feet from the shaft in the southeast drift a cross-cut has been driven 41 feet southwest to cut a large parallel vein which outcrops in a gully close to the main vein.

Location 656P

A suitable manway, with ladders and platforms properly arranged, has been constructed to the first level, with suitable division between it and the hoisting compartment. A substantial platform has been provided at the level, and had been effectively protected during blasting by the hanging of "bumpers" underneath. The mouth of the shaft is properly fenced. Smoke and gases are effectively cleared out after blasting by an aspirator, with metal piping six inches in diameter extending down the shaft, and up beyond the surface for a distance of about 10 feet. A jet of live steam turned upwards inside of this, a few feet from the top, creates a powerful suction which clears the shaft in a few minutes.

Condition of the Shaft.

The hoisting machinery consists of a new duplex 15 h.p. hoist with 18 inch drum and ⅝-inch steel wire cable, and a 30 h.p. upright boiler. A head frame and an engine house have been built. The other buildings consist of boarding camps, blacksmith shop, manager's dwelling and office, including assay office. The force, at the time of my first visit, July 18, consisted of 21 men, including 16 miners. Work had been going on since January 1, 1898. When there on the following January I found that the mine had closed down.

Machinery, Buildings and Employes.

Foley Mine.

I visited the Foley mine on July 20 and found that it had been closed down since May 20, preceding. Mr. W. M. Strong, the manager, who was still staying at the mine, informed me that a deal had been pending for the transfer of the property. He also gave me the following information on the underground work up to date: Depth of shaft, 420 feet; fourth level, north drift, 160 feet; south drift, 30 feet. Fifth level, depth, 400 feet, north drift, 72 feet, south drift, 28 feet. All ore had been stoped out between the third and fourth levels. No. 5 shaft, which when pumped out measured only 95 feet instead of 113½ feet as reported, had been sunk to 101 feet. On the west vein a test pit had been sunk 10 feet. Mr. O. B. Robinson is now in charge of the property.

Extent of the Workings.

Ontario Gold Concessions.

While in the Lower Seine river country in the latter part of July, I took advantage of an opportunity to visit Block A of the property of the Ontario Gold Concessions, Limited, of London, England, situated north of Red Gut bay, a northerly extension of Rainy lake. The nearest point from Fort Frances is 35 miles. The trip was made from the latter place in a small steamer, the Jenny Lind, with 40 feet keel and eight feet beam, purchased by the company for operations on this block. I arrived there on July 22 and spent a day and a half travelling by steamer and canoe and on foot over the concession, examining most points of interest and acquiring thereby a fairly good idea of the nature of the country included therein.

Exploration of Block A.

Before describing the geology or mentioning the "ore bodies" of Block A, a description of the topographical features will be given, along with an account of the method employed in prospecting, in order that an idea may be obtained of the difficulties to be encountered and the amount of work to be done

Topographical features of Block A

in exploring such huge areas in this country.

The total area of this block of the concession is 40,000 acres. Of this water covers 7,000 acres, swamp or muskeg, 7,000, and soil (making it unavailable for prospecting) 17,000, leaving only 9,000 acres of prospecting ground. These figures were obtained from Mr. Sullivan's report to his Company. The prospecting ground is scattered in irregular areas over the concession, so that the work of prospecting involves much more travelling than the mere covering of the available ground. The concession is nearly all forest-covered, which adds considerably to the difficulties of the work.

Between fifteen and twenty thousand acres have been surveyed into lots of various sizes, according to the character of the country and the closeness with which it deserves investigation, the smallest lots being 10 chains square. Niven's sixth meridian and south base lines are employed as reference lines, every corner post of each lot being marked with reference to both of these, so that by following any survey line to a post the exact position on the property can be found. The cutting out of the lines furnishes well defined boundaries, which allow of operations being confined to one or more lots, so that these may be prospected as much as desired. Topographical and geological notes are taken by the chainmen as they proceed. A contour of the shore of the whole block has also been made. The surveyors are followed by the prospectors, each block being allotted to three or more of the latter, as the case may be. They cross each lot backward and forward, walking abreast 30 feet apart until the whole has been covered. When a discovery is made all hands stop to strip and examine it. It is reported to the manager in the evening, who decides, after examination, what work shall be done in the way of test-pitting, stripping, etc. Samples are taken and tested for gold, and further samples are sent periodically to Rat Portage for assaying. So far there have been discovered and tested 26 veins and deposits in various parts of the block. Numerous test-pits have been sunk, ranging from three or four to 20 or 25 feet in depth. It was intended to test a couple of deposits with the diamond drill, but I understand this idea has been given up. The instructions from the Company were, however, to go ahead until the whole block was prospected. The camp, which is all of canvas, consisting of a number of tents, is moved periodically to the centre of operations. A force of 25 prospectors, etc., are employed continuously. Monthly expenses range from $2,500 to $3,000. Mr. Alan Sullivan is manager, or "The Chief," as he is called, of this block, and Mr. J. D. Shields assistant manager. Work was commenced on July 26, 1897, suspended for the winter on October 19, resumed again on May 9, 1898, and discontinued altogether in October. A reward in proportion to the assay value of the find was offered as an inducement, but after all it was discouraging work, as it must have been patent to the men, at least after the first season's work was completed, that the chances of making a valuable discovery were slight.

Scheme of the Survey.

The following is an account of my observations during the short stay I made on the property, Mr. Sullivan having kindly placed his time at my disposal, taking me to all important points of interest: The first trip was made by steamer to the north end of Porter inlet. Walking inland along a road for about half a mile over moss and tree-covered ground, with very little rock exposure, we came to a formation, probably several hundred feet in width, of a dark colored gneiss (doubtless crystallized green schist of the Keewatin series) associated with eruptive granite. This same species of dark colored crystalline schist is found on other parts of the concession and is the only rock which in any respect resembles, or corresponds to, the Keewatin or Huronian schists of other parts of the district. The association of granite is also characteristic, and, as I afterwards found, the rocks, etc., encountered on this short trip proved to be fairly representative of the entire block. The schists appear to be all in very intimate association with the eruptive granite which, with Laurentian granite, covers by far the greater portion of the block. Felsite dikes are very common in the schist, and the latter in many places is much contorted, showing beautiful folding on a small

Details of the Prospecting

scale. Another marked feature is the dip of the schists ; almost wherever found in other parts of the district this is nearly vertical, never varying more than a few degrees, but here the dip is about 30 degrees.

The idea suggested by a consideration of the above facts is that the schists in this portion of the district are possibly the lower or synclinal portions of the folds which are represented by the middle or nearly vertical portions in other parts, all the upper portion having been removed by glacial ice, according to Lawson's theory. The dip and the much greater degree of crystallization would favor this hypothesis. It is a peculiar fact that very little gold has been found in any of the numerous deposits examined in the block. This fact, in conjunction with the preceding hypothesis, would suggest a probable limit to the depth of our gold-bearing deposits. Of course, as these folds are thousands of feet in height, there would be considerable range in depth for underground operations between the central or nearly vertical outcropping of the schists and the lower portion of the folds. However the above is nothing more than a mere suggestion, as time allowed only a comparatively limited examination of the block.

There is considerable variation in the character of the granite in different parts of the concession ; much of it is Laurentian of a coarse porphyritic nature, and much of a later age, probably Huronian. Various kinds of dikes are found, felsite and pegmatite being common. In some of the latter the quartz and the felspar were each crystallized out into masses of over a square foot in area. North of Porter inlet a deposit of graphite was found of unknown extent, but probably too small to be of any commercial value. I saw a few pieces, some five or six pounds in weight, which must have been 60 or 70 per cent. graphite.

Occurrences of Gold.

But the objects of vital interest to the operators were the gold deposits, if such they may be called, considering how little gold has been found in them. I visited a number of these, including all that were considered of any possible value. The first visited was north of Porter inlet. It consisted of a large body of nearly solid quartz, over 30 feet wide at one point, but narrower and mixed with country rock at other points, being traceable by stripping at intervals for a considerable distance. It was heavily mineralized with leaf iron pyrites and molybdenite. A couple of test pits had been sunk on it, one to a depth of 25 feet, but assays were too low to make the deposit of any value. Another of these bodies was observed on the northern part of the concession. It had much the same characteristics. A shaft had been sunk 20 feet on it, but assays were too low here also to warrant further work. The country rock adjacent to the former deposit is granite and mica schist, and at the latter schist. In the same part of the concession I was shown a quartz vein about three feet in width cutting the schists at a distinct angle. A test pit had been sunk 17 feet on it. In one or two places I observed rusted bands of schist, resembling fahlbands, containing a little quartz. These had been test-pitted also. I saw several other deposits, some of which were zones of schist containing a large percentage of quartz and charged with pyrites. These were all test-pitted and stripped more or less, but unfortunately none carried gold in encouraging quantities, and consequently the concession has been abandoned.

Exploration of Block B.

Block B of the concessions, situated west of the Lake of the Woods, was visited on August 13. The trip was made on Mr. Deacon's small steamer which plied between Rat Portage and the concession camps. A report of this block, explaining the system of prospecting, is contained in last year's report of the Bureau, and a repetition of these details is unnecessary. Suffice it to say that the whole block has been prospected according to the methods described. Mr. Deacon informed me that a force of 27 men on an average had been employed throughout the season, work having ceased on October 26, 1898, and this block has also been abandoned.

Testing with a Diamond Drill.

The most promising finds have been tested by shaft-sinking, test-pitting and diamond-drilling, and numerous small test pits have been sunk on other veins of more or less possible value, besides considerable stripping, which constitutes

an essential part of prospecting operations in this district. A diamond drill had been purchased for the concession, and altogether 3,000 feet of boring done, six different veins having been tested by one or more holes from 100 to 250 feet in depth. Some good assays were obtained from some of the drill cores, but development work did not sustain these results, and the results on the whole of drill cores and of samples otherwise taken were too discouraging to warrant a continuance of operations.

Geological character of the Tract

The geological conditions of this block differ materially from those of Block A. An examination of the latter, with a knowledge of the assay results obtained and a consideration of the nature of the formation thereof, would give ample reasons for the belief that nothing of economical value would likely be found thereon; but, as Mr. Deacon intimates in his report, it would be expected from the geological nature of this block that remunerative deposits would be found, as the formations do not differ essentially from those in which working mines exist in the same district. A number of the assays obtained are evidence of the justifiableness of this expectation. It cannot be definitely stated that such deposits or veins do not exist, but after the thorough exploration which has been made of the property it does not appear that the chances of finding anything of value are sufficient to warrant further efforts. The total net sum expended in the exploration of the block, as given by Mr. Deacon in his report, is $22,313, after deducting all assets such as diamond drill, etc. There is no doubt that all expenditures both for this and block A have been made effective use of for the testing of the properties as far as was deemed advisable from appearances.

Work at the Shoal Lake Camp.

I visited the Shoal Lake camp only, which is situated in the northern part of the concession, close to Shoal lake. A convenient dock has been constructed for the steamer and a good level wagon road three-quarters of a mile in length extends from it to the camp. Work was then confined to testing a vein which gave encouraging assays from diamond drill cores by a prospect shaft. The vein outcrops on top of a hill about 40 feet high. It is on the contact between trap and eruptive granite. Tongues of felsite extend from the granite into the trap, and this material is associated in some places with the vein matter. The strike of the vein is nearly east and west and the dip 66° south. It has been stripped for about 300 feet, showing a range in width of from two or three to 10 or 12 feet. A 5-by 9-foot shaft was being sunk on the vein at the time of my visit; it was then 125 feet deep, and reading Mr. Deacon's report later I learned that it had been sunk to 145 feet with 40 feet of drifting from the bottom towards the bore hole. But, as appearances were not encouraging, work was discontinued. At a depth of 70 feet the vein became flatter, and the shaft was continued in the foot wall, but was of course struck again in the drift, as Mr. Deacon informed me. A hoisting plant had been installed consisting of a 12 h. p. duplex double drum hoister with kibble and wire cable and a 20 h.p. return tubular boiler.

A boarding camp and other small temporary houses had been built and a force of 10 men was employed.

Mines of the Upper Seine.

Slackness of work in the Region.

Mining has not been so active in the Upper Seine country during the year as it had been the previous year, owing to the suspension of work at the Sawbill mine. But at Island Falls and other places in the same region a considerable amount of development work has been done. A tri-weekly stage runs from Bonheur to Sawbill, leaving Bonheur on Mondays, Wednesdays and Fridays and returning on the following days. The distance is 33 miles to the landing at Sawbill lake. A canoe trip of two miles on the latter connects the mine with the stage. The road is very rough, making the trip a hard day's work. A general store, stopping place and post office are kept by W. F. Fortune of Port Arthur at Sawbill mine, and a hotel has been built at the Hammond Reef landing by another party. Bonheur is the point of entry, and Sawbill headquarters for the Island Falls, Clearwater lake and Steep Rock lake districts.

Sawbill Mine.

The Sawbill mine had been closed down from March, 1898, until August 29, when a Toronto syndicate which had bonded the property for a year commenced operations under an agreement to sink the present shaft to a certain depth, along with other exploitation work with a view to thoroughly testing the property for a certain interest in it. Since work has commenced sinking in the shaft has been going on and the mill running continuously on ore stoped from the different levels, etc. The manager of the mine is Captain J. P. Williams. There is a total force of 19, of whom seven are miners. The following are the underground measurements up to November 23: Depth of shaft, 230 feet; first level, north, 182 feet, south, 203 feet; second level, north, 134 feet, south, 132 feet; cross section of drifts, 4½ by 6½ feet. The following overhand stoping has been done: First level, north drift, shaft pillar, 16 feet; first stope, 91 feet long with a raise of 37 feet above the roof of the drift for the first 75 feet, 27 feet for the next 15 feet and from four to six feet for the remainder of the distance; average width, 3½ feet; second stope, at end of drift, 20 feet long, three feet raise above drift and three feet wide. South drift, shaft pillar, 15 feet; first stope, 81 feet long; average height above the roof of the drift, 19 feet for the first 60 feet, with a width of from four to six feet and six feet above the drift for the remainder of the distance, with a width of three feet; second stope, 27 feet long, four feet above drift and three feet wide. Second level, north drift, stope 34 feet from the shaft, 73 feet long, raise 20 feet (average) above the drift, four feet wide; drift under the stope widened to six feet. South drift, shaft pillar, 20 feet; stope, 62 feet long, with 18 feet average raise above drift, and a width of 5½ feet. At a distance of 67 feet from the shaft in the north drift of the second level an upraise has been made 33 feet above the roof of the drift, and will be continued to the level above. The vein underground ranges from two to five feet in width and averages 3½ or four feet. It has widened near the bottom of the shaft to six feet, as far as I could see, and I am told to eight feet at the bottom, there being a few feet of water.

Operations resumed at the Mine

Suitable stulls are provided where required in the stopes, for retaining the broken ore; a row of stulls is placed along the roof of the drift under the stope and mill holes carried up from the same through the broken ore, which goes through to the cars below.

Condition of the Workings.

Tramways are laid in all drifts, and trucks are provided which convey the ore bucket.

The ladderway has been suitably cased off from the hoisting compartment for a depth of 180 feet, with ladders and platforms suitably arranged. The shaft house was hardly large enough to enable a satisfactory guard rail to be placed around the shaft mouth without causing inconvenience, but instructions were left to increase the height of the present guard rail if too much inconvenience was not caused thereby.

Blasting in the shaft is done by electricity. Explosives are not stored underground, only sufficient being brought down for immediate use. The powder magazine is situated about three-quarters of a mile from the shaft, and at a safe distance from other buildings. The ventilation is satisfactory.

While drilling at the bottom of the shaft on September 20 water under high pressure was struck, the force being such as to cause the entire suspension of sinking operations down to the time of my last visit, November 23. Two and three, and sometimes more, pumps had been worked to their full capacity all the time to keep the shaft from being flooded. It was found necessary to purchase larger pumps than those already in use, and a Northey sinking pump of 110 gallons per minute capacity was installed, but this was drowned entirely and remained so for some weeks until a second pump of the same make, but of 50 gallons capacity, was put in, and with the help of the other pumps already in use the water was got under control. It is estimated that at least 5,000,000 gallons had been pumped out of the shaft during the first two months after the water had been struck, and as far as could be calculated it was coming in with unabated force up to the time of my last visit. An effort will be made to continue sinking by tapping the water on one side of

Strong flow of Water.

the shaft. A drift will be driven 10 feet from the bottom, and a winze sunk at the end, at the bottom of which it is expected the water will be tapped. A pump will be stationed in the drift, with the calculation that the water can be sufficiently well coped with to allow continuation of sinking in the shaft. Experiments will be made with a view to utilizing this water for mill purposes, in order to eliminate the expense of pumping from the lake, the present source of supply, which was resorted to as a consequence of the small creek which had been dammed above the mill having proven inadequate.

Mining and Milling equipment

An extension has been built to the hoisting engine house for a new 35 h. p. locomotive style boiler, formerly employed at the saw mill, and substituted for the previous hoister boiler. No other change has been made in the hoisting plant. A tramway 80 feet in length, on a trestle about five feet in height, has been constructed from the air shaft dump to connect with the main tramway to the mill. Practically no change has been made in the milling machinery; but henceforth no concentrating will be done, as the low percentage of the concentrates in conjunction with their limited assay value precludes the advisability of incurring the necessary extra expense required to operate the concentrating machinery, which consists of a Brown's hydrometric sizer and three Frue vanners, as described in last report. The following details of mill practice, although still subject to slight variation consequent upon further experience, will be interesting to some readers: Number of stamps, 10, in two batteries of five stamps each; weight of stamps, 750 lb.; height of drop, seven inches; speed, 80 to 103 drops per minute; capacity of mill, 20 tons per 24 hours; depth of discharge, seven inches, maintained constant by false bottoms; amount of water used, 60 to 70 gallons per hour per stamp; screens, 40 mesh, burr slot; apron amalgam plates, eight feet in length by width of the mortar; inclination, 1½-inch per foot; inside plates, back, 12 inches in width; front, four inches; lip plates, seven inches in width; amount of mercury fed to battery, a lump about the size of a pea to each battery every half hour.

A 30-light dynamo made by the General Electric Co., and driven by a 5 h.p. vertical engine, has been installed for lighting the mill and other surface works.

The only new building consists of a pump house at the lake.

Instructions.

Instructions were left not to allow exhaust steam to escape in the shaft near where men were working; to remove all loose rock from the walls of stopes, and to increase the height of the guard rail at the shaft's mouth as stated before.

Hammond Reef Mine.

The Hammond Gold Reef.

The Hammond Gold Reef has been in steady operation during the year, with a force varying from 20 to 30 men, under the management of James Hammond, with W. Tedford as assistant manager. The mill has been running most of the time, treating ore from the various open workings on the property.

Extent of Mining Work.

Nothing but open mining has been done since last year. This consists of the following: A few hundred tons have been blasted out in the old open cut on 337X during the summer, but as the pay streak proved to be narrow the work was discontinued. The present scene of operations is on the southern boundary of 338X, and partially on 316X adjoining, where an excavation 80 feet in length, 25 feet in width and 15 feet in depth has been made and is being continued northward towards the mill on 338X. Very satisfactory results have been obtained here. As the workings are in low ground, practically in a muskeg, or peat bog, sometimes as much as nine or ten feet of earth, peat and moss has to be stripped off. Water has also to be contended with, but a small pump keeps this under control. The reef has been tested at numerous points where it is high and dry, but as results were less satisfactory than here the expense of stripping, etc., is warranted. The vertical faces of the excavation are divided off into squares of one square yard each; each square is carefully sampled and assays made, thus forming a guide to operations. A costean 30 feet in length, 14 feet in width and about 12 feet in depth had been made north of the mill on 338X, and abandoned. Although a considerable amount of

work has been done upon the Reef on the whole, as yet a comparatively limited knowledge of its constitution regarding gold contents has been obtained, and in order to be in possession of somewhat definite knowledge of the position, size, depth, etc., of the pay streaks, (providing it is found necessary to confine mining operations to the location and working of such) a considerable expenditure of time and energy in systematic exploitation will be necessary.

Equipment of the Mine

The tramroad from the large open cut on 337X to the mill has been removed, and one about 250 yards in length laid from the present workings to the mill. The derrick, hoister, etc., from the old open cut have also been removed to the new workings. The hoister is a 12 h.p. duplex. A new 32 h.p. locomotive style boiler has been installed. A 14 by 24-foot boiler and engine house has been built. One machine drill is in use.

The Mill

With the exception of repairs and minor alterations, no change has been made in the mill. The old upright crusher boiler has been replaced by the horizontal boiler formerly at the pumping station at the lake. The engines, belts, etc., have been provided with guard rails as required. Number of stamps, 10, in two batteries of five stamps each ; weight of stamps, 750 lb. : height of drop, eight inches ; number of drops per minute, 86 to 87 ; capacity of mill, 15 tons per 24 hours ; material of shoes and dies, white iron first employed, but manganese steel now used ; depth of discharge, 6½ inches when dies are new, not maintained constant ; screens, 40 mesh horizontal, burr slot ; apron amalgam plates, slope 2¼ inches per foot ; front and back inside plates ; two dash plates ; about ¼ oz. of mercury fed into batteries altogether every three hours. No extra hands are required for running the concentrating machinery, which consists of two Frue vanners as mentioned in last year's report.

A new assay furnace has been built of stone and fire brick, with separate crucible and muffle compartments.

Water Supply.

The water supply from the mill is obtained from the lake, through 2,379 feet of pipe, buried to prevent freezing. A No. 6 Cameron pump and a vertical lidgerwood boiler constitute the pumping machinery. A dam 175 feet long and about 12 feet high at the centre, constructed of timber, with earth in front to seal the water off, has been built above the mill, on a small creek which flows past the latter. The water was dammed off at another depression by an earthen dam 80 feet long and five feet high. But as the water proved to contain too much vegetable grease for milling purposes recourse was had to the lake again.

Development of Water-power.

On the creek which runs from Clearwater to Sawbill lake a waterfall occurs, which, it is calculated, is capable of furnishing about 500 horse power when developed. The lake has been dammed at the point of outflow, and farther down the creek two other dams were being constructed at the time of my first visit, to furnish the necessary head. These, I learned later, have been completed. Power will be transmitted by electricity to the Reef.

Instructions were left to renew the driving pinion on the hoister, as the present one is too much worn for safety.

Location 320X.

The manager of the Hammond Gold Reef is also in charge of 320X, a property about a mile to the north of the former, belonging to Major Cartwright, a son of Sir Richard Cartwright, president of the Hammond Gold Reef Mining Company. The ore body is of the same nature as, and is believed to be an extension of, the Hammond Reef. A wagon road has been constructed from the latter property, and work has been going on intermittently since May 31, six miners being employed.

Toronto and Western Co.

Location 401X

The Toronto and Western Mines Development Company, Limited, with head office at Toronto, have been sinking on several of their properties on the southern part of Sawbill lake and vicinity for the past two summers. The only place visited was 401X, a small island of 2½ acres in the southern part of the lake. The formation is altered granite. A diorite dike 50 feet wide and dipping 45 degrees north crosses the island in a direction of N. 53° W. A couple of smaller dikes occur on the island

also. Small contact veins of quartz a few inches in width occur on both walls of the main dike. The main vein crosses the northwest side of the island with a strike of north 37° east and a dip 75 or 80 degrees east. Two shafts have been sunk 145 feet apart on the vein. One was sunk 23 feet and discontinued, and the other 50 feet. The vein ranges from 10 or 12 inches to 2½ feet in width. A force of six miners was employed, working day and night shifts, under Peter McKellar as superintendent of the work.

Big Six Mine.

Locations on Eye Lake.

In the early part of June I visited the Big Six mine, situated on the east end of Eye lake, south of Clearwater lake. We paddled to the lower end of Sawbill lake into a small inlet from which a rough portage, half a mile in length, led to Clearwater lake. A seven or eight miles paddle brought us to the lower end of the lake, where we left our canoe and walked to the mine, a distance of a mile over a very steep wagon road. The property consists of WR56, 57 and 58 and BG13 to 17 inclusive, aggregating 290 acres; also timber limit 63, containing 1,600 acres, which contains plenty of good Norway pine and other timber. The owners are the Clearwater Gold Mining Company, with head office at Saginaw, Mich.; capitalization $1,000,000 in $1 shares. President, W. F. Stevens; secretary, Charles P. Anderson. Mr. J. S. Steele is manager of the mine. He had been prospecting for the company during the previous year, discovering the present property in June, 1897. Work was commenced in the following October and has been continued ever since. There was a total force of 22 men at the time of my visit; of these nine were miners, working in two shifts in the shaft.

Veins in a formation of Eruptive Granite.

The formation is eruptive granite of apparently two different ages, and green chloritic schists, hornblendic near the contacts. The granite has the appearance of that of the Sawbill country. There are several veins on the different locations. The main one is on the contact which passes through the centre of WR56, with a strike of north 12° east. It outcrops on top of a hill 180 feet above and about one-third of a mile from Eye lake, furnishing an excellent opportunity for transportation of ore by gravity to a proposed mill site on that body of water. The vein is distinctly traceable, and has been stripped to a considerable extent for a distance of about 1,000 feet north of the shaft, which is sunk on the vein near the centre of the location.

Development Work.

The shaft is six by ten feet in size and 80 feet deep, sunk on the hanging wall, which dips nearly 90 degrees east. At the bottom a drift has been driven seven feet south. At a depth of 25 feet a cross-cut has been driven west 16 feet. The vein at the surface consists of two branches at the shaft, about 20 feet apart, aggregating eight or ten feet of quartz. These come together north of the shaft, where the vein averages three or four feet in width. The quartz is white, containing iron pyrites, galena and zinc-blende. A ladderway is in course of construction. Ventilation is obtained by a Sturdevant blower. Windlass and bucket are at present employed for hoisting, but a steam hoisting plant is on the premises ready for installation. The machinery consists of a duplex hoister with 4 by 6½ cylinders (having a guaranteed capacity to hoist 1,500 pounds a distance of 600 feet) 300 feet of seven-eighth inch steel wire cable, a 25 horse-power locomotive style boiler and two underground trucks.

East of the main vein at the bottom of the hill on the same location, a tunnel has been driven southwest 15 feet on a 3½ foot vein, which cut off sharply at the end with distinct evidence of faulting. West of the main vein in the greenstone several felsite dikes containing a little quartz occur, scattered over a distance of 100 feet or more. Shots have been put in on some of these, and stripping done at a number of points. East of the main vein a small quartz vein 19 inches wide outcrops and is said to be traceable for 1,000 feet.

Some test-pitting has been done upon veins on unsurveyed land in the vicinity of the Company's property. One pit was sunk 10 feet and another one has been commenced.

The camp is beautifully situated on the gently sloping shore of Eye lake, on a splendid sand beach about half a mile in length. Temporary log houses have been built for

boarding camps etc., and a neat and substantial office building has been put up. The other buildings will be replaced by frame ones as soon as the saw-mill is completed.

Camp and saw mill.

The saw mill which has a capacity of 15,000 feet per day, is being built on Eye lake about one-quarter of a mile from the camp. All the machinery is on the ground and will soon be in place.

A waterfall on Seine river, south of Moose lake, has been applied for and is being examined by an engineer for power purposes.

New Golden Twins Mine.

The New Golden Twins mine consisting of location BC18 and 327 and 328X, situated on the western shore of Clearwater lake, about four miles north of the portage to the Big Six, was visited in the early part of June while returning from the latter place. The property belongs to the Golden Twins Mining Company of London, England. Mr. E. Giessen (since deceased) was manager of the mine at the time of my visit. Work had been going on since October, 1897. The force consisted of three miners and two general hands. The workings are on a small peninsula containing four or five acres. The formation is green schist. The ore body is a large, irregular quartz vein from 10 to 25 or 30 feet in width, with indefinite walls extending across the peninsula and on to the mainland, with a strike of north 35° east, and traceable for nearly 1,000 feet with the greater portion exposed. Two shafts have been sunk on the vein on the peninsula 240 feet apart, and at an elevation of 30 or 40 feet above the water. No. 1 is five by seven feet in cross-section and 63 feet deep. Being partially full of water it could not be entered, but the foreman informed me that at a depth of 47 feet a cross-cut had been driven northwest 22 feet. No. 2 shaft is of the same cross-section and 16 feet deep, sinking being continued. The buildings consist of cook and dining camps, office, blacksmith shop and powder house.

Mining locations BC18 and 327 and 328X.

Island Falls Region.

I paid two visits to the Island Falls country during the summer and found that active work had been going on at several properties there all summer and part of the winter. A canoe trip of about 12 miles, with two short portages, up the Seine river from Sawbill, is the most convenient means of access. The formation is altered granite, similar to that of Sawbill, and the veins are all true fissures, containing white quartz of the same nature as that of the aforementioned place.

Location AL282.

The most extensively developed property is AL282, which had been involved in litigation from the time of its first acquisition until a considerable quantity of development work had been done. James Hammond of the Hammond Gold Reef was one of the parties contending for the title, and he had sold an interest in it to the Railroad Mining and Development Company, Limited, with headquarters at Port Arthur. This company did the development work, but Mr. Hammond lost the case, involving the patent, but received compensation for work done. He bought back a half interest in the property and gave over to the Railroad Company, by way of compensation, a full title to AL283, an adjoining property containing an extension of the AL282 vein.

A property in Litigation.

There is one vein on AL282, which is a true fissure, crossing the location, and others adjoining, with a strike of north 57° east approximately. It follows a small ravine with a bluff 15 or 20 feet high extending along the north side. The vein dips at an angle of about 65 degrees northwest into the bluff at the bottom. Test pits several feet in depth have been sunk on the vein all along, on this and adjoining locations. Some of these pits have only been sunk to bed rock, as the vein being in low ground is not exposed at any point except where test-pitted. For the greater part of the distance it underlies several feet of clay, besides moss, etc. In some of the test shafts or pits the vein is exposed as a well defined quartz body, several feet in width, with distinct walls. Usually on one or both walls several inches of clay selvage will be found. This selvage is apparently a decomposed inclusion of green schist, as it is found associated with nearly all veins in this country.

Character of the Vein.

and usually manifests itself as a continuous band of green schist, outcropping sometimes with a width of two or three feet. Its presence probably produced a line of weakness along which the faulting and fissuring of the country rock took place. In other test pits the vein consists of a zone of broken schistose granite, giving evidence of shearing and pressure. Usually a little quartz is present. The bluff or escarpment on one side of the vein, which is characteristic of more than one vein in this section, is probably caused by the upward throw of the hanging wall.

At a distance of 40 feet from the vein a 7 by 9 foot shaft has been sunk vertically in the hanging wall, striking the vein at a depth of 71 feet, and from there is continued as an incline on the vein for a farther distance of 70 feet, making 141 feet altogether. At a depth of 96 feet drifts seven by seven feet in cross-section have been driven northeast and southwest along the vein 65 feet and 72 feet respectively. These figures were obtained from Mr. Hammond and the manager of the mine, as mining operations were not in progress at the time of either of my visits and the shaft was partially full of water. The average width of the vein in the shaft is 17 inches, and in the drifts three feet.

A neat and roomy shaft house has been built, also a substantial and well-constructed head frame. The shaft is provided with a suitable collar, and is properly guarded at the surface. The hoisting machinery consists of a 15 h.p. hoister and a 25 h.p. vertical boiler. A three-drill Sarjeant air compressor with three drills and a three by 14 foot receiver have been installed. A No. 4 Cameron pump is employed for drainage purposes.

Equipment of the Mine.

C. C. Schroutz, formerly of the Sawbill, was manager at the time of my April visit. There was a force of 16 men all told. The buildings consist of cooking and sleeping camps, office, two storehouses and shaft and engine house, all neatly and substatially built. About 30 acres of land have been cleared. The property is reached from the Seine River landing by a foot trail of a mile in length, or by a road which is in poor condition for summer travel.

Location AL283.

The adjoining location AL283, previously mentioned, originally owned by Mr. Hammond and transferred to the Railroad Mining and Development Company, as stated, has been under development since May 1, 1898. C. C. Schroutz, the manager of AL282, was also superintendent of this property, and John Chapman foreman. A force of from eight to 11, all miners except two, has been employed continuously.

Development Work.

Four test shafts have been sunk on the vein (which is a continuation of the AL282 vein as stated before) at intervals of a few hundred feet, two of these being continued. No. 1, close to the boundary of AL282, is seven by seven feet in size and 22 feet deep. There is six feet of vein matter between walls, of which 18 inches is quartz, which is mineralized with copper and iron pyrites and galena. No. 2, the next pit going northwest, is 42 feet deep, with an inclination of 45°. It is provided with an eight by eight foot collar, 15 feet deep. The vein matter consists of a mixture of quartz and country rock. No. 3, 400 feet farther northwest, is seven by 13 feet inside the timbers and 75 feet deep, on an inclination of 45°. The collar is 24 feet deep. A very satisfactory showing of quartz, 13 feet in width, is exposed on the east end of the shaft, but on the west end the vein has changed suddenly to protogine, with a slight admixture of quartz. For hoisting, a double skidway with counterbalancing buckets is emplqyed. A small hand force pump is used for drainage purposes. Ventilation is secured by a blower, with tubing extending down the shaft. A ladderway has been constructed. Blasting is done by electricity. No. 4 shaft is near the northwest boundary of the location. It is 15 feet in depth, and exposes 10½ feet of quartz with selvage on the walls.

Location AL198.

W. D. Pettigrew is working on AL198, a location of 40 acres, which is claimed to contain the southwestern extension of the AL282 vein. The ravine corresponding to the strike of the vein is in evidence here. A shaft has been sunk to a

Development Work.

depth of 49 feet on the vein. There was eight feet of quartz on the surface, which pinched out at a depth of 13 feet, but is coming in again at the bottom. A cross-cut has been commenced into the foot wall in order to ascertain whether the main body lies in that direction or not. The quartz is charged with copper and iron pyrites and galena. There is a clay selvage on the walls, which are six feet apart, and filled in between with vein matter similar to that of the preceding properties. The shaft is provided with a collar 15 feet in depth and seven by 10 feet in cross-section. Hoisting and tramming machinery consist of a gin, ore bucket, head frame, several yards of tramway and ore car. The manager is Joseph Huston. A force of seven miners is employed. The buildings consist of cooking and sleeping camps, office, blacksmith shop and powder house. The location is plentifully supplied with timber for mining and building purposes. The property is about half a mile from the Seine river and is reached by a foot trail.

Proudfoot's Location.

Adjoining the preceding property on the southwest is a location owned by H. B. Proudfoot, of Port Arthur. The same vein outcrops here on elevated ground. Two shafts 50 feet apart have been sunk, 15 and 25 feet deep respectively. There is 2½ feet of quartz visible at the former, and over five feet at the latter. The owner was instructed to fence the shafts properly.

Locations AL298-9.

About a mile from the previous properties is the Roy mine, reached by a road 2½ miles in length from the Seine river. The locations consist of AL298 and 299, aggregating 75 or 80 acres. The property is owned and is being developed by the Roy Mining and Development Company. C. C. Schroutz had charge of the work in the spring, but since then Roy Sweeney of Toronto has assumed the duties of manager, with Gus A. Bawden as foreman. There is a total force of 13, of whom eight are miners working in two shifts.

The Roy Mining Co.

There is one vein on the property nearly parallel to, and at a distance of a mile from, the AL282 vein. It is traceable, with stripping for most of the distance, for about 400 feet, forming a slightly elevated ridge with a strike of about north 70° east and a dip of 55° northwest, running into a swamp at each end. It ranges from three to five feet in width on the surface, with an average of about four feet. Accompanying the vein is a band of weathered green achist, traceable for about 100 feet.

A shaft of eight by eight feet has been sunk in the vein to a depth of 81 feet, and is being continued. At a depth of 100 feet cross-cutting or drifting will be commenced. There is a distance of nine feet between walls, the intervening vein matter being chloritized schistose country rock (altered granite) irregularly mixed with quartz, of which there is an aggregation of several feet in width. The hoisting machinery consists of an eight h.p. hoist, a 10 h.p. horizontal boiler, etc., with a substantial head frame. A small steam pump drains the shaft. Blasting is done by electricity.

Development Work.

At the northeast and southwest ends of the outcropping of the vein test pits have been sunk 18 feet and 10 feet respectively.

The buildings on the property are boarding camp, warehouse, office, and powder magazine.

Laguerre lake, with an area of three or four hundred acres, furnishes an excellent mill site at a distance of 900 feet from the mine, at a sufficiently low elevation to allow of gravity transportation of the ore.

Location WN5.

On June 7 I visited a property on the north shore of Reserve island, where work was in progress under the superintendence of Dr. S. Wilkinson. The only information I could obtain was secured from a couple of miners working there. The property consisted of three locations, with only one, WN5, under development. The men were employed and housed under canvas close to the water's edge. The workings were about half a mile back from the shore, reached by a foot trail.

Exploration of the Property.

Two veins had been discovered. The main one is traceable for over a half mile at least, and, it is claimed, for about three miles, with a strike of north 20° east dipping

at an angle of 75° northwest into the base of a bluff similar to the vein on AL 282. In fact it bears a strong resemblance to this latter vein, and is believed to be an extension of it, although the difference in strike would indicate considerable curvature in the vein. It has been stripped and test-pitted for a distance of 150 yards, exposing a width of from two to eight feet, with well defined walls and associated bands of green schist. This portion of the vein ends up in a large outcropping of quartz over 40 feet in width and 70 or 80 feet in length, which is believed to be the junction with the other vein which comes in from the south with a strike of north and south. A test pit six feet deep had been sunk on this supposed junction. At intervals of a few hundred feet or less along the strike of the main vein south of the junction, small test pits have sunk all along, most of these being merely to bed rock, to show the continuity of the vein.

The branch vein outcrops along the face of a hill for a distance of 100 or 200 feet, with a dip of about 45° east. It is exposed by test-pitting in several places, showing a width of three or four feet. About 200 yards south of this, on the same strike, a mass of apparently solid quartz rises out of the muskeg to a height of 12 or 15 feet, with a width of about 40 feet, and a length of 70 or 80 feet.

Mines on Lake Superior.

Expectations of extensive workings on the north shore of lake Superior were not realized last year, owing to lack of capital, but some progress has been made and it is expected that several properties will be worked during the present year.

Ursa Major Mine.

The only property under development east of Port Arthur is the Ursa Major mine, which consists of locations AL219 and 220, containing 320 acres each and situated on a Government road which extends three miles beyond the Empress mine, near Jackfish bay. A road 10 miles in length connects the mine with the railway track. The property is owned by the Jackfish Bay Syndicate Mining Company, Limited. Head office, 23 Toronto Street, Toronto. President, C. B. Jackes, and general manager and acting secretary, G H. Patterson.

Locations AL219 and 220.

Work was commenced on August 8, 1898, under the management of Mr. E. R. Storrs, with a force of six to eight miners, and has been going on continuously. The place was visited on November 19, 1898.

The formation is green schist with a strike of northwest and southeast. Felsite dikes were observed in one or two cases. The ore body consists of a series of roughly parallel veins or bodies of quartz following the strike of the schists and extending over a width of 200 feet. These are only exposed where stripping has been done. A trench 239 feet in length cut through drift material to bed rock across the ore body reveals four or five quartz bodies or branches from six to eight feet in width. A vertical shaft, four by nine feet in cross-section had been sunk 53 feet and was being continued. Quartz is exposed on all sides in the shaft. Iron and copper pyrites is plentiful, with a little galena and zincblende.

The Formation and the Ore Bodies.

A neat collar has been constructed to a depth of 27 feet. A windlass and counterbalancing buckets are employed for hoisting. A small hand force pump is employed for drainage purposes. Owing to the expense of getting in supplies, which amounts to $20 per ton as a result of the bad roads, the cost of sinking amounts to about $50 per foot. The buildings on the property consist of cooking and sleeping camps, shaft house and blacksmith shop, stable and assay office. A good assaying outfit is provided so that a thorough knowledge of the vein is obtained as the work progresses.

Improvements.

Empress Mine.

The Empress mine was visited on November 19, and found in the same condition as when inspect ed last year. Mr. James E. Smith is looking after the property.

Slate Islands.

I am told that considerable prospecting has been done on the Slate islands during the summer and that some valuable discov

eries have been made, with the result that develepment work will be commenced in the spring.

Silver Mining.

Silver mining has been more active during the past year. More of the old mines have been opening up, and present appearances are that this industry, which has revived after years of suspension, will continue to increase until once more of considerable importance to the Province.

Rabbit Mountain Mine.

The Rabbit Mountain mine, formerly owned by Mr. Alexander M. Hay of Rat Portage, had been acquired by the Dominion Gold Mining and Reduction Company, Limited, of London, England, in the latter part of December, 1898, and Mr. Hay informed me that on January 20, sinking had been resumed in the shaft, which is 240 feet deep. Two machine drills are in operation.

Silver Mountain Mines.

East End Silver Mountain.

The East End mine at Silver Mountain was closed down on September 18, 1898, having been in operation on a limited scale for the greater part of the summer. A little exploitation, principally in the form of stoping, had been carried on in the old workings, resulting in the decision that nothing further will be done therein ; but if work is resumed in the future it will in all probability be on a small rich vein which occurs a few hundred feet north of the present one.

Mr. De Kalb and myself went through the old tunnels on August 24. No. 2 tunnel is 1,800 feet in length, with an irregular course. We observed many features of vein formation which were very beautiful, as well as interesting from a scientific standpoint. No. 1 tunnel is 70 feet above No. 2 on the same vein.

The mill had been running the greater part of the time, milling the dumps from the tunnel and from No. 2 shaft, which is sunk on top of the mountain and connects with the upper tunnel at a distance of 500 feet from the entrance. The material from the shaft dump was thrown down the shaft to the tunnel, a depth of 80 feet, wheeled along the tunnel a distance of 300 feet, and again discharged through a winze to No. 2 tunnel, and trammed to the entrance and over a newly constructed tram road to the mill. This tram road is about 150 yards in length, and constructed on a trestle which varies from five to 15 feet in height.

A new Blake crusher with 7 by 10 inch opening has been installed in the mill. The other machinery consists of a Tremaine 2-stamp battery, a Browne's 2-compartment hydraulic classifier and two Frue vanners, along with boiler and engine

Mr. Richard Sandoe was manager of the mine.

The most important mine in operation at present is the West End mine of Silver Mountain. It is situated one mile west of the East End mine, across the mountain, and is reached by a wagon road about a mile in length from the station of West Silver Mountain, which is 40 miles from Port Arthur, on the Port Arthur, Duluth and Western Railway. A fairly good road 36 miles in length extends from Port Arthur to the mine, enabling the trip by this route to be made in a day.

West End Silver Mountain

The property of the mine consists of three locations, R55, 56 and 57, containing 80 acres each. It is owned by the West End Mining Company of St. Paul, Minn., and has been re-opened after some years of idleness by the West End Mines Syndicate, among whom are Mr. Herbert Shear, manager of the mine, the Wiley Bros. of Port Arthur, and others. The post office address of the mine is Silver Mountain. Mr. Colon Tonkin is captain, and there is a total force of 40, including 18 miners.

The formation consists of flat-lying slates of the Animikie period, overflowed in a number of places by diabase. These areas of diabase are marked by constituting the cappings of numerous small mountains left by the glacial ice which removed the intervening soft slates to a considerable depth. A formation of dolomitic limestone lies underneath the slates. The silver occurs as argentite and native silver in veins caused by the faulting and fissuring of these formations ; the gangue material is quartz, calcite, barite and fluorite, in varying

Geological Formation.

proportions. The richest part of the vein is usually that portion which occurs in the slates directly underneath the trap

There are three shafts at the West End mine, only one of which is in operation.

Extent of Mining Work

No. 1 shaft is said to be 150 feet deep, but is partially full of water and unused at present, except for ventilation purposes. No. 2 shaft is 540 feet east of No. 1, and of the same depth. Mining has been all confined to it since the re-opening of the mine by the present syndicate. The third shaft is 800 or 1,000 feet farther east and is abandoned.

No. 2 shaft, as stated before, is said to be 150 feet deep, and dips 85 degrees north. The cross-section is 8 by 10 feet inside the timbers. The first level is 35 feet from the surface; a drift has been driven east 105 feet, and one west 127 feet. The second level is 60 feet from the surface, with an east drift 30 feet long and a west drift 212 feet. The third level is 90 feet from the surface, with an east drift 200 feet long and a west dr ft 380 feet. Work is all confined to the west drifts. A winze connects the first and second levels, and another the second and third west of the shaft. There is also connection between the end of the west drift in the third level and the east drift from No. 1 shaft, affording good natural ventilation. No work is going on below the third level in the shaft at present, but sinking will be resumed sooner or later.

The following overhand stoping has been done: Second level, length of stope, 30 feet; height above roof of drift, 11 feet; width, five feet. Third level, first stope, length, 70 feet; height, carried up to second level; width, five to seven feet. Second stope, length, 70 feet; height, 30 feet; width, six to nine feet. In the east drift, No. 1 shaft, the underhand stope has a length of 70 feet, a depth of three feet, a width of eight feet. The fourth stope has a length of 50 feet, a height of three feet, and a width of 12 feet.

Stulls in the drifts and stopes are sound and well set. A row of stulls is placed along the roof of the drifts under stopes, and the ore is shot down on them and sent through mill holes to cars below. The ore from the upper levels is all sent through the winzes to the third level and trammed to the shaft. The shaft is securely timbered, with a collar 18 feet deep. A suitable manway is provided and cased off from the hoisting compartment with landings at suitable intervals and ladders set at proper angles. A suitable ladderway is provided in No. 1 shaft also, furnishing an additional means of escape.

The mine is drained by a No. 5 Cameron pump, situated in the third level, the bottom of the shaft collecting all drainage water.

Dynamite is sent underground just as required for charging holes. The magazine is situated a quarter of a mile from the shaft.

The hoisting machinery consists of a 10 h.p. single cylinder h ist, with 28-inch drum, steel wire cable, and wooden kibble

Equipment of Mine and Mill.

sliding on an inclined plane. Steam is furnished by a 20 h.p. vertical boiler. New shaft and engine houses have been built to replace the old ones burnt down in September last. Tramways extend from the shaft mouth and from the dump to the mill, the former distance being 250 feet and the latter 180 feet. They are laid on a trestle which varies from 10 to 39 feet in height and is 180 feet long, one tramway being 15 feet below the other. Two self-dumping cars are in use.

The mill, which was erected last summer and has been in operation since September 5, is the ordinary gravity stamp mill, with Frue vanner concentrators such as are used in the treatment of free milling gold ores, with the exception that no amalgamation is done; hence a conspicuous feature of the gold mill is absent. The mill is conveniently situated with reference to the shaft, so that the movement of the ore is aided by gravity from the time of its arrival at the shaft until the discharge of the tailings. The machinery is from Fraser and Chalmers, and consists of a grizzly, Blake crusher with 7 by 10 inch opening, two batteries of five stamps each, the stamps weighing 950 lb. apiece, two Challenge ore feeders, a 4-compartment Browne's hydraulic classifier and three Frue vanners with 6 by 13 foot belts one corrugated. The capacity is about 40 tons per 24 hours. Power is furnished by a 150 h.p. Conway automatic cut-off engine and a 48 inch by 15 foot return tubular, 60 h.p. boiler.

A considerable quantity of the ore is very rich; all over a certain grade is bagged underground, brought to the surface, crushed, sampled and barrelled by hand, and shipped directly to the smelter, Omaha being the principal destination. All lower grade material, down to four or five oz. per ton, is treated in the mill, and the concentrates sent to the smelter. All material shipped is carefully sampled and assayed, furnishing a satisfactory check upon the smelters There is about three or four thousand tons in the dumps of both shafts which will be treated in the mill.

Shipment of Ores

The present water supply is Lizzie lake, a small body of water on top of the mountain, at an elevation of 91 feet above the tank in the mill, and connected with the latter by 4,000 feet of 2½ inch pipe, laid along the surface of the ground and boxed in to prevent freezing. The water is syphoned from the lake, the highest point in the syphon being 20 feet above the lake level. The pipe discharges into a cistern close to the mill, but is also connected to the tank above the mill if required to fill it directly. A No. 7 Cameron pump is installed for emergency, and connected with the syphon.

Water supply of the Mill

As the supply of water is limited, a device has been invented and put into practice by Mr. Shear, the manager, which saves about half the water from the tailings for use over again. The tailings are charged by a distributor into one end of a wooden box with pointed bottom, six by 13 feet in size at the top and seven feet in depth. This works on the spitzkasten principal; one half of the liquid material (containing all the solid matter) being discharged through an orifice in the bottom, with valve regulator, and the other half (nearly pure water) flowing over the lower end, whence it is conducted to the cistern. Now the water flowing over the lower end is caused to flow in a very thin sheet over a perfectly horizontal edge, careful adjustment being required to secure this. Surface currents are thus prevented from forming except at the very edge; hence all solid material has time to settle and get discharged at the bottom. The water from the shaft was first used, but will not likely be required now.

Two wood chutes have been constructed from the top of the mountain, one to the hoister about 125 feet in length, and one to the mill, about 200 feet

The buildings consist of two shaft houses, hoister house, blacksmith shop, mill building, office, manager's dwelling, general boarding camps, private dwellings and several miners' cabins.

Buildings.

All requisitions previous to my last visit dealing with the maintenance of safety to employés underground and on surface have been complied with. The following instructions were left on last visit: Fence or cover winze in second level Carefully scale walls in stopes where required. A more suitable and safer method should be devised for getting access to crusher in mill.

Instructions

About 400 or 500 feet west of No. 2 shaft an adit four by seven feet in cross-section had been driven north 90 feet into the foot of the hill, cutting a series of parallel veins or branches. At the end a winze had been sunk 14 feet and contained about eight feet of water. This is all old work. It was in this adit that the accident occurred which resulted in the death of Wm. Montogomery, who lived at the mine.

Reduction Works.

The interest in improved processes for treating ores is well maintained, and during the past year more than the usual number of claimants appeared who were confident of winning favors by the success of their methods. In the vicinity of Rat Portage three plants are attracting notice, but only two of them have been practically tested.

Rat Portage Works.

On September 9 the Rat Portage Reduction Works were visited. A 60-ton lot of ore from the Sentinel mine was being treated, Mr. Wm. Peters superintending the milling. No change has been made in the machinery or the ownership of the works; but Mr. A. D. Upton of Duluth, who has been interested in the development of mining properties in this vicinity for the past year or two, has secured an option on the works and may form a company and take them over.

Norman Works.

A new reduction works is being built at Norman, about a mile west of Rat Portage,

by the Canadian Gold Extraction Company, Limited, under the superintendence of Mr. R. H. Ahn of Rat Portage. It is purely a customs mill; the ore will be sampled and tested, and bought outright before treating. The machinery has not all arrived yet, nor will the works likely be ready before spring. The treatment will consist respectively of coarse crushing with a Blake or Gates crusher, finer crushing through rolls, roasting, very fine grinding in grinding barrel, amalgamation in revolving barrels, and chemical treatment. The last involves a patented process which the owners are not making public.

Keewatin Works.

The Keewatin Reduction Works, described in last year's report, were completed and in running order in January, 1898, and were kept fairly busy for the remainder of the winter, but unfortunately, during the summer following they were idle for the greater part of the time, with the exception of the assay department; however, prospects for a busy winter again are bright. Some changes have been made in the management of the works. Mr. F. T. Snyder, who had been general superintendent, terminated his engagement with the company on June 17, and this office has been abolished, the duties of it having been distributed over three different offices. The business manager is W. J. Craig, the mill superintendent N. B. Wilcox, and the manager of assay department H. A. Guess. Mr. R. A. Mather is managing director of the works.

Operations during 1898.

Some important changes have been made in the machinery, the necessity of which has been demonstrated by experience. The gyrating concentrators installed by Snyder have been condemned and thrown out, and will be succeeded by Frue vanners and jigs. The gyrators were found to concentrate very satisfactorily, but the difficulty of keeping them in repair and adjustment more than offset any advantage they might possess over the Frue vanners. There are at present four of the latter, with four-foot belts, treating the product from two batteries. Two of these will be arranged to treat the discharge from the other two batteries, or rather the middlings and tailings from the jigs, which will be interposed between the batteries and the vanners. Two Hartz jigs will be installed, similar to those at the Regina, which have proven to work very satisfactorily. Stationary apron plates four feet long will be interposed between the batteries and the present gyrating amalgam tables; the latter will of course be retained. The batteries have all been changed from wide double-discharge mortars with no inside amalgamation, to narrow single-issue mortars, with front and back inside plates, the same mortars of course being used. Mercury traps have been supplied to all batteries. From 35 to 50 mesh screens are used, according to the nature of the ore treated. The third turbine, installed from the first but hitherto unused, is to be connected sólely to the milling machinery for running the same, as the speed requires to be uniform; this being impossible under the present state of affairs wherein all the power comes through the medium of a single shaft, both for the continuous running of milling machinery and the intermittent crushing and sampling and aerial tramway machinery. The two turbines in use aggregate 350 h. p., while the third one will furnish an additional 225 h.p. An extension to the power room will be built. An addition has been made to the sampling machinery of two small Gates crushers, No. 00 and 2; this improves the sampling by finer crushing when necessary, and also obviates the necessity of running the larger machinery for small mill tests.

Alterations in Machinery of the Mill.

A jig amalgamator invented by and constructed under the direction of Mr. Guess is an addition to the assay department which greatly facilitates the making of free-milling tests of small samples of ore. A series of bottles, according to the number of tests to be made at once, capable of treating one or two pounds each, are charged with the finely ground ore and mercury, securely closed and set in a frame, to which are communicated by machinery 300 two-inch strokes per minute. A very short time suffices to amalgamate all the free gold.

The Assaying department.

Instructions were given to cover and fence belts in pulleys in several cases, and these have been satisfactorily complied with.

MICHIPICOTON MINING DIVISION

By David G. Boyd, Inspector

I HAVE the honor herewith to present to you the second annual report on the Michipicoton Mining Division. During the past season of 1898 the progress made has been encouraging. The majority of claims in the district between Wawa lake and Michipicoton river have yielded samples showing free gold, and in places where work has been done the vein matter improves the deeper it is worked. Town sites have been laid out, one situated at the west end of Wawa lake named "Wawa City," and one on the Michipicoton river, one mile up from its mouth, named "Michipicoton City." The river is navigable for small tugs with draught not exceeding six feet to the town. The old C. P. R. tote road connects the two sites. At Wawa City a hotel, store, billiard hall and two small houses have been erected, while at Michipicoton are found a hotel and two stores, as well as the houses of the Indians and half breeds who used to work for the H. B. Co. The H. B. Co. have (after being closed two years) re-opened their post under the agency of Jabez Williams, formerly of Lac Seul Post. Prospectors and miners now going into the country can get all their supplies and outfit from the above stores, thus saving the former expense and trouble of bringing in all their outfit.

Progress made in 1898

The first and only machinery in the district consists of a customs two-stamp mill erected by Mr. Thomas Wescott of Sault Ste. Marie, Ont. The stamps (830 lb. each) and frames were made at Sault Ste. Marie. The vanner and copper plates were bought from Fraser & Chalmers, Chicago; the crusher and ore feeder from A. R. Williams & Co., Toronto. The power is supplied by an engine and boiler lately used in a saw mill. On October 13 the buildings had been erected, engine, boiler and stamp frames set up, and foundation for stamps laid. Mr. Wescott expected to have his mill running before the end of the season.

Customs stamp Mill

The office was opened for the transaction of business in one of the H. B. Co. buildings on April 29 and continued open until the close of navigation on October 29. During this period there were 152 miners' licenses issued and 228 notices of mining claims registered and filed at Michipicoton. The total number of licenses issued for the year was 203 (of which number 69 are renewals) 51 being issued from Toronto. The total number of claims staked and recorded was 266, of which 38 were recorded at Toronto while the office at Michipicoton was closed during the winter months.

The Inspector's Office.

The amount of money forwarded to the Treasury Department from the office at Michipicoton was $2,316.50, and the amount received at Toronto was $907, making a total of $3,223.50. Of this amount $2,030 was received for miners' licenses, $205 for transfer fees of mining claims, and the balance, $988.50 fees for additional mining claims filed by licensees who had already filed one claim on their license.

All of the claims staked and recorded, with the exception of two on lake Manitowick, are situated in the neighborhood of Wawa lake.

Development Work.

In the early part of the season little development work was done owing principally to the Spanish war, the majority of claims being held by Americans. The myriads of black flies and mosquitoes also hindered operations, it being almost impossible to work on the surface during the months of June, July and part of August.

Development work on Mining Claims.

In the latter part of August and in September and October more work was done, and judging from appearances in October there will be from 15 to 20 camps in operation all

winter. Regarding the work done, as most of the licensees employed their time in stripping the veins and sinking test pits, only the more important are noticed in this report

At lake Manitowick.

On lake Manitowick G. F. Parks had a gang working all winter on claim No. 173; he sank three pits, the deepest being 23 feet. At the time of my visit on 7th September, the only operations going on were on claims 79, 80 and 81, with Mr. N. J. Dingman of Palmerston in charge of ten men. Work commenced about the 20th August and consisted in stripping and sinking a shaft on the top of a hill. Later he let a contract for a shaft of 50 feet in depth to be done this winter. This as far as I could learn was all the work that was done in this part of the country. On Dog lake nothing has been done.

Inspection of Work on Claims.

At lake Wawa.

On 6th October I visited claims 33, 34, 35 and 36, situated one mile north of the west end of Wawa lake. These claims are situated on a large vein of quartz heavily mineralized with iron pyrites, also containing pyrrhotite. The strike of the vein is east and west. Work was started in April and continued steadily with an average number of four men in charge of A. Goetz of Sault Ste. Marie, Mich. Besides stripping and sinking test pits, two tunnels have been drifted, the longer being 15 feet in. Work will be continued all winter.

Gananoque claim.

Claim No. 128, "Gananoque," situated three miles east of Michipicoton city, owned by J. Legge of Gananoque and S. Barton of Sault Ste. Marie, was visited on 13th October. The strike of the vein is N. E. and S. W. with a dip of 45° to the north. The vein is well mineralized with iron and copper pyrites, galena and free gold. It has been traced 600 feet over a hill, and varies in width where work has been done from five to nine feet. Work was commenced in the fall of 1897, ceased during the winter, and commenced again in May, 1898. At the foot of a hill 22 feet of stripping nine feet wide preparatory to drifting a tunnel has been done. Half way up the hill a tunnel six by eight feet has been drifted in a distance of 17 feet, besides 19 feet of preparatory stripping. Summer and winter camps have been built and a waggon road cut out to Michipicoton City.

Claims 72, 97, 98 and 99.

Claims No. 72, "Pixley," owned by Mrs. Hopkins, No. 97, "Woehler," owned by Mrs. Hopkins, No. 98, "Helen," owned by L. M. Ward, and No. 99, "Florence," owned by H. J. Hopkins, were visited on 17 October. Work was commenced in the middle of May with L. M. Ward in charge, and continued until 17 October. On claims 98 and 99 the strike of the vein is nearly east and west. It has been traced 600 feet with an average width of six feet, well mineralized with iron and copper pyrites, with showings of free gold and native copper. Three test pits have been sunk, one of six feet and two of 12 feet in depth. On claim 98 a smaller vein one foot wide, with a strike of east and west, a test pit eight feet deep has been sunk. On claim 99 another vein, four feet wide with a course of northeast and southwest, has been stripped for 70 feet. On claim 97, on a vein running north and south, two pits have been sunk to eight and 13 feet respectively. A log camp 18 by 20 feet has been built.

Claims 92, 93 94 and 95.

Claims No. 92, 93, 94 and 95 are owned by the Wawa Gold Mining Co., Ltd., of which Lt. Col. Tisda'e, Q.C., M.P., is President. They were visited on 18 October. Work was commenced in May and continued until the end of October with an average number of six men, employed under P. A. Derry as foreman. On claim 92 the strike of the vein is northeast and southwest, with no apparent dip; it has been traced 800 feet. The quartz is well mineralized with iron and copper pyrites. A shaft of six by eight feet has been sunk 35 feet, and stripping has been done in several places. On claim 93 two test pits were sunk on the continuation of the vein, one of 6 by 10 and 14 feet deep, the other of 6 by 8 and 10 feet deep. On another vein five feet wide, with a course of north and south and a dip slightly to the east, four test pits were sunk ranging from eight to 15 feet deep. The vein has been traced 500 feet and is well mineralized with iron and copper pyrites and showings of free gold. This claim being situated on a small lake, considerable time was spent in

lowering the level of the water four feet in order to get a suitable place to begin work. On claim 95, on a vein four feet wide with a course of north and south, a pit of 6 by 8 and 16 feet deep has been sunk. A cooking and eating camp was built 15 by 30 feet, the men sleeping in tents during the time they were employed.

Claim No. 75, "Jubilee," owned by the Great Northern Mining Co., Ltd., was visited 18 October. The strike of the vein is northeast and southwest with a dip of 40° to the east, well mineralized with iron and copper pyrites and free gold. Work was commenced in November, 1897, and continued until the end of April, 1898, with an average gang of eight men. In this time a shaft was sunk 7 by 9 and 60 feet deep. Work was commenced again on June 1st and continued until the middle of September, when a cross-cut at the 60 foot level was made 7 by 8 by 26 feet in length, and at 25 feet a cross-cut 7 by 8 by 11 feet in length. The buildings consist of manager's and engineer's houses, sleeping and cooking camps, blacksmith shop and stable. A contract has been let to Mr. M. B. R. Gordon for 50 feet additional sinking, which will be finished during the winter months.

Jubilee claim, No 75

Appended is an amended list of licensees, place of residence, number of license, and number of claim (if any). Where not otherwise indicated the licensees are residents of Ontario.

List of Licensees and Claims.

Name.	Residence.	License.	Claims.
Aiken, D. A	S. S. Marie, Mich	244	84
Amyott, ——	"	202	419
Andison, H	Lakeside	143	
Appleby, J. E	Toronto	455	
Arms, W. P	Youngstown, Ohio	447	230
Armstrong, H	Michipicoton,	145	278, 371, 478
Armstrong, W. J.	Guelph	302	300, 201
Audette, J	S. S. Marie, Mich.	300	
Baird, J. E	Bowling Green, Ohio	183	366
Baluss, H., jr	Wayne, Mich	296	488
Barton, J	S. S. Marie, Mich.	277	188
Barton, S	" Ont	265	128 (½ int), 264 (½ int.), 269 (int.)
Bauldrey, W. J	Michipicoton	169	385
Beirnes, J	Guelph	162	288
Billings, F	Cleveland, Ohio.	125	261
Black, J	Bowling Green, Ohio	197	405
Black, L	"	184	367
Blackinton, A.B	Detour, Mich.	261	282
Boyd, J. F	Thessalon	124	377
Boyd, J. C	S. S. Marie	235	208, 209
Boyd, W. S	"	286	258
Boyer, B	"	232	360, 425
Boyer, J	"	211	
Brown, A. F	"	279	113, 415
Brown, Jane	"	186	364
Bryan, H. J	"	196	402, 428, 434
Bush, C	Wawa	297	273
Bush, E	Hamilton	122	274
Buttrey, L. H	Guelph	163	289
Calvert, F. H	Cleveland, Ohio	198	424
Campbell, N	S. S. Marie	275	472
Carrick, F. J	Missanabie	205	422
Cass, J	Michipicoton	204	
Churchill, C	S. S. Marie, Mich.	154	310

Name.	Residence.	License.	Claims
Clark, D.	Palmerston	248	80, 421
Clark, E. D	Guelph	291	200
Clergue, E. V	New York	173	68
Clergue, F. H	S. S. Marie	174	
Cole, L. C	Bowling Green, Ohio	185	368
Conlon, T	Thorold	200	401
Cory, E. N.	Pennville, Indiana	199	389, 410
Cowen, F. M	Flushing, Ohio	242	90
Cowie, J	Nip'gon	445	
Cox, E. S	Toronto	452	
Cracknell, A. B	S. S. Marie, Mich	245	61, 63
Culbert, S	Missanabie	450	276
Cummins, E.	S. S. Marie	140	375
Davidson. J	Ottawa	231	45, 249
Derry, P. A	S. S. Marie	191	416
Dexter, J. B	Chapleau	130	262
Dingman N. J	Palmerston	247	79, 420
Donnelly, J. P	Port Arthur	203	411
Downey, L	Chapleau	177	469, 492
Drew, T. F.	Michipicoton	294	326, 330, 493
Driver, J	S. S. Marie	194	380
Dudley, H. D	S. S. Marie, Mich.	155	311
Dunn, C. B	Paterson, N. J	181	59, 436
Dycie, J. G.	S. S. Marie	131	373
Dycie, Margie	Michipicoton	303	490
Earl, J	S. S. Marie, Mich	172	359
Eccles, G. H	"	236a	100
Edey, M. C	Ottawa	227	*46, 244
Edey, R. W	Pontiac Co., Quebec	229	241, 245, 468, 475
Everett, H. L	Philadelphia, Pa	262	450, 454, 455, 471
Ganley, Jos.	S. S. Marie	268	137, 156
Ganley, T	"	269	155
Garlick, R. M	Youngstown, Ohio	443	233
Gaudette, C	S. S. Marie	151	299, 355
Georgia, J	New York	206	
Gilmore, D. B	Toledo, Ohio	149	275, 346, 473
Gilmore, S. M	"	263	199, 465
Gilmore, W	"	164	332
Godon, T	Missanabie	168	353, 354
Goetz. A	S. S. Marie, Mich	209	33, 34, 36, 69
Goetz, Mrs. A	"	210	31, 35
Goetz, P.	"	208	32
Graham, Mrs A	Bowling Green, Ohio	182	365
Grierson, W	S. S. Marie	195	
G. N. M. E. & D. Co	Toronto	135	38, 75, 103 (¾ int. in each), 307, 449, 486
Grevell, A	S. S. Marie	180	381
Halliday, J	Chapleau	226	474
Hankey, J. L	Bowling Green, Ohio	189	370
Hankey, J. R	"	187	369
Harris, J. R	Guelph	136	267
Harvey, A	Chapleau	224	292, 314
Harvey, T. R	S. S. Marie, Mich	170	357
Hayner, E	Ottawa	246	150, 243, 248
Hobson, A. B	Flushing, Ohio	243	91, 452
Holbrook, H. B	Watford	179	455

Name.	Residence.	License.	Claims.
Holum, M. H.	Kirkhoven, Minn.	142	271
Hopkins, Anna	Pleasantville, Penn.	153	72, 97
Hopkins, H. J.	Buffalo, N.Y	271	99
Hunt, J.	Rydal Bank	239	491
Husson, Jane	Guelph	150	
Husson, W.	"	290	202, 339
Hyman, J. W	London	295	265, 489
Jelley, J	Webbwood	288	335
Johns, I. H	Kirkwood	133	306
Johnson, A.	Pembroke	144	168 (½ int.), 169 (½ int.), 266
Johnson, J. H.	S. S. Marie	221	26
Johnson, T	"	220	27
Kearns, J. J	Palmerston	249	81
Kimball, Hattie	S. S. Marie	251	383, 418
King, S. A	Missanabie	201	399, 400
Kitely, H	Toronto	254	446, 462
Kitely, T. A.	"	255	445
Labelle, J. E	Buckingham, Que	161	334, 407, 484
Lands Corp'n of Mich.	Toronto	253	464
Lauzon, A.	S. S. Marie	457	⅛ int. 38 and 75, 1/12 in 103, 356, 408
Law, S	Guelph	148	287, 341
Lawlor, J. H	S. S Marie	278	432, 470, 38 and 75 ⅛ int. 103 1/12 int.
Legge, C. H	Gananoque	257	129. 447. 453
Legge, J	"	223	128 (½ int.). 264 (½ int.) 269 (¼ int.) 476
Lewis, A. E., jr	Milford, Penn.	258	304. 427, 178
Lewis, F	"	166	430
Lewis, G	"	260	303, 482
Lewis, W. H	Detour, Mich	167	312, 318, 319, 414
Lincoln, J. C	Bowling Green, Ohio	190	361
Manitou Mineral Co	Niagara	219	431
Martin, H. G	Goderich	250	52, 259
May, E	St. Catharines	160	325, 480
Miller, L. B.	Cleveland, Ohio	264	
Millikin, W. H	Bowling Green, Ohio.	188	362
Mitchell, J	Guelph	147	294, 340
Mitchell, Mary E	"	448	256
Moran, D	S. S. Marie, Mich	293	190
Moran, P	"	2365	71
Moran, Mrs. P	"	237	70
Morrish, N. D.	"	171	358
Morrison, W. H	Eau Claire, Wis	158	
Mowat, J. A.	Guelph	449	257
Myers, J	"	274	466
Myles, P	Toronto	453	
McCaslin, J. J	Pleasantville, Penn	141	
McDonald, C. J	Oscoda, Mich	121	13
McDonald, M	Gananoque	222	433
McDougall, W. H.	White River.	454	
McElevey, P. H	S. S. Marie, Mich	436	237
McGregor, D	"	215	439
McGillivray, W	Ottawa	228	44, 246
McLaren, A.	Chapleau	225	290, 315
McRae, P. J	Detour, Mich.	175	347, 456
McTavish, J	S. S. Marie, Mich	213	438
Noel, J	Missanabie	446	317

Name.	Residence.	License.	Claim.
Osborne, C. S	S S. Marie, Mich	240	437
Parks, G. F	Wawa	270	173, 328, 487
Partridge, E. T	S. S. Marie, Mich	146	263
Patterson, D. C	S. S. Marie	139	270
Perry, W. F	Wawa	451	121, 122 (½ int. in each).
Pettet, R	Tarantorus	134	305, 388
Pratt, W	Mellrue, Wis	159	
Proper, Clara A	Pleasantville, Penn	156	457
Proper, W. J	"	273	458, 459
Quigley, G. B	Bowling Green, Ohio	280	195, 363
Raine, H. D	S. S. Marie, Mich	214	440
Ranson, D. J	"	284	111
Reed, G	Michipicoton	282	477
Reynolds, C	Paterson, N. J	266	160, 161
Reynolds, F. R	"	267	479
Robinson, H. M	Youngstown, Ohio	439	234
Rogers, G. H	Ottawa	230	47, 240
Rohn, E. H	Cleveland, Ohio	276	481
Roth, Augusta	"	132	260, 295
Roth, F	"	285	253 (½ int.)
Rush, R	S. S. Marie	128	336, 386
Sampson, W. J	Youngstown, Ohio	442	232
Sanders, E. H	Watford	178	
Sayer, H	S. S. Marie	281	277
Sayer, J	Garden River	217	308, 429
Schuttpelz, H	Olmstead Falls, Ohio	238	253 (½ int.) 272
Sherman, W. M	Milwaukee, Wis	241	442
Sleeman, G	Guelph	123	16
Soulier, A	Missanabie	212	426
Stambaugh, D. B	Youngstown, Ohio	440	239
Stambaugh, H. H	"	438	235
Stambaugh, J	"	441	231
Steese, R. C	"	126	
Stewart, J	Pembroke	129	168 (½ int.), 169 (½ int.) 254
Sullivan, J	S. S. Marie	193	372
Supe, O	S. S. Marie, Mich	233	441
Superior G. & C. Co	Toronto	256	461, 463
Sutton, E. S. B	S. S. Marie, Mich	216	435
Thibault, N	S. S. Marie	138	437
Tisdale, D	Simcoe	234	189
Tisdale, W. E	"	299	207, 483
Todd, G	Youngstown, Ohio	437	236
Trembley, J	Toledo, Ohio	272	49, 403, 404
Vansickle, W. B	Lynden	137	301, 302
Wallace, J	S. S. Marie	165	309 451
Ward, L. M	Pleasantville, Penn	218	98, 378, 443
Ward, Myrtle	"	252	460
Ward, W	"	157	281, 391, 448
Wardell, C	S. S. Marie	192	384
Wardman, P	S. S. Marie, Mich	292	191
Wawa Gold Mg. Co., Ltd.		298	92, 93, 94, 95
Westcott, T. J	S. S. Marie	176	352, 467
Wheeler, Dwight	Bridgeport, Conn	289	121, 122 (¼ int. in. each.)
Wheeler, D. C	"	301	121, 122 (¼ int. in each.)
Wick, H	Cleveland, Ohio	127	
Wight, J	S. S. Marie	287	226
Wilfing, F. J	S. S. Marie, Mich	259	102
Williams, J. B	Michipicoton	283	
Wilson, W. J	S. S. Marie	207	444
Wylie, W. H	Niagara	456	322, 374, 376, 417

NICKEL EXTRACTION BY THE MOND PROCESS[1]

By Sir William Chandler Roberts-Austen

The rules of the Institution provide that an Associate shall submit a Paper within a year of his election. In complying with this direction, the Author was satisfied that no better subject could be selected for consideration than the interesting process which marks an entirely new departure, in metallurgical practice, from the principles which have hitherto guided it. This process depends on the remarkable property possessed by nickel of forming a volatile compound with carbonic oxide, or, as it is called in modern chemical nomenclature, carbon-monoxide. When this gaseous compound is heated to 180° C. nickel is released in the metallic form.

Original character of the Process

The Sudbury Ore.

The Author was much impressed during a recent visit to Canada with the Imperial importance of the great nickeliferous district of Sudbury, Ontario. In view of the magnitude of this deposit, the annual production of metallic nickel in Canada seems inadequate, as it has hitherto not exceeded 2,750 tons The description therefore of any new process which affords a hope of hastening the development of this remarkable district should prove to be interesting. The deposit itself presents many points of interest. According to Professor Coleman of Toronto, the nickel ores of Ontario resemble the gold ores of Rossland in British Columbia, as they consist of a mixture of pyrrhotite (magnetic pyrites) and copper pyrites. These sulphides form enormous masses near the margin of large areas of diorite, or weathered gabbro of Huronian age, the amount of nickel contained in the ore averaging between 2½ per cent. and 10 per cent., the lower proportion being the more common. It is worthy of note that pyrrhotine from other parts of the country, found in association with Laurentian rocks, is almost barren of nickel. The importance of the nickel deposits of Ontario may be judged from the fact that, until the mines in the Sudbury region were worked, the world's supply of the metal was drawn chiefly from the mines of New Caledonia, an island in the Southern Pacific, supplemented by the Gap mine in Pennsylvania, and a few isolated mines in Norway and Hungary. The extent of the Sudbury deposits is greater than any of these, and New Caledonia, which belongs to France, is virtually the only rival of Ontario in the production of nickel.

Points of interest of the Sudbury deposit

The ore at Sudbury is smelted into a regulus, or matte, which contains between 12 per cent. and 20 per cent of nickel, and about the same amount of copper, although usually there is rather more copper than nickel. This matte may be enriched by suitable treatment, and is "Bessemerized" into a regulus which contains about 40 per cent. of nickel, and is specially free from iron, as the following analyses show :

Mattes of the Ore

Analyses of Bessemer Matte Unroasted.

——	I.	II.
	Per cent.	Per cent
Nickel	40.938	31 35
Copper	45.714	48 86
Iron and (Al_2O_3)	0.405	0 81
Cobalt	0 136	....
Sulphur	11.960	.. .

[1] This paper on the Mond Process by Sir. W.C. Roberts-Austen, D.C.L., F.R.S., was read before the Institution of Civil Engineers, London, England, on 8th November, 1898. It is printed in this Report of the Bureau of Mines, with the permission of the Author, as a paper which describes from the scientific point of view a most interesting process, that it is hoped may ere long be utilized in the treatment of Ontario nickel ores.

It is unnecessary to give a history of the metallurgy of nickel, but it may be well to state that Chronstet isolated the metal in the year 1751, and that Bergman confirmed his discovery in 1774. The methods hitherto employed for extracting the metal from its ores are very complicated; they have involved concentrating the nickel either as a sulphide (matte or regulus), or as arsenide (speise) followed by either "dry" or "wet" treatment. In the case of certain ores, wet methods only have been employed. The metallic nickel has always to be subjected to a process of refining, mainly, as in the case of cast iron, with a view to separate it from associated carbon.

Former method of extracting the Metal.

History of the Mond Process.

As regards the process which forms the subject of this Paper a few brief historical details may be offered. In 1889 Dr. Ludwig Mond, F. R. S., in collaboration with Dr. Carl Langer, was engaged in working out a method for eliminating the carbon-monoxide from gases containing hydrogen [1] which they wanted for use in their gas battery.[2] In attempting to effect this, they were guided by the observation they had previously made that finely divided nickel has the remarkable property of removing carbon from carbon-monoxide at a temperature of 350° C., converting it into carbon-dioxide, while the dissociation of carbon monoxide by heat alone, according to Victor Meyer and Carl Langer, remains incomplete at the high temperature of 1,690° C. In the course of these experiments, which they carried out in conjunction with Dr. Friedrich Quincke,[3] finely divided nickel formed by reducing nickel oxide at 350° C., by hydrogen, was treated with pure carbon-monoxide in a glass tube at varying temperatures. In order to keep the poisonous carbon-monoxide out of the atmosphere of the laboratory the gas escaping from the apparatus was ignited They found to their surprise that while the tube containing the nickel was cooling, the flame of the escaping gas became luminous and increased in luminosity as the temperature sank below 100° C. Metallic spots were, moreover, deposited on a cold plate of porcelain held in this luminous flame, just as spots of arsenic are obtained in applying the Marsh test for that metal. It was also observed that on heating the tube through which the gas was escaping, a metallic mirror was obtained, while the luminosity of the flame disappeared. On examination these metallic deposits were found to be pure nickel. The next step was to endeavour to isolate this curious and interesting nickeliferous compound, by preparing nickel with great care at the lowest possible temperature, and treating it with carbon-monoxide at about 50° C. The amount of the volatile nickel compound in the gases passing through the apparatus was thus gradually increased. The gases issuing from the apparatus were treated with a solution of cuprous chloride to absorb the excess of carbon-monoxide, and in this way a residue of several cubic centimetres of a colourless gas was obtained, containing the volatile nickel compound. By passing this gas through a heated tube the nickel and carbon-monoxide were again separated, and the volume of the carbon-monoxide thus set free was found to correspond to about four equivalents of carbon-monoxide to one equivalent of nickel. By further improving the method of preparing the finely divided nickel, and by passing the resulting gases through a refrigerator cooled by snow and salt, the investigators at last succeeded in obtaining the new compound in a liquid state, and were able to produce it with facility in any desire quantity.

Experiments with Carbon Monoxide.

Metallic Carbonyls.

Nickel carbonyl in its pure state is a colourless liquid boiling at 43° C.; it has a specific gravity of 1·3185 at 17° C., and solidifies at —25° C. into needle-shaped crystals. It is soluble in alcohol, petroleum and chloroform; and it

Combining with Nickel and Iron.

[1] Ludwig Mond and C. Langer. "Improvements in obtaining Hydrogen," British Patent No. 12,608, 1888.

[2] Ludwig Mond and C. Langer. "A new form of gas battery." Proceedings of the Royal Society, vol. xlvi. p. 296.

[3] Ludwig Mond, C. Langer, and F. Quincke. Journal of the Chemical Society, vol, lvii. p. 749.

is not acted upon by dilute acids or alkalies. It can be readily distilled without decomposition, but on heating the vapour to 150° C, it is completely dissociated into its components, pure carbon-monoxide being obtained, while the nickel is deposited in a dense metallic film upon the sides of the vessel in which the compound is heated.

After the production of nickel carbonyl had become easy, Drs. Mond, Langer, and Quincke directed their attention to the action of carbon-monoxide on other metals. A series of experiments was made with a view to obtain a similar compound with cobalt, which in its chemical and physical behaviour so much resembles nickel. The experiments gave, however, the unexpected result that, unlike nickel, cobalt will not combine with carbon-monoxide. Experiments were then made with iron, and indications were soon obtained of the existence of a volatile compound of iron and carbon-monoxide; a long time elapsed before this new compound was obtained in a pure state. It was finally isolated in a way similar to that by which the nickel carbonyl had been prepared, and proved to be a somewhat viscous liquid of pale yellow colour.[4] Its specific gravity at 18° C. is 1·4664; and it distils completely without decomposition at 102·8° C. under a pressure of 749 millimetres of mercury. When cooled to —21° C. it solidifies into a mass of yellowish needle-shaped crystals. Its chemical composition is somewhat different from the nickel carbonyl, as it contains five equivalents of carbon-monoxide to one of iron. The liquid compound, to which the name of iron penta-carbonyl was given, undergoes no change when protected from the action of light, but exposure to daylight for several hours in a sealed tube is attended with the formation of gold-coloured, tabular crystals, and carbon-monoxide is evolved, so that the pressure in the tube rises considerably. The crystals have, when dried, a metallic lustre, and resemble flakes of gold; they contain two equivalents of iron to seven equivalents of carbon-monoxide.

[4] Ludwig Mond and Carl Langer on "Iron Carbonyls." Journal of the Chemical Society, vol. lix. p. 1090.

None of the other metals which were submitted to investigation showed indications of combining directly with carbon-monoxide.

The discovery that in a mixture of metals only nickel and iron would form volatile compounds with carbon-monoxide, and that they could, therefore, be separated from the other metals, was sufficiently important to induce Dr. Mond to arrange laboratory experiments with ores containing nickel, cobalt, iron, copper, etc., such as "kupfer-nickel" and "pyrrhotite." The experiments afforded such promising results that apparatus of considerable size, though still well within the limits of the resources of a laboratory, was set up, and in it several pounds of ore could be treated with carbon-monoxide.[5] A patent was also applied for on the 12th August, 1890, which describes the way in which such ores may be treated. It is pointed out that the principal nickel ores which are metallurgically treated contain the nickel in combination with arsenic and sulphur besides other metals and gangue. These ores have first to be submitted to the process of calcination, in order that the nickel may be present in the form of oxide, and to drive off, as far as is practicable, the arsenic, sulphur, and other volatile bodies. The resulting oxide of nickel is treated with reducing gases, such as water-gas or producer-gas, in order to convert the oxide of nickel into finely divided metallic nickel; the material containing it then is cooled to about 50° C., and is treated with carbon-monoxide. In dealing with nickel ores which contain nickel oxide in chemical combination with silicic acid, arsenic acid, or other substances which cannot be removed by calcination, the ores are so treated as to convert the nickel into nickel speise or nickel matte, which is then subjected to calcination.

Laboratory experiments with Nickel Oxide

The Smethwick Plant.

In 1892 an experimental plant on a large scale was erected at Smethwick, near Birmingham. After some years of patient work, during which the plant had several times to

[5] Ludwig Mond on "Metallic Carbonyls." Proceedings of the Royal Institution, vol. xiii. p. 668.

be reconstructed, in order to meet all the conditions of this somewhat delicate process, the plant gradually assumed the shape shown in Figs. 1, Plate 1. Before describing it in detail it will be well to give a brief account of the operations involved in the process, which are the outcome of many years of practical experience.

Operations involved in the Process.

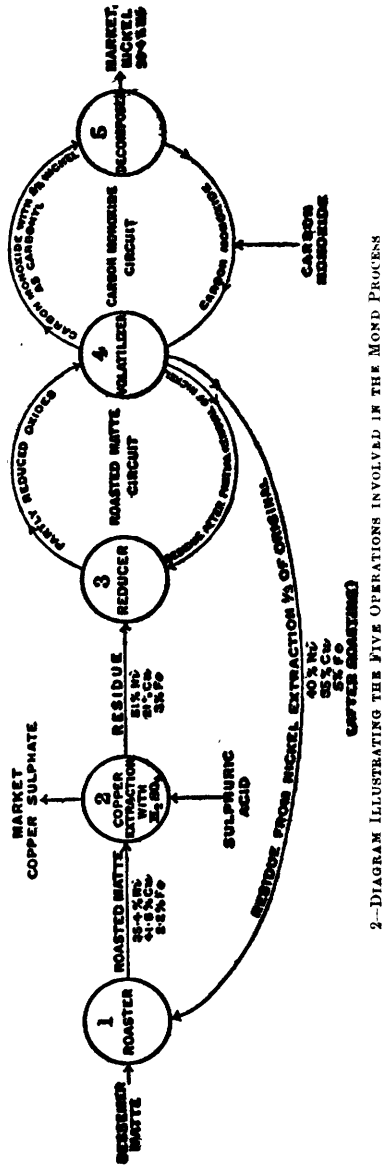
The process is more especially suitable for the extraction of nickel from ores which contain copper in addition to nickel and iron. These ores, which have on an average between 2 per cent. and 6 per cent. of nickel and about the same amount of copper, are first subjected to "heap roasting," to eliminate the greater part of the sulphur, and to convert the iron which forms their chief constituent into oxide. The roasting is necessary to enable the iron in the following operation of smelting to combine with the silica present in the ore to form a slag, and thus to effect the separation of the iron from the nickel and copper which unite with the remainder of the sulphur to form a regulus or matte. This matte contains the nickel and copper in a more concentrated form, the amount of each metal being usually 15 per cent to 20 per cent., the residue consisting mainly of sulphur and iron. To concentrate the nickel and copper still further, the matte is "bessemerized." A sample of such "bessemerized" matte is exhibited; it contains 31.37 per cent. of nickel, 48.62 per cent. of copper and 0.70 per cent. of iron. It was prepared by the Canadian Copper Company, Sudbury, Ontario, from their ores, which contain an average of 4 per cent. of nickel and 4 per cent. of copper. This "bessemerized" matte is crushed, ground, and subjected to a calcining operation so as to convert the sulphides into oxides, and it is then passed through a mill and dresser. This calcined Bessemer matte then consists practically of nickel oxide and copper oxide in varying quantities. It has been found in the practical working of the process to be advantageous to further concentrate the nickel by extracting part of the copper at this stage by treating the mixtures of oxides with dilute sulphuric acid, which dissolves about two-fifths of the copper present without taking up more than 1 per cent. to 2 per cent. of the nickel. The copper thus dissolved is in the form of copper sulphate and is obtained in a marketable form by crystallization. The undissolved residue from this operation contains between 45 per cent. and 60 per cent. of nickel, and after drying it is subjected to a carefully regulated reducing process by means of water-gas, after which it is treated with carbon-monoxide to extract part of the nickel present. In this first treatment with carbon-monoxide about two-thirds of the nickel can be easily extracted; after this amount is volatilized the extraction becomes much slower, so that it has been found advantageous to recalcine the residues and repeat the copper extraction, the reduction, and the nickel extraction.

Details of the Operations.

The five operations involved are diagrammatically illustrated in Fig. 2. The process begins, as will be seen, at one end with the material to be treated, "bessemerized" matte; it ends with the market product nickel. The "bessemerized" matte proceeds, as the arrow indicates, to the first operation (1) of dead roasting, and for this purpose any suitable furnace may be employed. After roasting, the matte contains 35 per cent. of nickel, 42 per cent. of copper, and about 2 per cent. of iron.[6] It then passes to the second operation (2) for the extraction of part of the copper (about two-thirds) by sulphuric acid, the copper being sold as crystallized sulphate of copper. The residue from this process contains about 51 per cent. of nickel and 21 per cent. of copper, and passes to the third operation (3) for reducing the nickel and incidentally the remaining copper, to the metallic state, care being taken to avoid reducing the iron This is effected in a tower provided with shelves, over which mechanical rabbles pass, the reducing agent being the hydrogen contained in water-gas. The temperature does not exceed 300° C., and should be kept lower when much iron is present. From this tower the ore is conveyed continuously to the fourth operation

[6] Average results are given in the Figure, rather than the best which have been obtained.

(4) of volatilization, in which part of the nickel is taken away by carbon-monoxide and forms the compound nickel carbonyl.



2—Diagram Illustrating the Five Operations involved in the Mond Process

The formation of this volatile compound is effected in a tower similar to the reducing tower, but the temperature is much lower, and does not exceed 100° C. From the volatilizer, the ore is returned to the reducer (3), and it continues to circulate between stages (3) and (4) for a period varying between 7 days and 15 days, until about 60 per cent. of the nickel has been removed as nickel carbonyl. The residue from this operation, amounting to about one-third of the original calcined matte, and not differing much from it in composition, is returned to the first operation and then naturally follows the same course as before. The nickel carbonyl, produced in the fourth operation, passes to the decomposer (5). This appliance is either a tower or a horizontal retort, which is heated to a temperature of 180° C., so as to decompose the nickel carbonyl and release the nickel in the metallic form, either on thin sheets of iron or, preferably, on granules of ordinary commercial nickel. Carbon-monoxide is also released, and is returned to the volatilizer to take up a fresh charge of nickel. It will be evident that, when the operation is in progress, the gaseous carbon-monoxide and the partially reduced oxides of nickel and copper are continuously revolving in two separate circuits which join and cross each other in the volatilizer (4). The commercial product contains between 99.4 per cent. and 99.8 per cent. of nickel.

Description of the Working.

Sudbury Ore under Treatment

It will now be possible to proceed to a description of the working as the Author saw it in full operation in Smethwick a few months ago. The details are clearly indicated in the plan of the works, Figures 1, Plate 1 (p. 112). The material under treatment during the Author's visit was of Canadian origin, and had been received as calcined Bessemer matte containing 35.4 per cent. of nickel, 41.8 per cent. of copper, and about 2 per cent. of iron. This material was first passed through a ball mill and dresser with a sixty-mesh riddle, and was then treated in quantities of 3 cwt. in a small lead-lined mixer with 200 lb. of ordinary sulphuric acid, which had previously been diluted with about 20 cubic feet of mother liquor from previous operations. These appliances are shown in the right hand portion of the plan and elevation, Figures 1. The

temperature of the mixture soon rises by the action between the copper oxide and the sulphuric acid, and is kept, by means of a steam-jet, at a temperature of about 85° C. for ½ hour. From this mixer, the charge is run out into a centrifugal hydro-extractor, provided with a filtering cloth, in which the solution of copper sulphate is separated from the solid residue containing the nickel. After the filtration of the charge is finished, the speed of the hydro-extractor is increased, and the residue is thus rendered sufficiently free from the liquor.

Extraction of the Copper

The solution containing the extracted copper runs from the hydro-extractor into a well, from which it is pumped into the crystallizing vats shown in the Figures. After a period of about eight days to 10 days, the crystals of copper sulphate are taken out of the vats and the mother liquor is mixed with fresh acid and is again used for the extraction of copper. As already mentioned, a small amount of nickel and a little iron are also dissolved in the sulphuric acid during the copper extraction, so that the mother liquor from which the copper sulphate has crystallized becomes gradually contaminated with these two metals. It is therefore necessary to replace some of the mother liquor from time to time by fresh water, and to recover the nickel from the solution. The simplest method is to evaporate the solution to dryness and to roast the nickel and copper sulphates so obtained. The oxidized material is again introduced into the main process. The copper sulphate crystals from the crystallizing vats are charged into a second hydro-extractor, where they are washed with a little clean water to remove all acidity; they are then dried and are ready for packing. The copper sulphate thus obtained is sufficiently pure for the market, as it contains only 0·05 per cent. of nickel and 0·048 per cent. of iron.

The Nickel Extracting Plant.

The residue from the copper extraction is taken from the hydro-extractor and stored in a bin until a sufficient quantity has been collected to make up a charge of five tons to six tons for the nickel-extracting plant. It now contains 52·5 per cent. of nickel, 20·6 per cent. of copper, and 2·6 per cent. of iron. The material is charged by hand at the rate of ½ ton per hour into a feeding-hopper, described as the matte inlet in the lower part of the plan, Figures 1, Plate 1, which communicates, through a rotary valve, with the conveyor, consisting of a tube enclosing a revolving spiral, which transports the material to an elevator. This lifts the material to the top of the reducing tower, and discharges it through another rotary valve into this reducing tower.

The Reducer.

The reducer and the volatilizer (shown in the centre of Figures 1) in which the treatment with carbon-monoxide takes place, are fully described in Dr. Mond's patent (No. 23,665 of December 10th, 1895). The reducer consists of a vertical tower about 25 feet high, containing a series of shelves, which are hollow so as to admit of their being raised to a temperature of 250° C. by producer gas. The roasted matte falling on these shelves from above is stirred and made to descend from one shelf to that below it by rabbles actuated by a central vertical shaft. Water-gas passes up the tower to effect the reduction of the material. There are about fourteen of these shelves or trays in the tower. The five lower shelves are not heated by producer gas, but are cooled by a stream of water in order to reduce the temperature of the roasted and reduced matte to the temperature at which the volatilizer is worked.

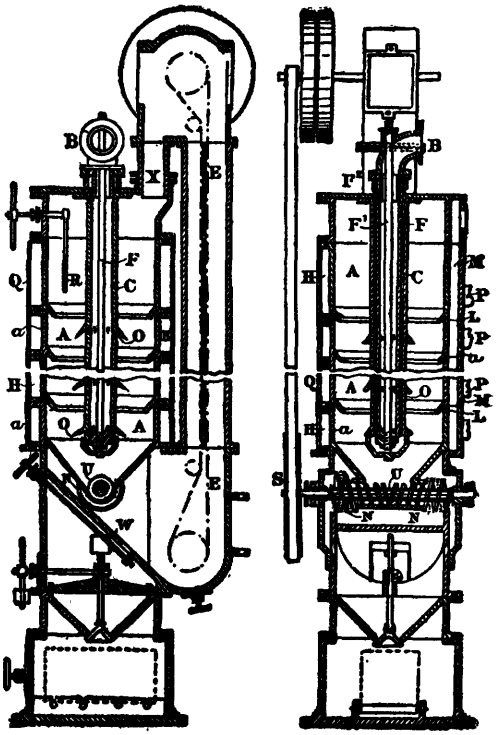
The Volatilizer.

The volatilizing tower resembles the reducer, but the shelves are not hollow, as there is no necessity to heat them. The reduced nickel requires a temperature of only 50° C. to enable it to combine with carbon monoxide and form a volatile compound, and the matte and gas are sufficiently hot to maintain this temperature. In the plant at Smethwick the volatilizer was made the same size as the reducer, but in the new plant it is somewhat smaller.

The Decomposer.

The decomposer has been devised with much care, and has, in its present form, only recently been patented. The nickel is deposited in it, from its gaseous compound with carbon monoxide, on granules of ordinary commercial metal. The arrangements by which this is effected are very in-

genious, and may be described almost in the words of Dr. Mond's latest patent The object is to obtain metallic nickel from nickel carbonyl in the form of pellets, which are specially suitable for the production of nickel alloys. For this purpose gases containing nickel carbonyl are passed through granulated nickel, which is kept at the temperature required for the decomposition of the carbonyl —about 200° C. The nickel which thus separates from the carbonyl becomes deposited on the granulated nickel, which consequently increases in size. In order to prevent cohesion of the granulated nickel, it is kept in motion. When a number of the pellets have attained a convenient size, they are separated by sifting without interrupting the depositing operation, the smaller granules being returned to receive a further deposit from the nickel carbonyl. A convenient form of apparatus for effecting the process described is shown in Figures 3, which represent vertical sections of the apparatus on planes at right angles to each other. A is a cylindrical vessel, preferably built up of short cylinders, *a a*, bolted together; it contains a central tube, C, provided with gas outlet holes, O, through which the gas containing nickel carbonyl, entering at the gas inlet, B, passes into the vessel which is filled with shot, or small granules, of nickel. The gas permeates through the interstices between these granules, and is brought into intimate contact with them, and when the nickel carbonyl is decomposed the nickel is deposited on the granules. The gases finally escape through the outlets, L, into the gas-exit pipe, M. In order to prevent the granules from cohering, they are kept slowly moving by continuously withdrawing some of the granules from the bottom of the cylindrical vessel, A, by means of a right and left-handed worm conveyor, U, which delivers the granules into two sifting-drums, N. The smaller granules fall on to the inclined plane, W, and collect at the base of the elevator, E, which conveys them again to the top of the cylinder, A, and feeds them through the feeding hole, X. In order to avoid the deposition of nickel from the nickel carbonyl in the central tube, C, it is kept cool by causing water to circulate down the tube, F, and up through passages F^1, formed in the central tube, to the water outlet, F^2. The cylindrical vessel, A, is surrounded by a



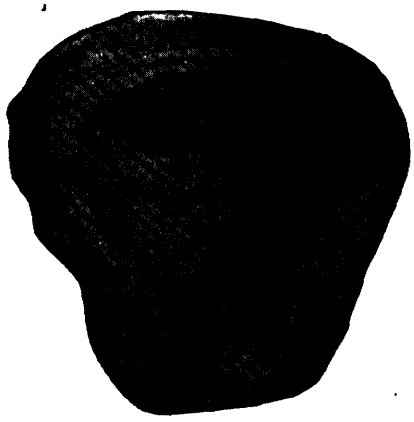
3. Vertical Sections through the Decomposer

wrought-iron casing Q, which forms heating-spaces, H, communicating with heating-flues, P, which are so arranged that the temperature of each cylinder can be separately regulated by dampers, so as to maintain the temperature of the granules of nickel contained in the vessel, A, at about 200° C., at which temperature the nickel carbonyl is decomposed. With a view to ascertain whether the cylinder, A, is full of granules, a rod, R, is fixed to the spindle of an external handle, which can be turned partly round, so that if the operator feels resistance to the motion of the R, it is certain that the granules extend to that height. The appliance used for depositing the nickel originally consisted of a series of retorts lined with thin steel sheets, on which the nickel was deposited in layers. It was found, however, that the metal so obtained was very difficult to cut, and the appa-

ratus above described was accordingly devised.

Depositing the Nickel

A magnified section of a granule of nickel, which was about ¾ inch in diameter, is shown in Figure 4. It will be seen that there is a core of nickel which under higher magnification shows a crystalline and convoluted structure, and this core is surrounded by concentric layers. The central core is ordinary commercial nickel, and



4 PHOTO-MICROGRAPH OF A GRANULE OF NICKEL MAGNIFIED THREE DIAMETERS.

the layers are nickel deposited from its carbonyl. In some cases granules of deposited nickel are found without any central core. these have grown from minute fragments of deposited nickel which have become detached during the course of deposition.

Production of Water-gas.

The water-gas used in the reducer is generated in gas-producers, three of which are shown on the left of the plan, Figure 1, Plate 1. Anthracite is used to decompose the steam, and the water-gas is collected in a gas-holder, whence it is taken to the reducing tower, to which reference has just been made. This gas contains, on entering the reducer, about 60 per cent. of hydrogen.

The reducing operation is so regulated that only a small quantity of hydrogen remains in the escaping gas, as a rule not more than 5 per cent. to 10 per cent. This waste gas is subjected to the action of a fine water-spray (not shown in the Figure), which condenses the steam generated by the combustion of the hydrogen in the water-gas. Part of this waste gas is used for making the carbon-monoxide required in the volatilizer, by passing it through the CO retort charged with incandescent charcoal, Figure 1, which reduces the carbon-dioxide contained in the waste gas, and this increases the amount of carbon-monoxide in it. The gas issuing from this retort contains about 80 per cent. of carbon-monoxide, and is stored in another gasholder, which communicates with the main circuit of the carbon-monoxide gas. The main circuit of the carbon-monoxide passes through the volatilizer already referred to, where the nickel is taken up. The carbon-monoxide, now charged with nickel, passes through a filter to separate the fine particles of matte-dust from the gasses, then through an apparatus called the decomposer, and so described in the Figure. In this decomposer the nickel taken up in the volatilizer is deposited. The gas now deprived of its nickel passes to the CO blower, Figures 1, which sends the carbon-monoxide to the volatilizer in order that it may take up a fresh charge of nickel.

Stages of the Process.

The solid material from which the nickel is being extracted is kept circulating through the reducer and volatilizer for a period varying between seven days and 15 days, during which time the oxides are gradually reduced to the metallic state and the nickel volatilized. When the material originally charged in has had the bulk of its nickel extracted it is run out through a rotary calciner roaster, Figures 1, which converts the metals into oxides, so that they may be treated for the second time with sulphuric acid and carbon-monoxide. The ratio between the nickel and copper in the residues from the nickel extraction is practically the same as in the calcined Bessemer matte, with which the operations were started, but the amount of iron has increased by the removal of the copper and nickel, as the following figures show:—Original matte contains, nickel, 35.27 per cent., copper, 41.87 per cent., iron. 2.13 per cent. After the first treatment of copper and nickel extraction, the quantities are, nickel, 35.48 per cent., copper, 38.63 per cent., iron, 4.58 per cent.; and after the second copper and nickel extraction, nickel, 35.83 per cent., copper, 35.56 per cent., and iron, 7.82 per cent. The amount of nickel

extracted in these two cases was, after the first treatment 61 per cent., and after the second treatment 80 per cent. of the nickel present in the original matte. It must be remembered, however, that in the second treatment only one-third of the original amount remains to be treated, while the final residue is only one-tenth. To avoid the formation of iron carbonyl, the temperature in the reducer has to be kept very low, and if this is done, the nickel extracted from a matte originally containing as much as between six per cent. and ten per cent. of iron will not contain more than 0.5 per cent of iron. If the amount of iron in the residues rises above this percentage, the extraction of the nickel is very much delayed, on account of the low temperature which must be maintained in the reducer. It is necessary, in such a case, to re-smelt the residues before proceeding with the extraction of the nickel and copper. The following are analyses of the deposited nickel :

—	I.	II.
	Per cent.	Per cent.
Nickel	99.82	99.43
Iron and (Al_2O_3)	0.10	0.43
Sulphur	0 0068	0.0099
Carbon	0.07	0.087
Insoluable residue	....	0.026

The experimental plant at Smethwick has been working for some time, and about 80 tons of nickel have already been extracted in it from different kinds of matte. The results obtained were quite satisfactory, and they point to the conclusion that the process is fully able to compete with any other process at present in use for the production of metallic nickel.

A Commercial Plant.

Plans for a Manufacturing Plant.

By the kindness of Dr. Mond, the Author is able to exhibit plans for a large manufacturing plant, and Figures 5, Plate 1 (p. 112), show a vertical elevation, sectional plan and cross-section of it. This plant will, it is estimated, produce 1,000 tons of nickel per year. The plant is so arranged that the matte is continuously charged into the first reducer and traverses the whole set of appliances. When the matte issues from the last volatilizer the first nickel extraction is finished. The matte is re-roasted and submitted to the second copper and nickel extraction. There are ten appliances, consisting of one large reducer, eight combined reducers and volatilizers, and one large volatilizer. They are so arranged that the matte has first to pass through the large reducer, and is then lifted, by means of an elevator and conveyor, into a volatilizer (erected on the top of the next reducer). The relative positions of the reducers and volatilizers are best shown in the cross-section, Figures 5. It passes through the volatilizer into the upper portion of the reducer and in traversing this it is further reduced. It is then lifted again to the next volatilizer, and so on till it finally reaches the larger volatilizer at the end of the whole series, and, after passing through this, it is discharged into the roasting furnace. The conveyor on the top of the volatilizers, into which the elevators discharge, is common to the whole set of volatilizers and reducers, so that, in case any portion of the plant has to be disconnected, the rotary valve through which the material is discharged from the conveyor into the volatilizer is stopped The material then passes on through the conveyor into the next volatilizer. The two gases, carbon-monoxide in the volatilizers and water-gas in the reducers, are kept separate by rotary valves of the same construction as in the small plant. The water-gas connections are so arranged that each reducer receives fresh gas from the main, with the exception of the first large reducer, through which the waste gas of all the other reducers is passed, so as to burn completely all the hydrogen in the water-gas. The carbon-monoxide passes through the volatilizers from a common main, and is collected, after it has passed through the filters, in a main leading to the blower. From the blower the carbon-monoxide charged with nickel passes through a set of decomposers, and again into the main which feeds the volatilizers.

Value of the Process.

Alloys of Nickel.

With regard to the application of steel containing between one per cent. and seven per cent. of nickle in constructive work, the Author need not remind members of the Institution of the importance of nickel steel not only for the manufacture of armour-plates but for all purposes where strength and lightness are essential. One manufacturer in the United States used in one year no less than 178 tons of nickel in the form of nickel steel, and it has been stated by a competent authority that "if propeller shafts were made of nickle steel the question of failures would seldom or never be raised." An attempt to deal adequately with the application of nickel would lead far beyond the scope of the present Paper, and the Author only adds that the extraordinary properties of these alloys have formed the subject of elaborate investigations by the late Dr. John Hopkinson[7] and by Mr. Guillaume.[8]

The Author acknowledges his indebtedness to Dr. Mond and to Dr. Langer for enabling him to examine the Smethwick Works in detail and for the drawing they prepared for him of the plant. The Author's assistant, Dr. Stansfield, was by Dr. Mond's kindness able to watch every stage of the process during a prolonged visit to the works.

Economy and Autonomy of the Mond Process.

It will have been evident that the process possesses unusual interest as being the only one, in the whole range of metallurgy, in which a metal is obtained from its ores by causing it to combine with a gas to form a gaseous product from which it is subsequently released. Not the least remarkable feature of the process is presented by the fact that the temperature at which the whole operation is conducted never exceeds 300° C., which is far below dull redness. As a consequence, the plant, which may still admit of simplification, is not, as is usually the case with metallurgical appliances, subjected to alterations of temperature extending through a considerable range. The repairs needed are therefore inconsiderable, and the amount of fuel required is but small. The process works more or less automatically, and the amount of labor involved in conducting it can be reduced within very narrow limits. The main operation is, moreover, a regenerative one; the carbon-monoxide moves in a cycle, and is the vehicle for continuously transferring the nickle from the ore or matte and converting it into a marketable form. It follows that in the extraction of the nickel no new material except the reducing agent, water-gas, has to be introduced into the system. This is true even of the granules of commercial nickel which fill the decomposer and serve as a basis for the deposition of the nickel from the carbonyl. Their presence is essential in starting the process; but their place is, as has already been pointed out, gradually taken by fragments of the deposited metal which becomes detached as the operation proceeds. The process will always occupy a prominent place in chemical history, and there would seem to be no reason why it should not play an important part in metallurgical practice.

As regards the application of the process in Canada, the Author trusts that this attempt to make it better known may contribute to develop one of the resources of the great Dominion.

The Paper is accompanied by six drawings and a photo-micrograph, from which Plate I and the Figures in the text have been prepared.

Discussion of the Paper.

President Preece

Mr. W. H. Preece, C.B., F.R.S., President, said it was his first duty to propose, and he was sure it would be carried with acclamation, a vote of thanks to the Author for the extremely clear and able way in which he had brought before the members a process that appeared to be new from beginning to end. It was one which they would watch with great interest and hope to have further light thrown upon. To many it was startling to think that nickel could be converted into a gaseous

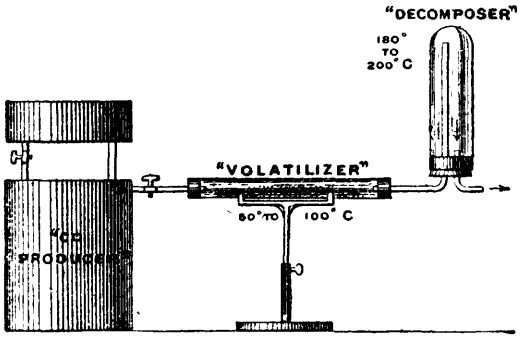
[7] Proceedings of the Royal Society, vol. xlvii. p. 23; vol. xlvii. p. 138; vol. xlviii. p. 1.

[8] Comptes rendus, vol. cxxiv. pp. 176, 752 and 1515, and vol. cxxv. p. 235.

form, and from the gas the solid metal that was so much required extracted by moderate increase of temperature.

Prof. Roberts-Austen remarked that as the process was of such great interest to Canada, he might be permitted to read a telegram he had received from Lord Strathcona and Mount Royal, the High Commissioner for the Dominion: "I am exceedingly sorry that owing to a severe cold I am compelled to deny myself the pleasure of being with you this evening. Your address would have had great interest for me, seeing how important the nickel industry is to Canada. Please accept my sincere regrets." He would first call attention to the liquid carbonyl compounded of carbonic oxide and iron. A sample was exhibited, for which the Institution was indebted to the kindness of Dr. Mond, together with a sample of the fluid carbonyl of nickel; but it was so poisonous that he feared to leave it where the tube in which it was contained might become fractured. He desired to show the actual experiment upon which the whole beautiful process was based, but it was an exceedingly delicate one to bring from a laboratory and show in a room far away from the place in which it had been arranged. The gasholder contained carbonic oxide, and a little of the gas was ignited to show that it burnt with the characteristic flame of that gas. This gasholder, figure 6, corresponded with the carbonic oxide retort of Figures 1 and 2, Plate 1. The gas was then passed over finely divided metallic nickel at a temperature not necessarily exceeding 50°C., and the luminosity of the flame was materially increased. The tube containing the nickel corresponded with the portion of the plant called "volatilizer" in Plate 1. In a very few minutes the carbonic monoxide took up its charge of nickel, and there was a luminous flame which deposited its nickel on any cold surface held over it. The flame was fully charged with nickel and deposited a black layer of the metal on a plate of cold porcelain. It could be seen within what a very small range of temperature the whole operation was conducted. By passing the gas into a tube, and by heating it, a brilliant deposit of metallic nickel was obtained on the inside, in the form of a mirror. This tube corresponded with the "volatilizers" of the plant shown in Plate 1. The plate of solid nickel, which he exhibited, stripped off a sheet of iron on which it had been deposited, was prepared precisely as shown by the experiment, only in a large retort. He also exhibited granules of nickel having a core of ordinary commercial nickel. If the nickel carbonyl was introduced into an ordinary non-luminous Bunsen burner it instantly became luminous. Photographs were projected upon the screen to illustrate (1) the roasting bed of the great ore deposit

Prof Roberts-Austen



6 Gasholder, Volatilizer and Decomposer

in the district near Sudbury; (2) a mass of nickeliferous regulus resulting from the process of heap roasting, showing on what a grand scale the operation was now conducted; (3) a magnified granule of ordinary commercial nickel surrounded by concentric layers of nickel, Fgure 4. The central core was unduly large. In conducting the process on the large scale, no new granules had to be introduced into the system, because the fragments of the external layers became detached and so served as a basis for the deposition of fresh quantities of nickel from the carbonyl; (4) an enlarged view of a granule showing the crystalline structure of the ordinary commercial nickel, which contained carbon, while the banded layers were magnifications of the pure nickel deposited on the nucleus of commercial nickel; and (5) heating and cooling curves of metallic nickel registered by means of an autographic pyrometer. As the nickel attained a temperature of 600°C. there was a

distinct break showing absorption of heat; and conversely, as the metal cooled there was a slight elevation corresponding in position with that on the other side, which meant that as the metal cooled there had been true recalescence, exactly as in the case of iron. The points in the curve were not in any way due to carbon, but to the molecular change in the nickel itself. Another bond of union was thus demonstrated between metallic iron and metallic nickel, which in many ways resembled each other.

Electricity as a Refining Agent.

Dr Ludwig Mond, the Inventor.

Dr. Ludwig Mond desired to express his gratitude to the Author for having introduced, in so lucid and eloquent a manner, his invention to the Institution. It had required very careful tending, but he thought it was now quite capable of taking care of itself in the struggle for independent existence among manufacturing processes. When the Author had first suggested that he should like to bring the subject before the Institution, Dr. Mond had some difficulty in seeing the connection between nickel extraction and the Institution of Civil Engineers; but having enjoyed the privilege of listening to the beautiful address delivered by the President a week before, he had learnt how many different kinds of engineers were admitted to the Institution; and he believed he had grasped why the Author was desirous to choose that particular subject for the Paper it had become his privilege and duty as an Associate to read. He hoped that the Paper, showing as it did the great engineering difficulties that had to be solved to carry out that apparently very simple process of manufacture, would have completely dispelled any doubts as to the position occupied by the chemical engineer in the great fraternity. In his remarkable address the President had made out a very strong case in favor of electricity becoming the exclusive handmaid of mankind, to minister to all its wants. He ventured to think that in future there would still be innumerable occasions on which chemical affinity would be called upon for assistance, and he believed the process described in the Paper would be one of those cases where chemical affinity would successfully resist all attacks by electric currents. It would be noticed how delicate the action of chemical affinity was in that process, how it became completely reversed by slight increase of temperature and how carbonic oxide and nickel combined readily at 100°C. and fled asunder again at 180°C. That was the great beauty of the process and the great facility which it offered to attain the end in view.

Col. Baker, of British Columbia.

Colonel James Baker, late Minister of Mining, British Columbia, was constrained to remark upon the immense importance the experiments that had been shown must have upon the mining interest of Canada generally. It was known that the nickel ores experimented upon by Dr. Mond had been all derived from the Sudbury district in Ontario. He was very anxious, if possible, to find the Province of British Columbia possessed of nickel ores somewhat similar to those of Sudbury, and he had issued instructions to the various mining recorders in different parts of the Province to send to the Government assayer all the ores they possessed, in order that they might be tested for nickel; but he regretted to say they had not yet succeeded in finding it in any marketable quantity. However, a large body of ore had recently been discovered in Vancouver island, similar to the ore which was, perhaps, familiar to some of the members present under the names of chalcopyrites, and somewhat similar to that at Rossland; but there was a difference, in that it contained a little more nickel and a considerable amount of gold. Therefore, he hoped that, by further experiments with ores in British Columbia, a quantity of nickel that might be of marketable value might yet be arrived at; if so, he was quite sure he might look forward to its being treated by the wonderful process which had been explained by the Author. It must be remembered that British Columbia was a young Province, and that the discovery of lode mines there was, comparatively speaking, of recent origin, and that it also took a considerable amount of time and capital to develop the mines. If the mines had not been brought to a remunerative basis more

quickly it was because of the time and capital necessary for that process.

Mr Stead. Mr. J. E. Stead observed that Dr. Mond's wonderful discovery had been known for some time to chemists, who had thought it impossible to make a practical process for the manufacture of nickel by it; but they also thought, at the same time, that if there was one man in the world who could do it, it was Dr. Mond himself. The process was a wonderful monument to Dr. Mond's chemical and engineering skill, for the elaboration and the skill which had been shown in the arrangement and the design of all the machinery to conduct the special process was very remarkable, and reflected enormous credit upon Dr. Mond and his fellow-workers. The Paper also reflected credit upon the Author for its great lucidity and clearness. Those who had studied the calcining of nickel ores would know the great difficulty of eliminating the sulphur, which seemed to be a great trouble in the present case. The sulphur adhered to the nickel very persistently, and the nickel must be in the state of oxide before it could combine with carbonic oxide; more information upon this point would therefore have been interesting. Again, after the first and second roasting processes, he should like to know why the copper and nickel remained in a definite ratio. Was some union formed between the nickel and copper? and why should the nickel refuse to give itself up in the presence of the particular quantity of copper referred to in the Paper? He thought the process a marvellous one to be conducted at such an extremely low temperature. It was certainly a new departure, first obtaining the metal in the form of gas at relatively an extremely low temperature and then depositing it at 200°C., below the melting point of tin. It was possible that for a time the process might be in the ordinary stage of infancy; but eventually, he hoped and believed, that, with Dr. Mond's skill and wonderful ingenuity, it would be, if it were not already, a practicable and valuable one for the manufacturer of nickel.

Mr. George Attwood. Mr. George Attwood had acted for some years as Consulting Engineer to the Dominion Mineral Company, the next company in importance to the Canadian Copper Company, and had designed and constructed all their mining and smelting works. He agreed that the production of metallic nickel in the Sudbury district was disproportionate to the extent of its mineral deposits. The lack of a refining process that could be worked economically on the spot had been one of the chief reasons why the Sudbury nickel deposits had been neglected. The mining companies, after converting the ores into a matte or regulus, had then to sell to the refiners in America, England, and on the Continent. Their agents had sometimes received 1*s.* per lb. for the nickel in the matte, and in some cases only 7*d.* per lb. in mattes containing 25 per cent. of nickel, and 15 per cent. to 20 per cent. of copper. In 1891 he conducted a series of experiments by the Mond process. The first trial was made on crude ore, which contained about 3.35 per cent. of nickel, and 1.70 per cent. of copper. After several days' treatment, the quantity of nickel obtained was so small that the experiments on that class were abandoned. He then decided to make a trial on matte containing about 25 per cent. of nickel and 14 per cent. of copper, and about 0.65 per cent. of cobalt. After dead roasting, the matte was treated as before, with much better results. The nickel obtained was free from cobalt, the separation of which was important in these ores. It was free from cobalt, although the matte contained 0.65 per cent. of it. The extraction of the nickel was very slow in his experimental plant. Finally he experimented with richer matte, containing nearly 40 per cent. of nickel, and 43 per cent. of copper and an unestimated amount of cobalt; the results were very good. Those experiments had been made on a small scale, a few pounds of ore for a special purpose. He was hopeful that the ore could be treated after it had been received from the mine, first roasting it, and then treating direct by the Mond process; but he found that that was not possible, and so the experiments were abandoned. He had no doubt that the Mond process would work well on the Sudbury mattes. He would be interested to have a

comparative estimate of the cost of a plant which would treat, say 3,000 tons of matte per annum, producing about 1,000 tons of nickel. He would also like to know the cost of working the plant, on either per pound of nickel or per hundredweight of nickel produced. He had been more or less concerned in the nickel and cobalt industries all his life, and he considered the process described the most important advance made during his lifetime.

Cost of Production.

Mr. R. A. Hadfield thought that, in view of the great interest now attaching to the use of nickel, the Paper would be more complete if information were given with regard to the cost of production. At present the prices were exceedingly high, reaching £120 to £140 per ton. He believed there was a very promising future for nickel steel. When ferro-manganese with 70 per cent. or 80 per cent. of manganese commenced to be used, £100 a ton was paid for it, and the consequence was that it was adopted only on a small scale. He thought the sooner the price was brought down to a moderate rate, the more quickly would the use extend. It was a great mistake to overdo high prices of these special metals. He was aware that the price of nickel had already fallen very considerably, as it was not many years ago since 5*s.* 6*d.* was paid per lb. The very admirable process which had been described should effect a further reduction in the cost of production. He believed that in Canada there were other sources of supply beside that of Sudbury. A well-known mining-engineer from Canada had informed him that several large deposits were now being prospected. It was singular that "Our Lady of the Snows" seemed to possess a very large part of the nickel ores of the world, and he was glad they were on British soil, especially at the present time when armour plates were a subject of such great interest. He had had put before him a certain quantity of Mond nickel and nickel made by the ordinary method, and he had produced an alloy of nickel steel with the two metals, one made by the Mond process, and the other by the ordinary process, and sold by the Orford Copper Company. He was pleased to say that Dr. Mond's metal gave steel of very high quality. The Mond nickel gave an elastic limit of 24 tons, with a breaking strength of 36 tons, elongation of 32 per cent., and a reduction area of 56 per cent. The material made from the Canadian Copper Company's nickel gave an elastic limit of 23 tons, a breaking load of 35 tons, elongation 27 per cent., and reduction in area 49 per cent.—not quite equal to the last result. On analysis, the steel contained 0.25 per cent. of carbon in the Mond product, and 0.26 per cent. in the other one; 0.06 per cent. and 0.05 per cent. respectively of sulphur; 0.04 per cent. of phosphorous, 0.75 per cent. each of manganese, and 2.9 per cent. each of nickel. They afforded an excellent comparison, and were very uniform in chemical composition. He also had an analysis prepared of the two metals, and the Mond nickel was certainly slightly purer. The length upon which the elongations had been measured was 2 inches, with an area of 0.5 square inch. He had also made a series of tests on a $\frac{1}{4}$ square inch area, and the results were very similar. Steel makers wanted to obtain the best possible product, and were very glad to see a high-class material in the market such as had been described by the Author. There was not a very large difference—about one per cent. in the nickel, and the carbon in the Mond metal was about half that in the other. In neither case was it high—about 0.16 per cent., and 0.05 per cent. There was also a little more iron in the Canadian Copper Company's nickel. He hoped the new development would add largely to the wealth and increasing prosperity of Canada.

Mr. R. A. Hadfield.

Mr. J. Bernays had had the honour of designing and erecting the original Smethwick plant under the instructions of Dr. Mond, and he greatly admired the beauty of the whole process produced by a few simple mechanical appliances, such as cylinders, elevators, grinders and furnaces. The whole apparatus seemed to be working at moderate heat from morning to night, ore going in at one end and nickel coming out at the other. The plant illus-

Mr. Bernays.

trated appeared to be considerably changed from that originally designed, and he noticed that the decomposer had been entirely altered from what it was in the first instance But such very important inventions always required a considerable number of alterations before the apparatus was brought to perfection.

Sir Frederick Bramwell, Bart., Past-President, remarked that having just seen the interesting experiment of the deposition and solidification of nickel out of its condition as a component of a gas, at a temperature of 200° C, he should be glad to know at what temperature solidification took place, when nickel was in the metallic state and had been fused; in other words, what was the ordinary melting-point of nickel?

Sir Frederick Bramwell

Dr. Ludwig Mond pointed out that one of the advantages of the process was that the sulphur need not be completely roasted from the matte in the first instance. The matte was roasted three times, and the sulphur left in at the first calcination was removed by the subsequent ones. There was the very peculiar fact that by attacking the roasted matte with sulphuric acid only a certain amount of copper was dissolved, until a definite relation between nickel and copper was established; still, he did not venture to base any theory on this fact. With regard to the questions asked as to the cost, he might say that he had not come to the Institution to transact business, but if any gentlemen were anxious to know any details about that matter he should be very pleased to reply, if they would send their questions in writing.

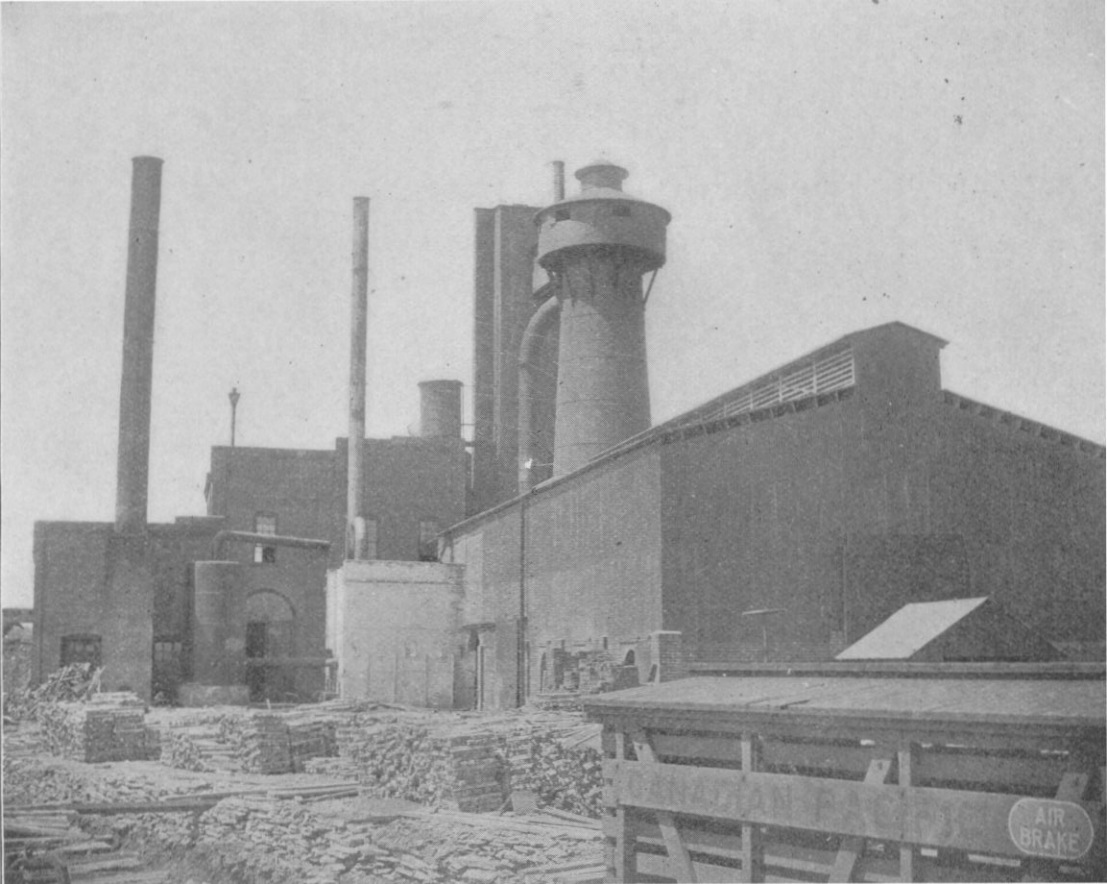
Dr Mond.

Professor Roberts-Austen, in reply to the discussion, stated the melting-point of nickel was 1600° C. He had considered the question of cost with very great care, but he felt it was rather beyond him; he was satisfied, however, that the process would compete favourably with any now in use, and he thought it unfair to draw up an estimate as to cost from appliances which were confessedly in a transitionary state. That was the reason why he did not produce the thoroughly comprehensive figures which were submitted to him, not only by Dr. Mond, but by Dr. Langer. He might add that Dr. Stansfield examined these data with the greatest possible care. It was with much confidence that he expressed his belief in the economy with which the process could be conducted.

Prof Roberts-Austen on the Economy of the Process.

Mr. Thomas Gibb, of Liverpool, pointed out by correspondence that keeping all the appliances for the treatment and circulation of the materials and gases rigidly enclosed would entail much skill in the construction and care in the working of the apparatus; this was made comparatively easy by the extremely low temperatures at which the operations were conducted compared with the temperatures usually employed in metallurgy. The Author could not have done a better service to metallurgy than bring before the Institution this unique process, now that its initial difficulties had been patiently and, to all appearance, successfully combated, and it was likely to be launched as an important industrial operation. The process, worked on a large scale, involved a large production of sulphate of copper. For instance, the 1,000-ton plant contemplated would have to be accompanied by plant for the production of 4,500 tons of crystallized sulphate of copper, and any general adoption of the process would entail a formidable competition with existing works. The copper could be precipitated either by iron or electrolysis; but, however it was performed, the plant for, and cost of, its utilization would have to be reckoned with whenever its quantity became too large to be advantageously placed on the market as sulphate.

Mr Gibb on Features of the Process.


AIR
BRAKE

OF

MINERALOGY

REPORT OF

THE BUREAU OF MINES

VOLUME VIII—SECOND PART

1899

CONTENTS

INTRODUCTORY NOTE - - - - - - - p.	IX
COPPER REGIONS OF THE UPPER LAKES -	121-174
THE NIPISSING-ALGOMA BOUNDARY - -	175-196
GOULAIS RIVER TO DALTON - - - -	197-204
CORUNDUM AND OTHER MINERALS - -	205-240
CORUNDUM IN ONTARIO - - - - - -	241-249
CORUNDIFEROUS NEPHELINE SYENITE - -	250-253
MICHIPICOTON IRON RANGE - - - -	254 258
COPPER IN PARRY SOUND DISTRICT - -	259-262
LOWER SEINE GOLD MINES - - - -	263-274
NOTES ON WORKING MINES - - - -	275-279
SUMMER MINING CLASSES - - - -	280-283
PROVINCIAL ASSAY OFFICE - - - -	284-289

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

Toronto:
Warwick Bro's & Rutter, Printers, etc., 68 & 70 Front St. W.
1899.

CONTENTS

PAGE.

Introductory Note ... ix.
Copper Regions of the Upper Lakes ... 121-174
General scope of the Season's work ... 121
St. Mary's River and the North Channel ... 122
Garden River Marble Quarry ... 122
Victoria and Cascade Mines ... 123
Echo Lake Region ... 123
Bruce Mines Region ... 124
Trap Rock for Road Metal ... 125
Laurentian-Huronian Contact ... 126
Northeast Shore of Lake Superior ... 126
St. Mary's Sandstone ... 126
Great Gros Cap ... 126
Goulais River Valley ... 127
Batchawana Bay ... 127
Mamainse Region ... 128
Mamainse Copper Mine ... 129
Point Aux Mines ... 129
Features of the Coast Line ... 129
Scenery of Montreal River ... 130
Agiwa River ... 131
Montreal and Lizard Islands ... 131
Sand River ... 131
Leach Island and Gull Rock ... 131
Gargantua River and Harbor ... 132
Region of Little Gros Cap and Doré River ... 132
Old Lake Terraces on Dog River ... 133
Geology of Pucaswa Harbor ... 133
Cascades of Pucaswa River ... 133
Kilkenny Harbor ... 134
Dikes of Otter Head ... 134
Cascades of Rideau River ... 134
White Spruce Harbor ... 134
White Gravel River ... 135
Oiseau Bay ... 135
Pic River ... 135
Heron Bay ... 135
Iron Sand Deposit at Peninsula ... 135
Michipicoton Mining Division ... 135
Exploration Tours from White River to Lake Superior ... 135
Ascent of Bremner River ... 136
Descent of Pucaswa River ... 137
Herrick's Roadway Line ... 138
Story of a "Salting Swindle" ... 138
Ascent of White River ... 139
Descent of Dog River ... 140
Iron Deposits on Dog River ... 141
Denison Falls of Dog River ... 141

PAGE.

Copper Regions of the Upper Lakes.—*Con.*
Tip Top Mountain ... 141
Ascent of the Mountain ... 142
Scenes of Rolling Hills and Spruce Forests ... 142
Caribou of the Region ... 142
Keweenawan Conglomerate at Pucaswa River ... 143
Caribou Island ... 143
Michipicoton Island ... 143
Philipps and Quebec Mines ... 143
Lake Terraces of the Island ... 143
Quebec Harbor ... 144
Volcanic Rocks of the Island ... 144
Michipicoton Mining District ... 144
Belt of Schist Conglomerate ... 144
Eruptive Granite ... 144
Hematite Iron at Gros Gap ... 145
Gold Mines at Wawa Lake ... 145
Contact of Laurentian and Huronian Formations ... 146
Extent of the Schist Conglomerate Belt ... 146
General Features of the North Shore ... 146
Population of the Region ... 147
Fishing Industry ... 147
Resources of the Mainland ... 147
Power of Wave Action ... 147
Michipicoton Post ... 148
Thessalon District ... 148
Huronian Rocks on Lake Shore ... 148
Cheney Copper Mine ... 148
Mississaga Placers ... 149
Goulais Bay District ... 149
Mountain Road to Goulais River ... 149
Formations on Goulais River ... 150
King of the Mountains ... 150
Settlement on Goulais River ... 150
Pleistocene Geology ... 150
Terraces and Old Lake Beaches ... 150
Measurement of Elevations ... 151
Water levels at Owen Sound and Collingwood ... 151
Thessalon and Mississaga Terraces ... 152
Terrace on St. Mary's River ... 152
Raised Beaches at Sault Ste. Marie ... 152
Terraces between Sault Ste. Marie and Batchawana Bay ... 153
Terraces from Gros Cap to Gargantua ... 153
Terraces at Michipicoton ... 154
Terraces at Dog River ... 15

PAGE.

COPPER REGIONS OF THE UPPER LAKES—*Con.*
Terraces on Pucaswa and Swallow Rivers 154
Beaches on Michipicoten Island 154
Table of Beach Levels on Lakes Huron and Superior 155
Results of Observations 155
Glacial Geology 156
Erosion of the Till on Shore Lines 156
Pebbles of the Glacial Drift 156
Fossils of the Glacial Pebbles 156
Records of Glacial Striæ 157
Logan's original Huronian Area 157
Rocks of the Thessalon Trough 158
Huronian and Keewatin compared 158
White Quartzite, Chert and Limestone. 158
Jasper Conglomerate 158
Red Quartzite 159
Upper Slate Conglomerate 159
Limestone Band 159
Lower Slate Conglomerate 160
White Quartzite No. 3 160
Green Chlorite Slate 160
Gray Quartzite No. 1 161
Basal Conglomerate below Logan's No. 1 161
Eruptive Rocks in the Huronian 161
Source of Materials of Huronian Rocks. 162
Suggestiveness of the Jasper and Chert Pebbles 162
Areas of Laurentian Rocks 163
Huronian areas on Lake Superior 163
Goulais-Batchawana Contacts 153
Huronian of Doré River 164
Extent of the Doré Conglomerate Band. 166
Relativity of the Conglomerate. 166
Schists of Heron Bay 167
Sequence of Archæan Formations 167
The Keweenawan Series 168
Localities of on Lake Superior 168
Relation of Dikes to the Keweenawan Rocks 168
Notes on Petrography 169
Eruptives in the Huronian and Keweenawan Rocks 169
Lava Flows at Thessalon 169
Diabase at Bruce Mines 169
Area of Grano-diorite between Thessalon and Mississaga Rivers 170
Dikes in Limestone 170
Basic Eruptives at Mamainse 170
Amygdaloids at Mamainse 171
Acid Eruptives 171
Porphyries and felsites 171
Dike rocks near Heron Bay 172
Description of a New Analcite Rock—Heronite 172

THE NIPISSING-ALGOMA BOUNDARY 175-196
Basin of Nighthawk Lake 175
Tributaries of the Lake 175

PAGE.

THE NIPISSING-ALGOMA BOUNDARY.—*Con.*
Geology of the West Shore 175
Redstone and Porcupine Rivers 176
Porcupine Lake 176
Areas of Farmland 177
Frederick House Lake and River 177
Huronian-Laurentian Contact 178
Frederick House Lake to Abitibi River. 179
Huronian Schists on Black River 180
Abitibi River 181
Cross-section lines of exploration 181
Long Sault Rapids 182
Meridian Line crossing at 179th Post. 182
Tributaries and rapids below the Line 182
Rocks of the Great Gorge 185
New Post Trading Station 186
Little Abitibi River 186
Region of Devonian Rocks 186
Laurentian Island in the Devonian Sea. 188
Deposit of Lignite in Boulder Clay 188
Extensive Gypsum Deposit 190
Great area of Sphagnum Moss 190
Meridian Re-crossing at 288th Post 190
Moose River and James Bay 190
Head of Navigation on the Moose 191
Rising Region of James Bay 191
Commercial Aspects of the Region 191
Fish and the Fur-bearing Animals 191
Moose Factory 191
Gypsum on French River 192
Summary of Exploration 192
Characteristics of Abitibi River 192
Soil and Agriculture 192
Timber Resources 193
Mineral Resources 193
Water Powers 193
Fur and Game 193
Geological Features 193
Missanabie River 194
Navigation of the River 194
Landmarks of Rapids and Portages 194
Height of Land Portage 196

GOULAIS RIVER TO DALTON 197-204
Garden and Goulais River Valleys 197
Rock Formations of the Line 197
Stretch of Montreal River 198
Mattawan River to Lake Windermere 199
Natural Resources of the Country 199
On Goulais and Batchawana Rivers 199
On Montreal River 200
Mattawan River to Height of Land 200
Batchawana River Region 201
Waterfall on Chippewa River 201
Agricultural and Pasture Lands 201
North of the Chippewa River 201
Around Chippewa Lake 202
Batchawana Valley 202
Economic Minerals of the Line 203

PAGE.

CORUNDUM AND OTHER MINERALS.. 205-240
Corundum Areas of Ontario..... 205
In Peterborough and Haliburton 206
Methuen and Burleigh Townships.... 206
Region of the Blue Mountains 207
Grenville Series and Fundamental Gneiss 208
Syenites of the Blue Mountains 209
An Outlier of Potsdam 209
Occurrences of Corundum in Methuen 210
Syenite Outcropping on Stony Lake.. 212
District North of Stony Lake 213
Chandos Township 214
Mica Syenite at Coe Hill 214
Cardiff Township..... 215
Monmouth and Glamorgan Townships 215
Nepheline Syenite..... 215
Herschel and Faraday Townships . . 216
Connection of Corundum Areas 216
In Hastings County 217
Dungannon Township 217
Features of the York Branch River .. 218
Murray's Map of York Branch..... 219
Crystals of Blue Corundum 220
Monteagle and Carlow Townships ... 220
Promising Deposit in Monteagle..... 220
Extension of the Syenite Band Eastward 221
Relations of Crystalline Limestone, Syenite and Granite..... ... 222
In Renfrew County 222
Raglan Township... 222
Tracing the Corundum Belt to Madawaska River..... 222
Radcliffe and Brudenell Townships... 223
Sebastopol and South Algona Townships..... 224
Nepheline Syenite in Sebastopol 224
Along the Snow Road 224
In Lanark and Frontenac..... 225
Corundum in South Sherbrooke 225
Corundum-bearing Anorthosite..... 226
Anorthosites of Ontario and Quebec.. 226
Corundum in Oso Township..... ... 227
Parham Gabbro Area..... 228
Minerals in the Gabbro..... 228
Scapolite Rocks 229
Corundum in Other Countries 229
In India 230
Theories of Origin 230
Rubies in Crystalline Limestone..... 231
Burma..... 231
Paparapatti Area.... 232
Relative Richness of Ontario and India Deposits 233
Corundum Rocks of Ipdia..... ... 234
In Russia 234
Corundum-Anorthite Rock 235

PAGE.

CORUNDUM AND OTHER MINERALS.—*Con.*
Corundum-Orthoclase of the Urals ... 235
General Conclusions 237
Localions of Ontario Deposits 237
Statistics of Corundum..... 237
Prices of Abrasive Materials..... 237
Abrasive Quality of Ontario Corundum 238
Comparative Tests at Hamilton 238
Testimony from Other Sources 239

CORUNDUM IN ONTARIO 241-249
Occurrences of the Mineral 241
Oriental Ruby in Burma 241
Corundum and Emery in the United States.... 242
Discoveries in Ontario..... 242
By Dr. Sterry Hunt in Burgess 242
By Henry Robillard in Raglan 243
By N. T. Armstrong in Carlow..... 244
By Dr. Coleman in Float Boulders..... 244
Geological Reconnaissances 244
By Alexander Murray..... 244
By Dr. Frank D. Adams 244
By Barlow and Ells..... 245
By Prof. W. G. Miller..... 245
Occurrences in Renfrew and Hastings 246
Economic Uses of Corundum..... .. 247
Scheme to Establish a Home Industry.... 248
Agreement for Treating and Manufacturing Corundum..... 249

CORUNDIFEROUS NEPHELINE SYENITE 250-253
Discoveries of Nepheline Syenite and Corundum 250
Variations in the Nepheline Syenite..... 250
Microscopic Characters 251
Distinct Types of Rock 251
Alumina a prevailing Constituent 251
Specimens from various localities..... 252
From Lancaster's Farm.... 252
From Methuen, in Peterborough..... 252
From Raglan, in Renfrew..... .. 252
Drift Boulders at Cobourg 253
Qualities in common exhibited in types... 253

MICHIPICOTON IRON RANGE..... 254-258
Instructions to Dr. Coleman.....
Red Hematite at Little Gros Cap 254
Brown Hematite at Boyer Lake..... 255
Probable origin of the ore body 255
Nature of the Rock Formation at Boyer Lake 255
Tracing the Iron Formation.... 256
Near Magpie River..... 256
McDougall's Claims at Dog River 256
Probable extent of the Iron Range..... 257
American Prospectors in the Region.... 257
Deposit on Pic River 257
Summary of Observations 257

COPPER IN PARRY SOUND DISTRICT..... 259-262
First Discovery of Minerals in the Region. 259

PAGE.

COPPER IN PARRY SOUND DISTRICT.—*Con.*
- The McGown Mine 259
- Extent of the Cupriferous Deposit 260
- The Wilcox Mine 260
- The Lafex Property 261
- Undeveloped Properties 261
- Nickeliferous Pyrrhotite 261
- Prospects in the Northern Townships 261
- Ores of Copper, Iron Pyrites and Platinum 262
- Caution necessary in an Undeveloped Region 262
- Geology of the Country 262

LOWER SEINE GOLD MINES 263-274
- Instructions to the Inspector 263
- Varieties of Gold-bearing Formations 263
- Golden Star Mine 264
- Underground Workings of the Mine 264
- Suspension of Development Work by former Owners 266
- Condition of the Mine 266
- Tramway from Mine to Mill 266
- Mill on Vermilion Lake 267
- Sampling of the Mine 268
- Assays of the Samples 268
- Locations Adjoining Golden Star 271
- MLM JO41 271
- AL114 and AL116 271
- Randolph Farm 272
- Randolph Mine 272
- Olive Mine 272
- An Extensive Gold-bearing Band 272
- Sinking and Drifting at the Mine 272
- Location G69 273
- Swede Boy Mine 273
- Lucky Coon Mine 273

PAGE.

LOWER SEINE GOLD MINES.—*Con.*
- Ferguson Mine 273
- Golden Crescent Mine 273
- Decca Mine 273
- Manhattan Mine 273
- Alice A. Mine 274
- Gold Bug and Emma Abbott Locations 274
- Foley Mine 274
- Independence Mine 274

NOTES ON WORKING MINES 275-279
- Report by J. Watson Bain 275
- Silver Mountain Mines 275
- Western Gold Mines 275
- Mines on Lake of the Woods Waters 276
- Mines in the Lower Seine Region 277
- Encouraging General Outlook 278
- Geological Notes 279

SUMMER MINING CLASSES 280-283
- J. Watson Bain's Report 280
- Classes in Northwestern Ontario 280
- Visits of Instruction to the Mines 280
- Attendance at the Classes 281
- Course of Instruction 281
- Dr. W. L. Goodwin's Report 282
- Classes in Northern Ontario 282
- At Parry Sound 282
- At Mattawa 282

PROVINCIAL ASSAY OFFICE 284-289
- Report of J. Walter Wells 284
- Record for Six Months 284
- Scheme of the Laboratory 284
- Equipment of the Laboratory 285
- State Assay Offices Elsewhere 286
- Mineral Industry in Eastern Ontario 288
- Future of the Assay Office 289

MAPS AND ILLUSTRATIONS.

PAGE.

86 Map of the Western Part of the Michipicoton Mining Division 121
Dikes of Greenstone in Quartzite near Bruce Mines 136
Murray's Lower Slate Conglomerate 136
Gorge of Mississaga River 136
Baboon Falls on Mississaga River 136
Shaft House at Cheney Mine 136
Steam Shovel Excavating Gravel Beach at Garden River 136
Mill and Rock Dump at Victoria Mine, Garden River 136
Cascade Mill at Garden River 136
Cliff of Chloritic Slate on Echo Lake 152
Cliff of Lower Slate Conglomerate on Echo Lake 152

PAGE.

Shaft, Incline and Engine House at Mamainse 152
Mamainse Copper Mill 152
Caves in Amygdaloid, Roussain's Point 152
Cave in Conglomerate with Granite Overlying, north of Point aux Mines 152
Cliff north of Pointe aux Mines 168
Eroded Keweenawan Conglomerate near Point Mamainse 168
Remnant of a Dike north of Pointe aux Mines 168
Boulder in Lake Superior near Point aux Mines 168
Gravel and Sand Bar at Mouth of Dog River 168
The Collingwood Skiff, Caribou 168
Denison Falls on Dog River 168

	PAGE.
Eroded Dike near Spruce Harbor, Lake Superior	168
Camp near Night Hawk River	184
Surveyor's Party at Luncheon on Montreal River	184
H. B. Co. Factor's Family at Fort Matachewan	184
High Water Scene on Night Hawk Lake	184
Trader and Indian Chief at Night Hawk Lake	184
Fort Matachewan	184
Packing Supplies over Height of Land	184
Upper Western Cascade, Frederick House River	184
Lower Middle Cascade, Frederick House River	184
Scene on Frederick House River	184
Iroquois Falls on Abitibi River	184
Indian Packer at the Long Sault	184
Running the Long Sault	184
Supplies at the Long Sault	184
Below Island Portage on Abitibi River	184
Abitibi Canon from Level of River	200
Abitibi Canon from Bank of River	200
New Post on Abitibi River	200
Indian Camp at New Post	200
Camp on Lower Reach of Abitibi River	200
Lignite Deposit on Abitibi River	200
Limestone Cliff at Sextant Rapids	200
Bishop of Moosonee's Cathedral at Moose Factory	200
"Bishopscourt" at Moose Factory	200
Chief Factor's Residence (H. B. Co.) at Moose Factory	200
H. B. Co. Employe's Family at Moose Factory	200
Indian Camp on Moose Island	200
Moose Island, showing Buildings of Moose Factory	200
Corundum core in Mica	216
Corundum in Syenite	216
Photomicograph of thin section of Norite	216
Photomicograph of thin section of Scapolite	216
Photomicograph of thin section showing Corundum in Nepheline Syenite	216
Photomicograph of thin section of Anorthosite	216
Crystal of Corundum	216
Corundum in Anorthosite	216
Weathered surface of Nepheline and Felspar rock	216
Weathered surface of Nepheline with Hornblende, Garnets and Felspar	216
X-ray Photograph of pure Corundum and ruby Corundum	216
X-ray Photograph of grain Corundum, various sizes	216
Rapids above High Falls, York Branch River	232
High Falls on York Branch River	232
Foot of High Falls on York Branch River	232
Second Falls on York Branch River	232
View on the York Branch River	232
Foster's Rapids on York Branch River	232
Corundum bearing Rock, lot 3, con. 18, Raglan	232
Corundum bearing Rock, lot 4, con. 18, Raglan	232
Map of the Michipicoten Iron Range	291
Map of Golden Star Location	293
Longitudinal Section of Golden Star Mine	296

INTRODUCTORY NOTE.

The following table presents by quantities and values the statistics of metallic production in Ontario for nine months ending September 30, 1899, and for twelve months ending December 31 in the years 1896 and 1893 respectively :

Metals.	1899 (9 mos.)		1896 (12 mos.)		1893 (12 mos.)	
	oz.	$	oz.	$	oz.	$
Gold	20,210	318,212	7,154	121,848	1,695	32,960
Silver	98,000	58,800	. . . . .	... ...	. .....	. .. .
	lb.		lb.		lb.	
Nickel	1,608,000	566,633	3,897,000	357,000	3,306,000	454,702
Copper ...	4,642,000		3,736,000	130,660	2,862,000	115,200
	tons.		tons.		tons.	
Pig Iron .	48,216	693,155	28,302	353,780	.	. ...

No silver was produced in the Province in 1893 or 1896. The mines were closed down in 1892 and were not re-opened until 1898. The first production of pig iron after an interval of more than thirty years was in 1896, and the first production of gold after almost as long an interval was in 1892. The total value of metallic products in 1893 was $602,862 and in 1896 $963,288. For the nine months of the present year it has been $1,637,100, and if the same rate of production be maintained to the end of the year it will reach $2,200,000. The total value of the metals produced in the Province for the twelve months of last year was $1,655,968, made up of $290,919 gold, $51,960 silver, $514,220 nickel, $268,080 copper, and $530,789 pig iron. The revenue from sales and leases of mineral lands has been $147,666 for the nine months of the present year, as compared with $97,762 for the whole of 1898, $40,588 for 1896 and $26,159 for 1893.

Part II. contains in addition to the Reports of Dr. Coleman on the Copper Regions of the Upper Lakes, of Mr. Parks on the Nipissing-Algoma Boundary, of Prof. Miller on Corundum, etc., special Reports of work done during the present year on the Michipicoton Iron Range, on Copper deposits in Parry Sound, and on the Lower Seine Gold Mines. A. B.

COPPER REGIONS OF THE UPPER LAKES.

By Dr. A. P. Coleman.

Introduction.

IN accordance with the instructions of Mr. Archibald Blue, Director of the Bureau of Mines, last summer's work was devoted to an examination of the rocks on the north channel at the northwest end of lake Huron, and of the northeast shore of lake Superior, with special reference to the copper deposits of the region. Professor Arthur B. Willmott, of McMaster University, was once more appointed assistant geologist and proved as helpful and efficient as on former occasions. Messrs. R. W. Coulthard and R D. George, B.A., were appointed junior assistants and rendered valuable service during the summer's work. Our modes of travel were more varied than usual owing to the different type of country in which we were employed, part of it more or less settled, with backwoods roads passable with wheeled vehicles, and another part capable of being traversed only with canoes; while the main portion of our travel along the stormy shore of lake Superior was performed in a Collingwood skiff manned by two skilful French-speaking fishermen from Sault Ste. Marie, Edward Sayers serving as captain and Stephen Jollineau as seaman and cook. Both did their work satisfactorily. Our craft, the Caribou, carried only two fore and aft sails and had very little accommodation under the deck covering the bow, so that we had to camp at night at some harbor or shore. She was safe as handled by Sayers and proved a good sailor, but very heavy to row, which occasionally cost us much time and labor. Travelling by canoe or row boat has many advantages, but on so large a lake as Superior one runs a certain risk in a small boat and may lose days in succession by high winds. Fortunately there are innumerable small harbors on the wild and rocky north shore of the lake, so that a fishing boat seldom requires to go more than a few miles to find shelter.

The Party and the Modes of Travel

We left Toronto on June 7th and proceeded by way of Collingwood to Sault Ste. Marie. A canoe trip was made down the St. Mary's river as far as Thessalon to examine the rocks of the Huronian as originally defined by Logan, and to visit the copper deposit at Bruce Mines and other points. We then cruised from the "Soo" along the northeast shore of lake Superior, coasting with canoes as much as the weather permitted, and visiting the copper mines near Mamainse. This trip ended at Heron bay, where the Canadian Pacific railway first touches the lake. Here we divided into three parties. Prof. Willmott and Mr. George went east by rail to White river and pushed south by Dog river to lake Superior over unmapped territory which they surveyed with micrometer and compass. Mr. Coulthard with Sayers went south to examine Caribou island, and I crossed unexplored territory from Bremner on the railway to the mouth of Pucaswa river on lake Superior, making a track survey. The Caribou picked up Prof. Willmott and myself and took us to Michipicoton island, where copper deposits were examined; and then to Michipicoton Post, the gateway to the new gold mining district, which we visited. Here the Caribou was dismissed and we finished our travel by steamer Telegram.

General Scope of the Season's Work.

During the summer, as directed by Mr. Blue, we visited all the water falls possible, and determined their height and the volume of water at the time in order to obtain materials for a report on the numerous and important water powers of the region.

After revisiting the Huronian tract east of the "Soo" we returned via Owen Sound

and reached Toronto on August 14. As on former occasions, my acknowledgments are due to many mining men and others interested in the development of the region for valuable assistance and for ready hospitality. The maps and reports of the Geological Survey of Canada were of course of the utmost value to us in carrying on our work. The old map of the Huronian region, prepared to accompany Logan's geology of Canada in 1863, is still the only geological map available for the study of the region just east and just north of the St. Mary's river; and was found to be very accurate as far as we covered the ground, though on too small a scale to permit of very minute mapping.

The Blue Mountains.

A Topographical Feature of Simcoe County.

Desiring to examine the Blue Mountains and the old beaches on their flanks, Prof. Willmott and I left Toronto for Collingwood a day earlier than was necessary to catch our steamer, and drove out to the nearest part of the long escarpment which stretches across the southwestern peninsula of Ontario and is known everywhere from Hamilton to Georgian bay as "the Mountain." It is really of course the edge of a tableland capped by the resistant Niagara limestones, the softer shales to the east having been more rapidly denuded by the action of frost and water, leaving the limestone-covered portion to rise as more or less prominent cliffs. Between Collingwood and the foot of the Blue mountains the land is almost a plain, sometimes boulder covered, with a series of gentle steps, probably representing old shore lines, up to 207 feet (aneroid); above which there is a steep ascent over grassy or wooded slopes, mainly of reddish and greenish Medina shale. There appear to be beach lines also at 288 and at 468 feet above the bay as shown by aneroid, and probably also at 940 feet.

The top of the escarpment is of thickly bedded limestone of a creamy color, forming perpendicular and often unscaleable walls, with a talus of rough, frost-quarried blocks at the base. This cliff is divided into pillars and bastion-like projections by profound fissures, many of which still retained the winter's snow on the hot day of early June when we visited the spot.

The rock is burned for lime, and, if in demand, would make a handsome building stone, which could be furnished in blocks of almost any dimensions required.

A few hours stay in Owen Sound was utilized in examining the drift terraces in the rear of the town. Clays making red brick and white pottery occur here.

St. Mary's River and the North Channel.

The original Huronian Country and its Minerals

On June 10th we reached Sault Ste. Marie, our starting point for a study of the original Huronian as described by Sir William Logan, and his assistant, Alexander Murray, whose work still gives the most complete account of these interesting rocks and is referred to in every text book of geology. A good summary of their results is given in the 1863 report,[1] while Murray's more extended earlier reports are now hard to get.[2]

On June 11th we set out by canoe down the St. Mary's river, halting for the night at Garden River, where interesting exposures of the original Huronian rocks are to be seen. The channel we followed is now almost deserted by steamboat traffic since the opening of the shorter and straighter cut on the American side. Only a few local craft now ply here, and the villages and landings often have rather a deserted look.

Garden River Marble Quarry.

The village of Garden River was once an important lumber centre, but has fallen away since the mills were burned some time ago There is a reserve at the mouth of the river with an Indian village and a mission under the charge of the English Church. The village is on a very pretty sandy point, but two or three miles inland rocky hills, almost high enough to be called mountains, rise with steep flanks and more or less rounded, woody summits. Some years ago a marble quarry was opened on a band of Huronian limestone not far from the village, a switch being carried north from the railway to give access to

[1] Geology of Canada, 1863, pp. 55-63.

[2] Geol. Sur. Can., 1857, p. 18, etc., and 1858.

it. The stone displays variously banded surfaces of pale gray, and would probably be handsome when polished. The quarry had been opened up to a considerable extent, and a chancelling machine put at work, but apparently without being satisfactory, as it has been abandoned and the rails removed from the spur of track. Further mention will be made of this limestone in the portion of the report dealing with the Huronian question.

The railway has opened a gravel pit in some old beach deposits east of the quarry, showing a face of about 20 feet. The materials obtained are used in filling a long trestle at the mouth of Echo river a few miles to the east. Much higher terraces of drift materials are found up the valley of Garden river, but these will be discussed under the head of pleistocene geology.

Victoria and Cascade Mines.

An excursion was made under the guidance of George Kabaoosa to the Victoria mine north of the Indian reserve, passing wide forest-covered terraces between rocky walls as we ascended the river valley. We were struck by the rich forest with its splendid maples along the way, the only unpleasant feature being the number of tent-caterpillars which attacked the leaves and dropped upon the passers beneath. The road was fairly good up to lake Ann, being used to this point by lumbermen. The damming and raising of the lake here cuts it off, and the last two or three of the nine miles to the mine are in very bad repair. Beyond lake Ann we found a few outcrops of Laurentian-looking gniess with dikes of granite rising through the drift, but at the Victoria lake near the mine rock looking like Huronian shows itself again as greenstone and chloritic and other schists broken by some small granite dikes and apparently inclosed in granite or gneiss. The two lakes are small, really only ponds, and the stream connecting them and flowing to Garden river is unimportant.

Victoria Mine.

At Victoria mine there are numerous buildings, a boarding house, shaft house, mill, assay office, dwellings, stable, etc., with a tramway to the dump. The mill is of respectable size, but no machinery is to be seen except tanks, jigs, etc., for concentrating the ore, apparently little used. The large dump consists chiefly of chlorite schist with some quartz. There are at the mill a number of barrels of galena in small lumps and some powdered ore of the same kind. Associated with the galena one finds some dark zincblende and copper and iron pyrites as well as quartz. This mine was visited in 1876 by Dr. Bell, who describes two veins as being worked at the time, one of solid galena only three inches across at the surface but widening to nineteen at the bottom of a shaft fifteen feet deep. A sample of galena taken from the ore pile yielded 168 oz. of silver per ton of 2,000 lb. when assayed by Dr. Harrington. Two other samples however taken by Dr. Bell himself from the veins assayed only 12 and 2 oz. per ton.[3] An assay in the laboratory of the School of Science, Toronto, gave 3 oz, 16 dwt. per ton.

Cascade Mine.

Three-fourths of a mile farther up stream, along a good road paved with tailings, is the Cascade mine, with similar ore with the addition of calcite. The rock dump is large, and consists mostly of soft green chloritic schist with dike material of red granite and some greenstone breccia. The ore in both mines seems to occur in irregular veins in large dikes or masses of sheared and weathered diabase. The Cascade mine is provided with a mill, shafthouse, engine house for a compressor and dwelling houses. A dam provides water which falls at the "cascade" about 50 feet, though the stream is of small volume. An assay of the galena yielded 9 oz. 16 dwt. of silver per ton.

Though there are no settlers in the valley, perhaps because the lower end of it is included in the Indian reserve, there is a considerable area of very fair land to be seen on the road to these mines.

Echo Lake Region.

A Plague of Tent Caterpillars.

Proceeding down the stream from Garden river we stopped first to examine a high projecting hill of altered diabase a mile to the north of Great Lake George, probably a mass erupted through the Huronian, now standing out because of

[3] Geol. Sur. Can. 1876-77, pp. 212-13.

its greater power of resistance to erosion. Along this part of the shores the poplars and to a less extent other trees were stripped of leaves by a plague of tent caterpillars. Even ferns and alders were somewhat attacked, and one could hardly step on the rocks without crushing the creatures. Some of the woods looked as bear as if swept by fire.

Echo River and Echo Lake.

Echo river opens into wide shallow flats with marshy borders and Great Lake George is very shallow itself, the steamboat channel requiring to be dredged almost the whole length of the lake. Entering the river one sees white hills of Huronian quartzite on the east shore, with cultivated farms in the valleys. The river winds towards the northeast for three or four miles through alluvial plains until beautiful Echo lake with its mountainous shores opens out. Just where the lake enters the river there is considerable clearing at the foot of a mountain, and a farm house with a garden full of bloom, an unexpected sight in this somewhat wild region. The shores of Echo lake present excellent exposures of the Huronian, as noted by Murray in 1857. The limestone band seen at Garden River shows as two promontories on the lake, and has the same character as at the former point.

Austin Copper Mine.

A good road leads a mile northwest to the buildings of the Austin copper mine, and a poorer road goes some distance farther to the shafts which are high up on a hill. In addition to the shafts a tunnel has been driven into the hill, which consists of Logan's "slate conglomerate," a graywacke containing a few pebbles. The ore on the dump is white quartz with some copper pyrites and a carbonate like ankerite. The mine has not been worked for years.

Trout and Iron Lakes

An excursion was made to Trout and Iron lakes, north of Echo lake, going up the river a mile and a half, as far as there was good navigation, and then walking inland by old lumber roads. Trout lake is about three miles from the landing place and 350 feet above Echo lake, which is a few feet higher than lake Huron. The lake is very pretty, with high rocky shores to the north, partly of handsome jasper conglomerate. This outcrop of red jasper conglomerate is not noted on Murray's geological map of the Huronian region, but was found by Prof. Willmott ten years ago. Iron lake lies two or three miles northwest of Trout lake, is about a third of a mile long and 575 feet (aneroid) above lake Huron. At its outlet a creek flows swiftly down through a rock wall ravine to join Trout creek. Fine trout are said to inhabit all these waters. We saw no trace of iron on the lake, but found another outcrop of jasper conglomerate, the most striking of the Huronian rocks. This region was visited in 1876 by Messrs. Lount and Frank Adams, then Dr. Bell's assistants, but they took a course different from ours and saw no jasper conglomerate, only slaty rocks, quartz, etc.[4]

Bruce Mines Region.

Bruce Mines to Rock Lake.

Leaving Echo lake we made a hard day's pull against headwinds down Great Lake George and the North Channel to Bruce Mines. Along the lake there are very few outcrops of rocks, but many along the shores of the channel—various rocks of the Huronian on the north side and of Cambrian and Lower Silurian on the south. On June 18 we drove out to the Rock Lake copper mine and the Ophir gold mine, passing Ottertail and Rock lakes, by a road showing great variety of geological interest. As far as Ottertail it runs over stiff gray clay, evidently a lake silt, with exposures of jasper conglomerate and other Huronian rocks along the way. The farm land seems strong, if rather heavy, to this point. Beyond the country grows more mountainous and the valleys and plains more sandy as the road works upward on a series of lofty beach terraces, the highest 470 feet (aneroid) above lake Huron or more than 1,040 feet above the sea.

Rock Lake Copper and Ophir Gold Mine.

The Rock Lake copper mine is really only a prospect, no mining having been done. It is on Sandy McCloud's land, and the deposit extends to the neighboring farm on the south. The country rock is chloritic slate with red quartzite just to the south, and the ore bodies are

[4] Geol. Sur. Can. 1876-77. pp. 210-11.

very irregular veins or lenses of quartz running partly parallel to the strike, partly across it. The widest part measures about 12 feet with some decayed rock included, but has no definite walls. The ore is copper pyrites with a little ankerite in quartz. Rusty places with more or less copper ore are seen at other points. A tunnel has been started on the lot to the south to tap one such ore body, but had not reached it at the time of our visit. So little work had been done on the property that no certain idea could be formed as to the quantity of ore likely to be found.

Everything was shut down at the Ophir mine, and as it has been pretty fully described by Mr. Blue, who visited it while work was going on in 1893,[5] it will be unnecessary to give any account of it here.

Bruce and Wellington Copper Mines.

The old Bruce copper mine, with its long and irregular open cut running about N. 20° W., now a yawning chasm partly filled with water, has also been described by Mr. Blue [6]; and as it has long been abandoned nothing further need be said of it. We found, however, that the Wellington mine, a mile and a half northwest on the same vein or a parallel one, was being pumped out by Captain Thomas Trethewey as superintendent for Lord Douglas of Hawick, who represents a London syndicate. We went down the Scott shaft 180 feet to the third level. The fourth level had not yet been pumped out. The veins are nearly vertical, with a width of about eight feet. The walls are sometimes distinct and slickensided, sometimes quite irregular. We found more or less copper pyrites in the quartz on the levels, and also some rich ore on an open cut, but had no time nor opportunity to explore the mine thoroughly. Captain Trethewey says that the lodes are faulted by three dikes.

A new opening was being made on a vein between the Wellington and Bruce mines, and quartz very rich in copper pyrites was to be seen. It was Captain Trethewey's opinion that, although drift-covered at the surface, the vein or system of veins could ultimately be followed all the way from the Copper Bay location to the southeast end of the Bruce, a distance of 7,800 feet. As the old plans of the mine had been lost, fresh ones were in course of preparation. We were rather surprised to be taken to the gaol to see them. It seems that Bruce Mines is so law-abiding that the lock-up has not had a prisoner for five years, so that the mine captain was allowed to set up his drafting tables there.

On our return journey early in August, we found that Professor Hatch of London was sampling the mine with a view to reporting upon it for Old World capitalists.

Trap Rock for Road Metal.

Although mining was at a standstill the village of Bruce Mines seemed fairly prosperous, largely, no doubt, because of the farming community growing up about it, more extensive and important than the traveller passing by rail or steam would suppose. Another industry of importance is the quarrying of "trap" as road metal.

Road-making Material for Cleveland.

This is carried on by the Spence Brothers of Cleveland, Ohio, who ship their product to that city for use in making its famous park roads. The firm had 42 men at work in the quarry, at the southeast end of the Bruce mine, and were just beginning operations for the summer. They employed 65 men the previous year. Dr. Spence, the member of the firm in charge of the quarry, gave me some information regarding the method in use in road making at Cleveland, for which and other courtesies I wish to express my thanks. As the method may be of interest to Canadian cities a brief account of it is given here.

The Method of Road building.

As a foundation, blue limestone slabs not less than four inches in thickness are set on edge, and smaller pieces wedged in to make the whole firm. This road bed is rolled till smooth, when two or three inches of two-inch trap are placed on top and rolled till hard. This is followed by one or two inches of one-inch trap, rolled till hard while wet; then by a half-inch to one-inch of trap having a half-inch diameter, rolled hard while wet; the whole being covered with a

[5] Third Rep. Bur. Mines, pp. 37-45.
[6] Third Rep. Bur. Mines, pp. 35-37.

half-inch of trap dust, which is wet down and rolled till water stands on top and hoofs leave no impress. Twenty-ton rollers are used for the work, which costs at present $2 per square yard. The cost was formerly $3.50.

The trap is a greenish-gray medium-grained diabase, which forms the country rock of the copper veins of the region, and is present in inexhaustible quantities. Some small quartz veins occur in the rock quarried, but the quartz is picked out and rejected.

This mass of diabase, included by Murray in the "lower slate conglomerate," is evidently of later age than the Huronian, since at more than one point to the east of the harbor it may be seen penetrating eruptively the red quartzite.

Other Excursions.

After examining the shore as far as Thessalon and studying the contact of Laurentian and Huronian four miles beyond on the small islands scattered along the shore and also on the railway, we returned to Sault Ste. Marie. The results of this study will be given in another part of this report. Visits to a copper mine and also a supposed placer gold mine north of Thessalon were postponed till our return journey, when it was expected that the placer would be in operation.

Bruce Mines to Thessalon.

Before leaving the "Soo" an excursion was made some miles northeast to examine the Laurentian-Huronian contact at a fresh point, and a brief survey was made of an extraordinary wash-out in an old lake terrace on section 9, two miles south of the boundary of Tarentorus township. Springs have undermined the drift materials and carved in three years a V-shaped ravine nearly 300 feet in length and 110 feet in depth at its outlet. It is said that most of the work was done in a single year. The road was destroyed and had to be shifted 100 yards to the west, and Silver creek, flowing in the valley below, was forced a long distance to the east by the debris which filled its valley, so that it now flows among the trees in the woods.

Wash-out on an old Lake Terrace

Northeast Shore of Lake Superior.

On arrival at the Sault all arrangements were made for the Lake Superior trip, which began on June 22. The shore has been visited at various points by a number of geologists, especially at the copper deposits near Mamainse and on Michipicoton island, in regard to which there is a considerable literature, mostly of scattered papers and mine reports. An outline of the history has been given by Mr. Blue, who visited the region in 1893; and his report quotes the opinions of the more prominent geologists who have examined the copper mines.[7] The general geology of the region has been sketched by Sir William Logan in the Geology of Canada,[8] and Dr. Bell traversed the shore in 1876,[9] from Batchawana bay to Michipicoton river.

Literature of the Region.

Along St. Mary's river and for varying distances inland one sees only the St. Mary's sandstone where the solid rock is not covered with thick lake deposits forming a succession of terraces. The sandstone is red or green or pale gray or mottled, and has some shaly layers. It is best seen along the banks of the Canadian and American ship canals, where it is often beautifully ripple-marked and cross-bedded, being evidently a shallow water formation. As no fossils have been found with certainty in it the age has not been positively determined. Logan thinks it of Chazy or Cambro-silurian age;[10] but others place it in the Potsdam or Upper Cambrian. As noted by Logan, these sandstones lie nearly horizontal, unlike the other and older rocks of the region, which are usually tilted more or less steeply; and the country which these soft rocks underlie is usually flat and low, differing greatly from the parts formed of Huronian and Laurentian rocks. This sandstone is to some extent available for building purposes, though rather soft and fragile, as well as too much inclined to cleave into blocks of unmanageable shapes, to be considered a good building stone.

St Mary's Sandstone

Following up the shore, Gros Cap, where the sandstones end and rocks mapped as Laurentian begin, is the first point of interest. The cape rises in a

Great Gros Cap

[7] Bur. Mines, 1893, pp. 63-88.
[8] Geol. Can., 1863, pp. 70-86, also p. 699, etc.
[9] Geol. Sur. Can., 1876-7, p. 213, etc.
[10] Geol Can., 1863, p. 86.

mountainous way with sheer cliffs towards the west, and is a very striking feature. There is a small landing on the southeast side of the point for fishing boats, and a sawmill with a few settlers' houses are scattered along the low sandy shore to the east. In the rear of the little settlement two old lake terraces rise, one 56 feet, the other 224 feet, above lake Superior.

The rock at the point of Great Gros Cap is red porphyry, containing a few fragments of rather coarse quartzite, so that it is no doubt later than Huronian, but just around the point one finds a few hundred yards of diabase and then Laurentian granite or gneiss. At various points beyond amygdaloidal diabase (or melaphyre) and red quartzless porphyry occur in small patches, and with them veins of calcite and a red material like the vein matter associated with the lake Superior copper ores ; so that the projecting points of the coast consist of the Keweenawan or Upper Copper-bearing series, while the interior is Laurentian. The latter shows much variety, including greenstones and hornblende schist very like the Keewatin of Rainy lake, red granite, syenite and gneiss.

After rounding the point a thin strip of the St. Mary's sandstone extends along shore to the mouth of Goulais bay, after which the shore is again formed of Archæan rocks. We attempted to enter the mouth of Goulais river so as to anchor there and explore it, but found a bar stretching across its mouth giving too little water for our craft, which drew about 2½ feet. Later in the summer Prof. Willmott and I drove out to the river from the Sault and examined parts of the valley and surrounding mountains. As the first rapid is 30 miles up Goulais river, which winds through alluvial flats in the lower part of its course, we were unable to carry out our instructions regarding the examination of water powers without spending more time than could be spared. There are said to be three high falls about 40 miles up, and as there is a considerable volume of water these may in the future furnish valuable power.

Goulais river Valley.

The point on the west of Goulais bay, where the mission and a small fishing station are placed, consists of St. Mary's sandstone, and the same flat lying rock forms the shore until the mouth of Batchawana bay, the next inlet to the north.

Batchawana Bay.

The name of this bay is spelled variously by different authorities. Logan's map makes it Batchehwahnung, the British Admiralty chart of lake Superior spells it Bachewanaung, and the United States chart follows its precedent. The map issued by the Crown Lands Department of Ontario gives it the form Batchawaung ; and the people of the region generally call the bay Batchawana. The last form is easily spelled and pronounced and, as it is rather euphonious, should perhaps be preferred.

The Bay and its Name

The bay has a very interesting shore line, rising to low mountains towards the southeast, east and north, and presents fine outcrops of Laurentian, Huronian and St. Mary's sandstone the latter mainly at its outlet and on a large island which stretches more than half way across the entrance. As usual, the Cambrian sandstone lies nearly horizontally and forms the low ground, while the harder and more ancient rocks rise steeply as hills, at one point on the east to a height of 690 feet as determined by aneroid.

Small bands of Keweenawan or Upper Copper-bearing rock come out on the east shore, as mentioned by Logan, though not so mapped. There are small outcrops of red quartzless porphyry and larger ones of amygdaloid, the latter forming a row of hills running about east and west at the northeast corner of the bay. The rocks just referred to are very much like the Keweenawan farther west.

Geology of the Bay

Professor Willmott gives the following account of the geology of the southern portion of the bay :

"The south-eastern shore of Batchawana Bay consists of slate conglomerate holding boulders of coarse-grained red granite. A band of red, porphyritic, granitod gneiss cuts through the slate, appearing on a point on the west shore and on a point of the opposite shore a mile to the east. This gneiss,

which is in eruptive contact with the slate, in one place loses its porphyritic character near the slate and then assumes it suddenly a few yards away. A few hundred feet from this point the gneiss was observed to hold sharp angular inclusions of basic schists closely resembling the Keewatin contacts of the Lake of the Woods. On the eastern point the gneiss was in places quite dark in color."

Chippewa River

The Chippewa river entering Batchawana bay on the north has a splendid fall of over 80 feet about a mile from its mouth. Above this there is said to be good navigation for a long distance. The portage past the fall is about three-fourths of a mile and is rough in places.

Batchawana River

The Batchawana river also was visited and ascended about six miles, mostly against a swift current. At five and a half miles up there is a rapid too heavy to pole up, so the canoe was taken no farther. No falls of importance were met with in the distance traversed, and few outcrops of rock occur, all that were observed having the look of Laurentian. The shores are often steep cut banks of sand and gravel, with a little stratified clay at bottom, and form well-marked terraces.

The northeastern part of the bay is almost cut off from the western part by the large island mentioned before and a long sandy point projecting southwards. As we approached the latter a group of sleek lumbermen's horses was collected at the point where the wind swept strongest, so as to avoid the flies, which were very tormenting in the bush at the time.

Prof. Willmott describes the Carp river as follows :

Carp River

"The Carp is a small stream flowing into the north side of Batchawana bay. For the last mile it flows through a sand and gravel plain in a rapid and tortuous course. All obstructions have been removed by the company cutting pulpwood on its bank, so that it is navigable down stream. The banks are often fifty feet high, and in places stratified clay is seen as well as sand and gravel. Beyond the pulpwood camp, one mile inland, the stream is a succession of falls. Two miles and a half from the mouth the bed is 250 feet above Superior. At this point the rock is gneiss, but changes at once to the south into a band of amygdaloid striking east. Three-quarters of a mile farther down the stream a conglomerate lies against the latter which are both doubtless of Keweenaw age."

Corby Point.

There is a steamboat landing and fishing station on the east side of the point which protects the bay from the prevalent west winds; and a lighthouse stands a mile or two south on Corbeau point. The village is not a savory one, since the offal of the fish taken is dumped not far off, forming a perpetual attraction to gulls and crows; and the idle horses of the lumbermen roam the point at will. Lumbering will soon cease in this region, the pine having been removed as well as much of the spruce, balsam and cedar. The material left is mostly valuable as pulpwood, of which we saw large quantities in the more inland parts.

The Mamainse Region.

Roussain's Station.

Rounding Corbeau point we found too much wind to coast with canoes and sailed straight to Roussain's fishing station, where there is a small snug harbor and a tiny settlement. The shore here is bold and very rugged, consisting of black eruptive rock in thick layers, separated by beds of amygdaloid and conglomerate. As the latter rocks are soft and easily attacked by storms, they wear away along the shore, leaving the harder eruptive masses standing as cliffs, stacks and islands. Many small caves are eaten by the waves in the softer rocks, the harder layers roofing them over.

Mamainse Harbor.

The next point stopped at was Mamainse harbor, where narrow channels between small islands and the shore make a tiny harbor. Sand bay, where the mine of the same name is located, is a mile to the south, but affords little shelter for boats. The mine is not working, being left in charge of a caretaker who served us as guide to visit the different pits and shafts. As the mine has been described by Mr. Blue,[11] little need be said of it here. A mile north of the bay,

[11] Bur. Mines, 1893, p. 66, etc. References to the literature are given here.

at a small costean pit, there is a plate of native copper eighteen inches long by an inch in thichness standing up from the decayed amygdaloids. This and the pile of ore rich in native copper at the main shaft give evidence that the metal is present in considerable amounts.

Mamainse Copper Mine

About two miles north of Mamainse harbor is the old Mamainse copper mine, worked, it is said, 46 years ago, and again 17 years ago, where a village of 30 houses without an inhabitant may be seen. The houses have stone foundations and are well constructed frame buildings in a fair state of preservation except for doors and windows, all of which have been carried off. There is a church, two shaft houses, and a large mill containing crushing and concentrating appliances. There is very little ore to be seen on the dumps, which evidently consist of waste rock, mainly amygdaloids. The site is an attractive one, but with a very poor harbor. Rugged strips of black amygdaloid and trap run out into the lake with curving beaches of well-rolled pebbles between. The village stands on a low terrace, with wild flowers, red and white clover and wild strawberries all about, and a pretty stream flowing into the lake.

Pointe aux Mines.

Geology of the Point.

Beyond Mamainse rocks apparently of Laurentian and Huronian age show themselves, red granite and gneiss penetrated by dark green dikes and also great masses and dikes of a very coarse grained pegmatite or giant granite, having flesh red felspars as large as one's hand embedded in a coarse grained granite ground mass. Here and there are strips and masses of Keweenaw rocks leaning up against them, often with a basal conglomerate or breccia of gneiss and granite at the bottom. A few beds of brown shale and sandstone, probably Cambrian, occur at the foot of bays.

Pointe aux Mines from the south seems to be a mixture of Laurentian and Keewatin rocks, but to the north shows amygdaloids and conglomerate having the usual rugged shore formed by Keweenawan rocks. The mine is a few hundred yards inland from the landing place in a bay north of the point.

Ruins of the old Mine.

On the hill side there are the ruins of two or three buildings with massive stone foundations, and the opening of a tunnel with its timbers all rotten and falling in. There are several deep pits farther up the hill and several heaps of rock from the excavations, with little amygdaloid and no conglomerate to be seen. There are also two heaps of slag containing a number of tons resulting from smelting operations. An assay of this slag gave 1.20 per cent. of copper. This mine is reported to have been worked 46 years ago, and is said to have been attacked by Indians. For its defence two cannon and a body of militia were brought up, according to Sayers, the captain of our fishing boat.

There are several heavy square iron stamps on the beach, perhaps landed but not put in place at the mill. In all there must have been a large amount of work done at this mine, but there is now very little ore to be seen, perhaps because all that was obtained had been smelted. Young trees are now growing among the ruins of the buildings, and from the shore there is nothing but woods to be seen.[1,2]

Features of the Coast Line.

To the north of Pointe aux Mines in a large bay flat lying sandstones, like those of the last bay, probably St. Mary's sandstones, cover a wide area beneath the shallow water and appear to slope off towards the open lake. The points however are of Laurentian, containing fewer Keewatin inclusions than farther south. The scenery is magnificient, granite cliffs rising 500 feet above the lake. A curious cave shows at the northern point of the bay and two others at 30 and 50 feet above the water, probably old shore caves. Here small patches of conglomerate with gniess and granite pebbles lean against the granite and are with difficulty distinguished from it. Old chasms in the Laurentian are filled with this rock, proving that an old shore stood just at the level of the present shore and presenting the same conditions. This conglomerate is probably Keweenawan. As the cement is soft it easily weathers out and sets free the

[1] Cf. Macfarlane, Geol. Sur. Can., 1863-66, p. 144.

pebbles and boulders of the old rock to be washed on the present beach as if recently made. A remnant of conglomerate rests against the edge of a large diabase dike and contains boulders of it, showing that the dike is older than the Keweenawan.

These diabase dikes are exceedingly numerous along this part of the coast and have much to do with its shape. Sometimes the dike is the more resistant rock and rises as walls, protecting the softer rock behind or serving as breakwaters for small harbors or forming narrow islands or long points, features noticed by Logan in the Geology of Canada. At other times the dikes are less resistant and weather out, forming narrow deep ravines with walls of gneiss. The general strike of the dikes is about northwest and two of them project sharply, one on each side of Montreal river forming a sort of harbor, not well protected however from northwesterly winds.

Montreal River to Little Gros Cap.

Features, Geology and Scenery of Montreal River

Montreal river is probably the largest stream up to this point on the shore of lake Superior. There is a bar at its mouth, above which fishing craft find a safe harbor, though the powerful current is not easy to meet unless a line is taken ashore for towing. The scenery of the harbor is splendid, with its two rocky points and the reddish Laurentian mountains in the rear. Three forest-covered terraces rise above the bay, indicating former higher levels of the lake ; and at the inner end of the bay one catches glimpses of the white series of cataracts flowing through a deep narrow canyon by which Montreal river finds its way down from the mountains to the shore. The river was explored six or seven miles inland, and for that distance is very difficult of navigation, being a succession of falls for the first mile or two and then short stretches of slack water separated by long flat rapids up which one must pole.

Instead of following the river up from the bay at its mouth it is necessary to portage south past the point enclosing the bay on that side and then, after a few hundred yards paddle, one climbs up from the shore, following a trail for some distance on level ground and then up an ascent so steep for 180 feet that canoes cannot be carried but must be dragged. A quick descent leads down from this ridge to the placid river above the main fall, which has in all a height of 172 feet (aneroid). There are two more respectable falls on the way up the river, which rises 250 feet as shown by aneriod in the first six miles. Five portages were made on the way up, but returning all except the three main falls may be run in a canoe.

The river is clear, with slightly brownish waters, and there has been no fire on its shores, so that beautiful woods run to the top of the highest hills when not broken by faces of rock too steep for trees to grow. A good deal of white pine is scattered through the woods ; and spruce and cedar are common, some of the latter being of good size. One which was measured had a diameter of 3 ft. 10 in. at the butt. Apparently no lumber has been cut on this river.

There is no agricultural land to be seen as far as we ascended the river, perhaps largely because it flows in a narrow valley below the general level of the mountainous country around.

The rocks observed are Laurentian, with several large inclusions of Keewatin, and some masses of coarse grained red granite and flesh colored pegmatite. These rocks are cut by two systems of diabase dikes, like those whose lakeward projection forms the harbor. It is probable that the canyon through which the river flows in its final cascade was made by wearing out and removing the materials of two such dikes, meeting nearly at a right angle. This would account for the fact that the canyon walls are not vertical, though parallel to one another. The one on the left bank overhangs the river several degrees and stands in places fully 100 feet above the torrent of foam at its foot.

The scenery along this part of the river is extraordinarily wild and romantic, and can scarcely be equalled elsewhere in the Province. It is singular that in its striking canyon scenery this western Montreal river is very like the eastern river of the same name emptying into the Ottawa.

Professor Willmott reports as follows regarding the Agiwa (Agawa or Aguawa) river, entering the lake about seven miles north of the mouth of Montreal river :

"From the mouth of the Montreal river to a point three miles south of the Agiwa the shore consists of gray gneiss frequently much contorted. Some masses of pegmatite occur, and many Keewatin-like inclusions were seen. There are numerous dikes of greenstone, occurring usually at points, and all bearing 80° to 100°. A sand plain extends south from the mouth of the Agiwa for three miles. It is covered with a fine forest of Banksian pine, straight and branchless for 40 to 50 feet. Just north of the mouth the shore becomes gneiss again. An Indian village and a Hudson's Bay Post were once situated here, but the buildings alone remain.

Agiwa River.

"The river flows so rapidly near the mouth that it can only be ascended by poling. At one point the current was estimated at four and a half miles an hour, and the width at 150 feet, and the average depth at three feet. Travelling inland, two fine terraces were found at 111 and 126 feet above lake Superior. On the first terrace was an excellent hardwood bush which had been extensively used by the Indians for sugar-making. There is here an area of some extent well adapted to agriculture."

Montreal island, which lies five miles northwest of the mouth of Montreal river, is covered with wood, presents no rock to be seen from a boat cruising like ours, and is without hills. Bayfield reports that it consists of sandstone, probably like that at Sault Ste. Marie.[13] The Lizard islands seven miles farther northwest give a good landing and harbor, and so are used as a fishing station. The rock is to be seen here as flat lying sandstone rising only three or four feet above the water. It is mottled and banded with red and white, and has all the characters of the St. Mary's sandstone. There are a few houses inhabited by fishermen on the main island, and at the time of our visit also a family of summer residents. The island is said to be free from flies and to be the home of many lizards (salamanders). The fishermen state that the water of lake Superior has fallen of late years ; but their houses, evidently a number of years old, now stand only two or three feet above the lake. It is not likely they would have been built any nearer the shore than they are now, which suggests very little change in the level of the water. There are no large trees on the island, perhaps all have been cut off.

Montreal and Lizard Islands.

Sand river enters lake Superior just east of Lizard islands, and forms a series of falls and rapids for about a mile inland, when comparatively quiet water is reached. In the ascent three well-marked terraces are passed at heights of 72, 144 and 234 to 260 feet (aneroid). The main fall, of 95 feet, is about a mile inland. There is a very good portage path to the quiet water at the head of the rapids, nearly 200 feet above the lake, suggesting that the river is used by Indians ; unlike Montreal river, where the portages are badly grown over and hard to find and follow. It is, however, much smaller than Montreal river. The rocks seen are mainly gneiss, striking nearly east and west and pierced by coarse granite of pale flesh color. One fall is formed by a dike of diabase cutting the gneiss.

Sand River.

Leach island, five miles west of the Lizard islands, shows no rock on its north shore, though gray flat masses of St. Mary's sandstone may be seen under shallow water near shore. The beach is formed of fragments of the same rock, which no doubt underlies this low wooded island. Gull rock, north of this on the way to Gargantua, is of the same sandstone. This rock is used as a breeding place by the gulls, whose half-grown squabs scramble over its stones, while hundreds of fully-fledged birds hover and scream about it. The young gulls are very stupid and helpless creatures, but good swimmers. If tipped on their back in the water they lie there without attempting to right themselves. The young birds are said to be fat and good eating by the Indians, and the eggs are often gathered and eaten by fishermen and Indians earlier

Leach island and Gull rock.

[13] Geol. Can., 1863, p. 82.

in the season. Sayers says that they incubate about the same length of time as common hens, and that the first fowls kept on Caribou island, a fishing station far out in lake Superior, were hatched by gulls from hen's eggs.

North of Leach island on the main shore patches of a basal conglomerate containing granite boulders were seen, probably of Keweenaw age, but no amygdaloids; though there is a curious rim of red agglomerate or ash rock dipping about 30° away from the upturned gneiss in a bay just south of Gargantua harbor.

Gargantua harbor is a picturesque bay south of the cape of the same name. It affords good shelter for fishing boats and the small steamers used in the fishing trade, including the Telegram, and could accommodate vessels of a much larger class. An island of rock rises in the mouth of the bay supporting a small lighthouse whose lamp is 85 feet above the lake, the only light between Corbeau point on Batchawana bay and Quebec harbor on Michipicoton island.

Gargantua Harbor and River.

The rocks at the harbor consist of reddish granite or gneiss sometimes containing large masses or angular fragments of gray gneiss or schist, forming at some points almost a breccia. There are dikes of coarse pegmatite and of diabase penetrating the Laurentian rocks. A hill used as an observatory during the hydrographic survey of the coast by the United States government rises 431 feet a little to the north of the bay.

A fringe of amygdaloids extends along part of the shore and the small adjoining islands to the northwest of the harbor at cape Gargantua, resting directly on the gneiss without any basal conglomerate between. Many agates are found in the amygdaloid and as pebbles on the shore. The light keeper, Louis Miron, has found native copper also.

Gargantua river enters the lake south of the hook shaped promontory of the cape, but as it does not seem to be a very important stream it was not ascended as far as the falls or rapids.

Just north of the cape there is a small patch of red Keweenawan conglomerate and also of red volcanic breccia at the foot of a bay, remnants of a sheet of rocks once covering the whole shore and perhaps still existing below the level of wave action.

A cascade 90 feet high is seen close to the shore a little farther north, and fine mountain scenery all the way from Gargantua to the wide flat valley of Michipicoton river.

Only a short stay was made at Michipicoton Post near the mouth of the river, as it was intended to examine the gold region near Wawa lake to the north on our return journey.

The rocks at Little Gros Cap, five miles west of the river mouth, and near Doré or Pickerel river just beyond, were included by Logan in his original Huronian, and were studied by us for a day or two because of their geological interest; and Doré river was ascended for about two miles to examine its falls and rapids. The river is very bad for canoeing and cannot be much used, since only the first fall has a path cut for portaging. The first fall. which is close to the shore, is only about 20 feet high, but less than a mile above there is a fall of 78 feet (aneroid, two readings), and the height reached in two miles is about 310 feet. In this distance we were obliged to make six portages, mainly over rock; and the river at one place flows through a small canyon not more than six feet wide.

Little Gros Cap and Dore River.

The rocks observed were boulder conglomerate near the lake and felsite schist with a few bands of chlorite schist to the north as far as we proceeded, all Huronian. A high steep hill near the mouth of the river consists of diabase, probably a mass erupted through the Huronian. The strike runs from 60° to 80° east of north, and the dip is from 70° to vertical. The schist conglomerate at the mouth of the river has been described by Logan, who gives a detailed section having a width of 1,700 feet, and states that the series of slates (schists) must be much greater than this. A micrometer measurement to a small island of the same rock nearly south of the river mouth gives the distance as 2,500 feet, and the conglomerate has been found $\frac{1}{8}$ of a mile inland, or 650 feet farther. These conglom-

Schist Conglomerate

erates, which are very like those of Shoal lake in the west, extend in patches for about three miles along shore toward the west, and contain a few barren looking quartz veins. Still farther west granite cuts off the schist conglomerate eruptively, and is followed by green schist. More or less conglomerate occurs at intervals however as far as Dog river.

Dog River.

For three or four miles east of Dog river a magnificient series of old lake terraces fronts the shore, best seen from a mile or two out in the lake. They are clean cut and very well defined, and consist chiefly of sand and gravel. The highest rises about 360 feet above the river, and the even level lines of the forest-covered surfaces of the successive steps are very striking in contrast with the rugged cliffs and dome-like mountains elsewhere seen on this wild coast. These terraces extend only a short distance west of Dog river. Two miles west of the river there is a sheltered little harbor, well adapted for fishing craft, though deserted when we were there; and a few shanties stand along the sandy shore of the bay and near the rocky point which protects the small pier and storehouse.

A View of old Lake Terraces

As Dog river is one of the largest streams on this part of the coast we devoted some time to its study. There is a long gravel bar at its mouth, crowding the brown water of the river against the cliff on the west gide of the valley. About half a mile above this the river becomes too rapid for canoe navigation, flows through canyon-like narrows parallel to the strike of the Huronian schists, and finally turns off at right angles, forming one of the most beautiful falls we had yet seen. The foot of the main fall is about 33 feet above the lake, while its head is 159 feet higher (aneroid). The fall is in three steps, but all visible from one point of view. Above the fall the stream once more turns parallel to the strike of the schist, following a narrow canyon. From the appearance of the shores it is evident that the river has great fluctuations in level. The rocks seen are pale green schist conglomerate and porphyroid.

The River and its Falls.

In this and rivers visited before, speckled trout are plentiful, sometimes the real brook trout. Our captain caught several fine fish from the pier in the harbor, one measuring 19½ inches in length. The red spots are not so bright as in the brook trout, and are surrounded by a small bluish halo; otherwise these fish are very much like the brook trout in appearance.

Speckled Trout.

West of Dog river to the mouth of Eagle river various green Huronian schists are found, penetrated often by felsite dikes. West of this a reddish or gray granite mass bursts through the schists and is itself cut by dikes of diabase.

Pucaswa River to Pic River.

Our next important stop was at Pucaswa[14] river, where two small islands form a tiny harbor, very welcome after long pitching in a high sea; and a stretch of sandy shore affords good camping ground, though infested with sand-flies and blackflies. The rocks here are chlorite schists with purplish felsitic layers, crossed by numbers of large diabase dikes having the crumbling look of Keweenawan rocks, though perhaps not of that age. One of these dikes, forming a point just west of the river mouth, is cut by a smaller columnar dike, which has been breached by the waves so as to give a tunnel-like opening through the point. The cave is about 30 feet long by 15 in width and height. The basaltic columns are six feet long and tilted to about 45° on both the roof and floor of the cave.

Geology of Pucaswa Harbor.

There were many fresh caribou tracks on the sand near the mouth of the river. For about a third of a mile beyond the bar there is little current, but there the valley turns off through a wild gorge overhung by a cliff hundreds of feet in height. A portage path of half a mile leads past the series of cascades by which the stream breaks through this barrier, the only well beaten portage found on the whole river. The first fall is of about 55 feet, and a series of rapids rise beyond this. There is a mass of pyrites

Cascades of the River.

[14] The name is variously spelled, Pucoso, Pukasquaw, etc., but the spelling followed here corresponds best with the pronunciation of the Indians employed as guides, though one of them spel'ed it Bagoswa when asked to write it down.

a foot thick at the foot of the rapids, at which some one has done a little work; but there is no quartz accompanying it, and the deposit shows little promise.

A little west of Pucaswa granite shows itself as far as Kilkenny (or Killarney) harbor, now deserted; beyond which there is gneiss with a strike of about northeast and southwest and a dip of 80° to the northwest. In a bay west of Kilkenny there are several old beaches rising above the water to a height of 42 feet, the upper ones completely lichen-covered. There is no sharp break in the series of beaches, which all consist of well-rounded boulders about as large as one's head. This seems to imply a gradual fall in the level of the lake.

At Kilkenny Harbor

Between this and Otter head the scenery is very striking, pale gray or flesh red gneiss being penetrated by many wide diabase dikes of a very columnar character, often, when weather-beaten, suggesting great piles of cordwood. As the head is neared the gneiss becomes interbedded with long bands of gray or green schist, showing an eruptive contact of Laurentian with Huronian, like that seen in the Rainy Lake region.

The Dikes of Otter Head.

There is a long bay with mountainous shores to the north of Otter head, and a large island protects its mouth, so that the sheet of water is as placid as an inland lake, forming a great contrast with the turbulent waters of lake Superior, which are seldom free from ground swell even in the calmest weather. On the north shore of the bay, where a waterfall tumbles over a dike of diabase in green schist, a mining location was taken up some years ago by Mr. Mudge, of Peninsula. There are some small veins of quartz charged with pyrites, supposed to contain copper, but showing when assayed no copper and only $2 per ton in gold and silver; so that nothing further has been done with the property.

On the main land opposite Otter island the Rideau river falls as a cascade visible for a long distance on the lake. There are two falls in succession, having in all a height of 86 feet.

Rideau River.

From this point to White Spruce (or Spruce) harbor no stop was made. At the latter point there is a well-sheltered bay, once a fishing station, but the frame houses, pier and storehouse are now abandoned. From here we attempted to ascend Tip Top mountain, marked on the map as seven miles to the east, but owing to the shortness of the afternoon available for the work and the heavy rain which came on, we did not succeed. The trail is faint at present, though it must have been considerably used when the summit was occupied as a triangulation station by the U. S. Hydrographic Survey. The blazed trail as far as we could follow it leads up a small creek past a lake about a half mile long and then up an extraordinary ravine or canyon, evidently the result of the weathering out of a diabase dike. Though only a few feet wide it had a depth of about 100 feet, with smooth parallel walls of granite both having a dip of 80°, so that one wall completely overhung the path. On an adjoining granite hill top at a height of 982 feet (aneroid) we found an old triangle of poles, perhaps used as a temporary observatory or signal, and had a magnificent veiw of the mountainous country around, though somewhat shrouded by mist and rain. A high point, or rather dome, three or four miles to the east was probably Tip Top[15]; and a number of higher hills than the one we had climbed were in sight, ours representing not much more than the average height of this part of the shore. No land of any extent fit for agriculture was passed on our excursion.

White Spruce Harbor and Tip Top Mountain

The rocks observed were granite or granitoid gneiss, with diabase dikes. At Spruce harbor the rock is gneiss imperfectly foliated, with no very distinct strike. On a small gull rock three miles to the northwest we found gneiss with a strike of 80° and a nearly vertical dip. A young gull picked up here, though not yet able to fly, had a spread of wing of 45 inches. All the gulls were fledged or nearly so at this time, and their islet was very foul from the debris left upon it.

[15] This mountain was ascended on my return journey going in from Swallow river to the south.

A short stay was made at White Gravel river, a small stream north of Spruce harbor, and a longer one at Oiseau bay ten miles north of it. Unlike the coast observed hitherto, we found that along this part a number of points had been burnt over, as if the climate was drier than nearer to the Sault; and the lofty hills along the shore had a very barren look. The only timber of value is spruce, both here and on the route of our excursion towards Tip Top mountain. Of that, however, there is a considerable quantity. At Oiseau bay there is an interesting succession of rocks displayed. Yellowish Laurentian gneiss, containing black bands of older schist, probably Keewatin, is cut by gray granitoid gneiss, and all of them are intersected by pegmatite. The gneiss has a strike of 150°, but a mile beyond this it has changed to 60°.

White Gravel River and Oiseau Bay.

From this point to Heron Bay the shore as far as observed by us consists of green schists cut by dikes of granite and larger areas of coarse reddish-gray granite, perhaps Laurentian.

At the mouth of Pic river sand bars and dunes form the shore; but just beyond this a rocky point consists of what appears to be Huronian schist, with a strike of 110°-120° and vertical dip. Rounding the point and turning north into Heron bay there are reddish rocks, at first taken for gneiss or granite, but proving on more careful examination to be schist conglomerate, consisting of pebbles or boulders of quartz porphyry and other rocks in a darker matrix. This rock forms almost the whole shore of the bay.

Pic River to Heron Bay.

Heron Bay.

At Heron Bay we were delayed a day or two in getting guides and canoemen for our projected trips south from the C.P.R. to lake Superior, owing to the fact that all the Indians of the reserve were waiting for the most important event of the year, viz., treaty payments. After our lonely journey along the deserted shore of lake Superior where for about 70 miles, from Ganley's harbor to Heron bay, there is not a settled inhabitant, the bustle was not uninteresting.

A day was spent in walking along the railway to Peninsula to examine the rock formations and to visit the immense gravel deposit on the way. West of Heron bay to mile 805 the schist conglomerate is found; beyond that, greenish gray slate with many dikes of diabase. As the rocks near Peninsula and along the railway for some distance west were referred to in a previous report, no mention need be made of them here.[16] The iron sands referred to in the same report,[17] were examined under the guidance of Mr. M. J. Paterson of Toronto, who was engaged with Mr. Mudge in collecting bags of the material for a test of the value of the deposit. The area of sand containing magnetite is large, 1,200 acres we were told. An assay of one of the best samples taken by us yielded 48.6 per cent. of iron. The Heron Bay mine close to the station of the same name was visited also. A shaft 40 or 50 feet deep has been sunk in a country rock of felsite; and the ore on the dump consists of calcite with a little quartz and pyrite, not very promising in appearance.

Iron San deposit at Peninsula.

Heron Bay Mine

Pic river is one of the largest on the north shore of Superior, and has falls of some importance, but too far inland to make it advisable to ascend it for the purpose of examining them. Where the railway crosses the river half a mile east of the station its width is 225 feet. The water at the time we visited it was exceedingly muddy, justifying the name, which is said to mean "mud" in Ojibway.

Pic River.

Michipicoton Mining Division.

By the kind aid of Mr. W. H. McDougall, a fur trader who has a store at White River as well as at Heron Bay, Indians and equipment were secured for Prof. Willmott and myself, and on July 20 we commenced our respective journeys southward, my starting point being Bremner Station of the C. P. R.; Prof. Willmott's, White River. It was arranged that Mr. George should accompany Prof. Willmott, and Mr. Coulthard and Sayers should sail the Caribou down to Caribou island while we were occupied with our canoe trips, so as to examine the rocks composing that seldom-

Plan of Exploration Tours.

[16] Bur. mines, 1897, p. 133. [17] Ibid, p. 83.

visited island; and then to return to the north shore and pick us up at the mouth of Pucaswa and Dog rivers, respectively. This programme was carried out punctually by the three expeditions.

Bremner River.

Bremner Station to Lake Superior

Going east by rail from Heron Bay to Bremner river my party of four, including two Indians, Toussaint Weesiau and Jim Shoes, engaged as canoeman, set out on July 20 through a region only partly known to the Indians and rarely traversed by a white man. We were told it would require two weeks of hard work to cover the distance to lake Superior, about 45 miles in a straight line; but of course much farther by the small and winding rivers we were to follow. It required in reality only about half that time, although the carrying on of the survey with prismatic compass hindered our progress considerably. Bremner station is on White river, but a quarter of a mile up stream we turned off to the south on Bremner river, which seems the larger of the two branches, and followed it up to its head waters which reach more than half way to lake Superior. About four miles up the first rapid requiring a portage is reached, and the first outcrop of rock also occurs, gneiss with an east and west strike. The portage, which is on the right bank going up, is about a fifth of a mile long and well beaten. The rise is about 10 feet. The next rapid, about a mile farther up, has a fall of 32 feet (aneroid); and is passed by a crooked trail on the left side about three-quarters of a mile in length. Another rapid is passed less than a mile beyond, with a fall of nine feet and a portage of 100 yards on the right side. The rock exposed here is gneiss with dikes of diabase. A large creek enters the river from the left about 12 miles from Bremner, in a region of low sandy banks; and half a mile beyond this hills that have been burnt over were found to consist of fine grained pale gray granite, covered with the black trunks of jack pines.

Ascent of Bremner River.

The timber up to this point on the river is chiefly jack pine, though on the lower ground some spruce and tamarac are to be seen. My cook, Stephen Jollineau, who has worked for a pulpwood lumber company, says that the spruces would make good pulpwood, each tree cutting two logs 16 feet long.

Above the last rapid mentioned the river grows smaller and very crooked, and has only a gentle current. Several small rapids follow, with short portages scarcely at all beaten, over gneiss or granite; and then a bad portage one-third of a mile long over fallen timber past a series of rapids having a total fall of 60 feet (aneroid); and from this on there are numerous small rapids with slack water between.

About 23 miles from Bremner the river suddenly becomes straight for about two miles, much of the way having a steep granite or gneiss wall on the left bank. The straight part probably follows the line of a diabase dike which has weathered out, forming a long canal. At a rapid having a fall of 32 feet the stream is at one point so narrow that one can easily step across. The channel follows the strike of the gneiss.

The stream now grows more crooked than ever for two or three miles, and then straightens again for about the same distance, three small creeks entering it meantime from the east.

Headwaters of the River.

After another bend and a tiny lake expansion we at last reach the headwaters of Bremner river in a lake about a mile in length, called by the Indian family which hunts over this region Peenay or Partridge lake. The lake is surrounded by low rounded hills of granitoid gneiss, the highest rising perhaps 100 feet above it. The pale gneiss includes many angular fragments of dark green schist.

The whole rise from Bremner station to Partridge lake, as determined by summing up the heights of the different rapids measured by aneroid, is about 200 feet. As there is very little current between rapids only a few feet need be added to complete the elevation of the headwaters of Bremner river above the railway. As Bremner Station is 527 feet above lake Superior, the fall from Peenay lake to Superior is 725 feet.[18] Toussaint, who

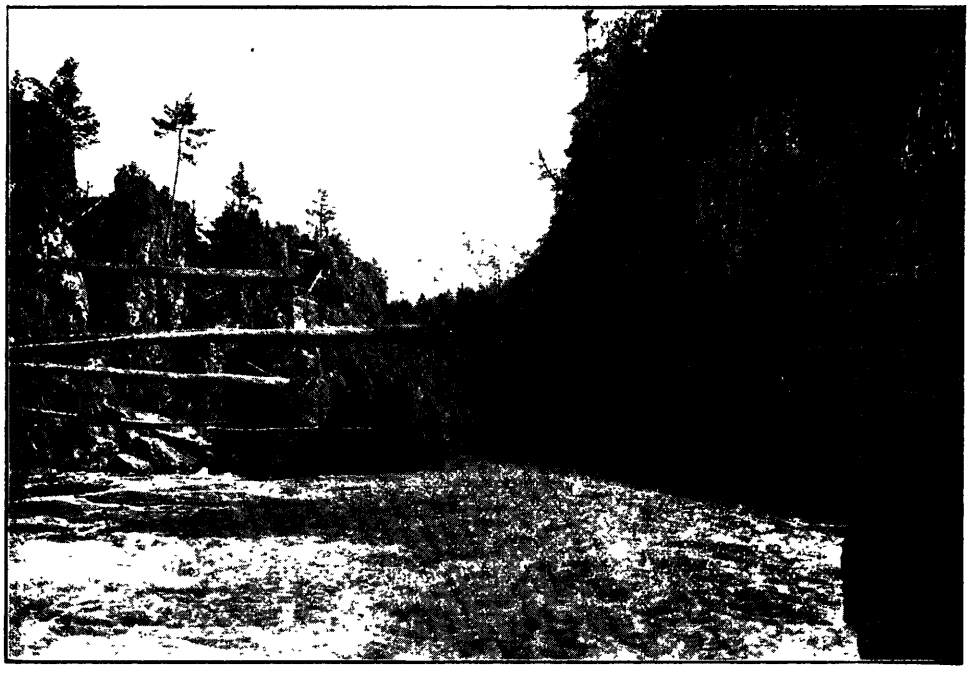
[18] Mr. J. White of the Geological Survey has kindly informed me that the elevation of Bremner station above sea level is 1,129 feet. Subtracting 602 feet, the height of lake Superior above the sea, gives 527 feet.



Dikes of Greenstone in Quartzite at Island one mile east of Bruce Mines Willmott



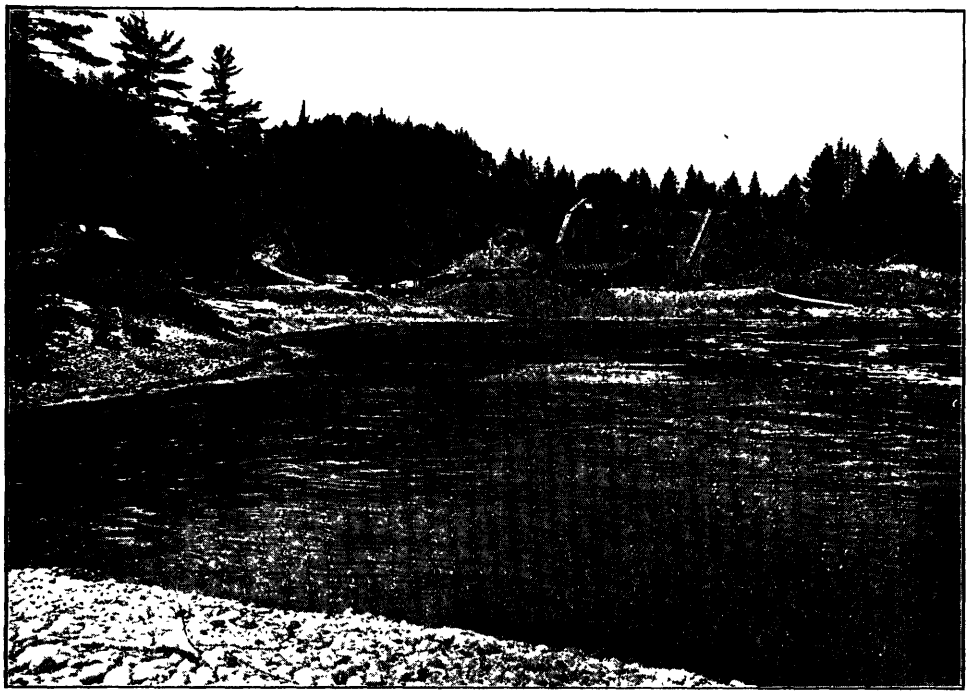
Murray's Lower Slate Conglomerate, showing a Gneiss pebble, a faulted pebble, joints and glacial striæ.
Palladian Islands, four miles east of Bruce Mines. —Willmott.



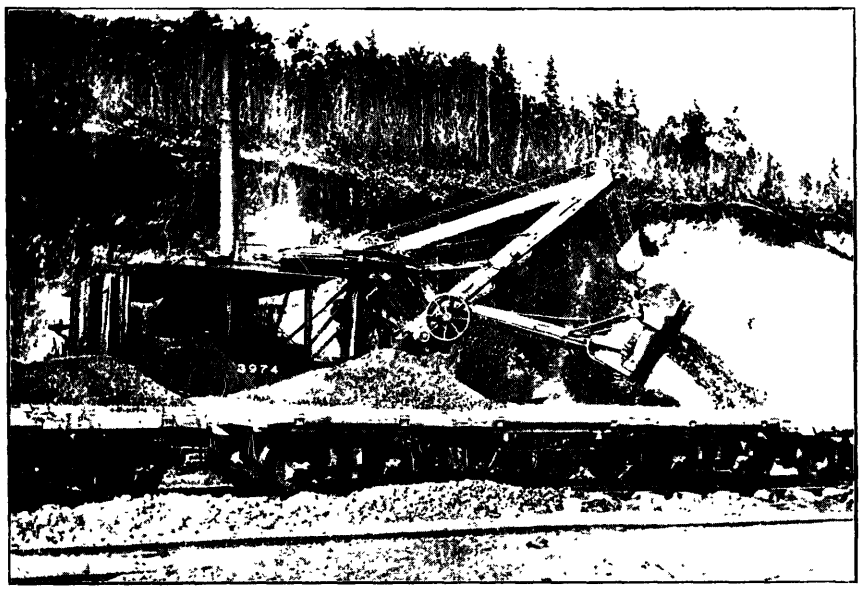
Gorge of Mississaga River —Cheney



Baboon Falls on Mississaga River —Cheney



Shaft House at Cheney Mine —Cheney.



3 Steam Shovel excavating Gravel Beach back of Garden River Station, C.P R —Willmott.



Mill and Rock Dump at Victoria Mine, Garden River. —Willmott



Cascade Mill at Garden River, showing crushings in foreground —Willmott

hunts along this valley, states that a lake a mile or two away empties by a small creek into Partridge lake and also into the headwaters of Pucaswa river.

The scenery of the river is not striking. Much of its shores has been burnt over, and the timber left is of little value except for pulpwood. Jack pine, birch and spruce are the commonest trees; but tamarac and cedar are found occasionally. There are unusually few lakes along the stream, and those are scarcely more than pond-like expansions of the river. The shores being generally low, afford few exposures of rock except at rapids; and the only rocks observed are granite, gneiss and dikes of diabase.

Pucaswa River.

A portage 2¼ miles long, broken however by three little ponds, leads southeast, across very rugged and hilly country with no distinct path, to a small creek flowing into Pucaswa river. The fall from Partridge lake to canoeable waters flowing into the Pucaswa is 126 feet. Much of the portage leads across flat-topped granite hills over bare rock; but there are long stretches of muskeg and meadow as one approaches the lower end of the portage. The hills were covered with blue berries when we crossed on July 23; and the Pucaswa waters provided us with plenty of speckled trout.

Crossing the Divide.

The little creek at which the portage ends joins a larger stream which flows 2½ miles southwest to meet the main Pucaswa river flowing first west and then southwest. After crossing the divide there were no beaten portages and we simply worked our way down stream over endless flat rapids, wading much of the time. The reason why the Indians never navigate the river was clear, although the presence of caribou tempts them to the headwaters of the Pucaswa in winter. Beaver cuttings were plentiful on this part of the river.

Descent of the Pucaswa

A few miles below the forks the stream divides, enclosing a wooded island a mile and a half in length. About 15 miles above its mouth the shore at a rapid shows many black masses of hornblende schist, probably Keewatin in age, the first rock other than Laurentian gneiss observed on the river. The gneiss thus far seen generally strikes about east and west. With the exception of a few narrow lake-like parts, the river down to this is almost a continuous flat rapid with a few higher falls, the portaging being done generally down the bed of the shallow stream; only striking into the woods where falls of some height occur. About 11 miles from the mouth red granite or graintoid gneiss is seen at a rather lofty fall (27 feet) and continues for some miles down stream. Below the main fall there is a continuous series of rapids for a mile and a quarter with a fall of 198 feet; a difficult bit of river with such precipitous rock walls as to make portaging very laborious. This part of the river contains many elongated islands among the rapids, and presents a series of magnificent views. Here for the first time a distinct sand and gravel terrace indicating an old lake level is to be seen rising 40 or 50 feet above the river, and the valley has been cut low enough into the high tableland to give its rocky walls the appearance of mountains.

Rock Formations

A little more than seven miles above lake Superior, following the windings of the river, here very crooked, but only three miles in a direct line, Huronian rocks first show themselves in continuous beds, having a strike of 80° or nearly east and west, and running parallel to the course of the river. The dip is from 30° to 45° to the north. The red granite observed for several miles above this is probably eruptive, perhaps a continuation of the granite area found on the shore of Superior a few miles east of the mouth of the Pucaswa. The strike of the green schist varies somewhat, being 60° a mile lower down.

About 4½ miles from its mouth the Pucaswa is joined by a smaller river from the left, estimated at a quarter of its volume. Just above this there are two falls having a total drop of 22 feet, and near by a small bedded quartz vein with pyrite was observed. A mile below the tributary felsite schist occurs, having a strike of 30° and dip of 30° to the northwest; and the river passes through a canyon where many dikes of diabase are seen. Below the canyon there is a soft gray rock much seamed with small veins of calcite. A succession of flat rapids

and one fall of about 18 feet intervene between the canyon and the main fall of the river, 55 feet high, below which there is a lake-like expansion reaching to the bar separating the river from lake Superior. The river mouth has been described in a previous part of this report.

Readings of Elevation.

There is a considerable amount of spruce, some of it large on the lower reaches of Pucaswa river; but besides the timber nothing of economic importance was observed on the whole route from Bremner to Pucaswa harbor. Summing up the results of aneriod readings from the foot of the long portage which leads from Partridge lake to a tributary of the Pucaswa, the whole fall is 575 feet. As there is a fall of 126 feet on the long portage this gives the elevation of Partridge lake, the headwaters of the Bremner river, as 700 feet. This result must not be looked on as having great accuracy however, and the estimate made from Bremner station, 725 feet, is probably more correct.

An inhospitable Region.

The Pucaswa as a whole is one of the most difficult rivers in Ontario to navigate, being almost a succession of rapids, some with very shallow water over small boulders; others are considerable falls over solid rock. There are few stretches of dead water and no lake of any magnitude on its whole course. Since the Canadian Pacific Railway crossed the country to the north it is never navigated even by Indians, though we found two families of Indians camped at the mouth of the river for fishing purposes. They came from Pic river in a sail boat however. In winter the country is more accessible than in summer, and a few Indians hunt caribou along parts of the Pucaswa.

Herrick's Roadway Line.

The roadway surveyed by T. W. Herrick in the summers of 1857-9,[19] running about 20 miles inland through the whole region from the Sault Ste. Marie along the north shore of lake Superior, was apparently never cut out, and will never be made use of since the railway has been carried through the northern part of the district. His work seems to have grown up so as to be unnoticeable from the river. The line is mapped as running past the headwaters of the Pucaswa; but was not observed by my party in portaging from Partridge lake. He represents the river on his map but makes it straight except at the lower end, probably having sketched it in from the reports of Indians. For a few miles above its mouth the Pucaswa is fairly well mapped in the plan of the township of Homer in the Crown Lands department. Bremner river and Partridge lake are not shown by Herrick, though his line must have come close to them.

Bell's map of the "Basin of Moose River and Adjacent Country," illustrating his work in 1875, 1877 and 1881, and published by the Geological Survey in 1883, does not make use of Herrick's work. A tributary of White river, Oskabookuta river, is dotted in, probably from Indian reports, in such a way as to make it meet or even cross Bremner river near its headwaters. It is probable that the river is not as long as represented, as my Indians, though they had canoed ten miles up it from White river, were not aware that it approached Bremner river.

The Story of a "salting" Swindle.

Twenty-seven years ago two townships were surveyed on this part of the barren shore of lake Superior, Homer and Byron, and the old lines may still be seen in the woods. As the history of the affair, which included the "salting" of a tin mine, is of some interest, Mr. John McAree, who took part in the survey, has been asked to write an account of it. This is given in the footnote.[20] In later times deposits of copper ore have been found in or near these townships and may prove of value.

[19] Upper Canada Surveys, 1860-66.

[20] McAREE'S NARRATIVE.

The township of Homer was surveyed by the late C. C. Forneri, P.L.S. of Port Arthur and the writer in December, 1871, and January, 1872, for W. A. Northrup, who came to Port Arthur from the south shore of the lake—from Houghton if I remember rightly—in the summer of 1871. We went down by the Manitoba, Captain Symes, on November 30 and left the survey on January 24 on the return trip. Our route was around the north shore, and the transportation of our baggage, etc., was by toboggans made in the bush before starting. We reached Port Arthur on February 17. We then learned for the first time that we had been making a survey of lands upon which valuable deposits of tin ore had been discovered the previous season. In those booming days of sur-

White River.

Prof. Willmott, who ran a micrometer survery from White River to the mouth of Dog river, reports as follows :

" Leaving Dr. Coleman at Heron Bay, Mr. George and myself proceeded by train to White River, where supplies were purchased. Two Indians, Alexander Matchinini and William Pansway, were engaged as canoemen and proved very satisfactory. By the kindness of Mr. W. H. McDougall I was provided with a bark canoe, tent, extra compass and some of the necessities of a camp, which were returned by the canoemen two weeks later.

" White River is a divisional point on the Canadian Pacific Railway, 304 miles west of Sudbury. It is a village of about 300, dependent almost entirely on the railway. Two other industries are the collection and shipment of $10,000 worth of fur yearly, and the manufacture of cold weather statistics. White River enjoys the unenviable reputation of being the coldest place in Ontario reporting to the Meteorological Department. Nevertheless the observer finds farming profitable and I noticed that the blueberries were fully two weeks earlier than on lake Superior, 40 miles south and several hundred feet lower.

White River Station.

---

veying and taking up mining claims many of the operators thought it necessary to conduct their operations with as much secrecy as possible, and for a member of a survey party to have asked any questions as to the exact destination of the expedition, or the nature of the mineral discovery, would have been resented as being very ill bred. Homer Pennock, also of the south shore, and a man named Johnston posed as the discoverers of the tin; whilst Northrup and Wood were the vendors, and sold the discovery to a syndicate of Detroit mining men, who organized a company, paying Northrup's crowd part in cash and part in stock, besides buying the land from the Government and paying the survey and all other expenses. During the winter the Northrup party quietly disposed of their stock, much of it in Boston, I believe, and other eastern cities. In the spring the writer and Mr. Forneri's assistant went back to Homer and made the survey of the shore line, and of some additional sections which were added along the east boundary of the first survey. The Detroit company were now in charge in the person of Captain Slawson, a western mining man. Pennock came on the ground, staying at Slawson's camp, but although he made excursions into the woods to the supposed tin vein, he absolutely refused to show its location. Slawson, in my hearing, offered one of the survey party who had been on the original survey one thousand dollars if he would show the vein; but this person knew no more of it than Slawson himself. Pennock went back to New York and the tin company took proceedings which resulted in his being incarcerated in the Toombs. He then said that the survey had not been properly placed to take in the discovery, and that if this error was rectified and an additional tract, which he indicated, surveyed, he would show the tin. Accordingly, late in the autumn of 1872, the writer again visited Otter head with Isaac Traynor, lately out of his apprenticeship, as assistant, and surveyed the township of Byron, adjoining Homer on the north. During the progress of this survey, which was directed by Northrup in person, he and his confederates made preparations for the culminating of their swindle by fixing up a vein containing quantities of tin oxide. This was not known to any of the survey party at the time, for Northrup requested us not to go near the place. A Mr. Childs of Duluth had charge of what proved to be the " salting" operations. No one as yet suspected that a swindle was being perpetrated. Upon the completion of the survey the writer returned with his party to Port Arthur. Later the report came that the tin vein or veins had been visited and inspected by Captain Harris of Ontonagan, Mich., the expert appointed by the syndicate to make the examination, and that his report was favorable—it was all right. A good deal of stock was sold as the result of Harris' report, for he was a man of undoubted integrity, a Cornishman who knew tin ore when he saw it, and who had had a very successful career in copper mining on the south shore of lake Superior. The vein was seen on the east side of Otter cove, and also crossing the point of land on the west side of that sheet of water.

Early in the spring of 1873 people from Fort William and from Silver Islet went down to Byron and discovered the fraud. I believe Captain Pritchard of Fort William was the first to see that the vein was bogus. A survey party from Silver Islet was then at work taking up what they believed would prove to be valuable tin mining lands; their operations came to a sudden stop when the truth became known.

The circumstances under which Captain Harris' examination of the property was made should be mentioned in justice to him. It appears that on his way to Otter head he arrived at Sault Ste. Marie late in November, if not actually in December. No steamer could be got to take the party to Otter head, where the vein of tin ore was to be seen, and they were obliged to engage a schooner. Arrived at Otter head they found six inches of snow on the ground, and very soon after their arrival the skipper of the schooner discovered the near approach of a storm, and as there was poor shelter where he was, and the season very late any way, he insisted that the mining party should hurry their work, if he was to wait for them. Harris, I suppose, on being able to pick the tin ore out of the vein that was shown him, took the rest for granted; he may not have been an hour absent from the craft, and in that chilly and dreary November weather may have been taking a little too much stimulant, or may have been betrayed along that line, as has been reported, by the interested parties who had him in charge. It was subsequently ascertained, I believe, that the tin ore for the " salting " was procured from Cornwall.

The total amount of land in these two townships is about 30,000 acres, I think; the price of mineral land at that time was one dollar an acre.

JOHN McAREE.

"Our course lay east for two miles along the railway track, which here crosses the White river a number of times. The river is rapid, so that we found it easier to transport our provisions along the track to a point one-eighth of a mile west of mile board 744. Here we began a track survey with micrometer telescope and compass which was carried to the mouth of Dog river.

Ascent of White River.

"The route begins with a portage nearly half a mile long over Laurentian gneiss. Then we launched our canoes in the White river and ascended it in an almost due south direction for a distance of seven miles. Two more portages had to be made, one of 600 feet with a rise in the river of 12 feet; the other half a mile long around two rapids where the river rises 13 feet. At the south end of this portage the rock is a gneiss with Keewatin-like inclusions, both cut by dikes. Two miles and a quarter south similar Keewatin-like inclusions were noticed in the gneiss.

"Seven and a half miles south of the railway a sluggish stream enters from the south. The White river itself has little current except at the rapids mentioned. For much of the distance it flows in a marsh with rocky hills one-quarter to one-half mile apart. From this point to the railway I made the total fall 65 feet by aneroid. The hills are low and burnt, and thickly strewn with boulders, mostly granitic.

"One-fourth of a mile up the tributary stream, Pokay lake was reached. Its extreme length north and south is three and a half miles, its greatest width one and a half. On its western side another small band of Keewatin included in gray gneiss was seen. The shores of the lake on the north and east consist of burnt tamarac and spruce swamps; to the south and west are some hills.

Pokay Lake.

Dog River.

"From the extreme south of Pokay lake a portage nearly a mile and a half long leads over the height of land to the headwaters of the Dog river. The trail, known locally as the Mountain portage, is at its summit 300 feet above Pokay lake. The path is steep and stony in places and burnt logs are too frequent for comfort. The lake to the southeast of the portage is known to the Indians as Clear lake, but as this name is becoming too common for convenience I have designated it as McMaster lake. It is about a mile and a half long and surrounded by spruce. This lake, the headwaters of the Dog river, is 786 feet above lake Superior and 145 feet above the White river at the C. P. R. crossing at mile board 744. An unnavigable creek runs from the northern end into University lake, two-thirds of a mile to the east. The trail is level and dry and may be crossed in fifteen minutes. One mile and a half southeast of University lake a marshy channel may be followed by which half a mile of paddling may be avoided. From University lake to Obatonga lake, a distance of five miles, the river meanders through a marsh with little current. Occasional rocky islets consist of gray gneiss.

On the Mountain Portage.

"Obatonga or Sand-bar lake is a little over three miles in length from northeast to southwest and from a half to three-quarters of a mile wide. It receives its name from the sandy peninsula and island which nearly divide it in two. To the north it is surrounded by low rounded hills of gray gneiss. A portage route leads from the north end to Amyot on the C. P. R. At the outlet is a small rapid where the river descends two feet. Thirty feet above is a small plain with well-rounded gravel which can hardly have been made by the river.

Obatonga Lake.

"Three-quarters of a mile below is Knife lake, a fine body of water a mile and a half in diameter. About the middle of the western side on a small island there is an inclusion of green schist striking 100°. A mile and three-quarters south of this the true contact of the Laurentian and Huronian was found. The stream on leaving Knife lake is rapid for a mile, falling 33 feet. To avoid this a short portage was made to the east into lake George, a shallow sheet of clear water three-quarters of a mile long. Half way down it the gneiss becomes granitoid and then appears in eruptive contact with the green schists which strike 85° to 90°. Twenty-five miles to the east, on the Magpie river at a similar contact, the strike of the schists

Knife Lake and George Lake.

is 88° and this is probably a continuation of that band [21].

"An unused trail of one-sixth of a mile leads from lake George to the river. Numerous quartz seams of small size were seen in the schists for some distance. Two miles and a half below, a portage of one-third of a mile occurs. A half mile below is a gold prospect belonging to W. H. McDougall of White River. A small amount of stripping has been done, exposing a bed of solid quartzite 15 feet wide and perhaps as much more mixed with schist. The quartz is rather glassy, but contains a considerable amount of pyrites, which on the surface has weathered to hematite. An altered quartz porphyry adjoins the chlorite schist on the north, the strike being 90°. A short distance below a much stretched schist conglomerate occurs. South of this is a sheared quartz poryphry in contact with a hornblende schist. A prospecting pit in the latter proved of no value, the quartz seams soon disappearing. A mile and three-quarters below McDougall's camp a stream comes in from the north. On a lake at the head Mr. McDougall informed me that he had found iron. In the absence of a guide it seemed useless for us to attempt to find it.

McDougall's Mining Claim on Dog River.

"From here to lake Superior the Dog river is not now travelled, even the Indians avoiding it on account of its numerous rapids. So far as I could learn but one white man had ever been down it to its mouth—a C. P. R. engineer who investigated it as a possible route into the interior. Seven miles below McDougall's, an old Indian route to lake Superior by a chain of lakes branches off on the west. Even this has fallen into entire disuse. From this point we had to make our own portage paths, and they were very numerous. Every few hundred yards there was a rapid stretch of water filled with angular fragments of rock, which made it impossible to take a canoe down with safety. The stream becomes very crooked also and our telescope sights were shortened to a few hundred feet. The higher falls have been marked on the map.

A difficult reach of River.

"A short distance below the portage route to Superior gray gneiss striking 120° was observed, though the exact contact was passed. Over two miles below pieces of Keewatin green schists were found included in the gneiss, so the contact is doubtless an eruptive one. A little farther on the river has excavated a narrow gorge in a band of included schist, gneiss forming both banks.

"Numerous pot holes have been made by this turbulent stream. One measured 10 feet by 12, and was six feet deep. A more striking one was perfectly round, 11 feet in diameter and 23 feet deep. A flat rock just at water level formed three-fourths of the circumference.

Pot Holes.

"Ten miles from lake Superior the water of the lake was visible from a hill top. Eight miles north of Superior a very considerable stream comes in from the east. One mile and a half to the southeast a very schistose gneiss occurs in eruptive contact with the green schists. Both are cut at right angles by a dike of greenstone 10 feet wide. Near the contact are a number of bedded quartz veins, one 15 inches wide. A mile and a half below the contact large felspar crystals were noticed in the schist, which dips 45° north. Just south were numerous quartz veins, one three feet wide. Two miles from its mouth Dog river flows through a narrow gorge for 800 feet parallel to the strike, then turns at right angles and in several fine cascades plunges down 159 feet. The portage we cut around this fall crosses several well marked terraces, continuations doubtless of those measured a few miles to the east on the shore. The name Denison was given these falls by Messrs. Herrick, Tight and Jones, who described the geology of the shore in 1886.[22] A band of schist conglomerate which occurs at the lower fall was found with the same strike 140° about a half mile east of the mouth of the river."

Lower stretch of Dog River.

Denison Falls.

Tip Top Mountain.

Having reached the mouth of Pucaswa two or three days before the expected time, and knowing that the Collingwood fishing boat must pick up Prof. Willmott at Dog river before coming for me, I decided to coast northwest to the mouth of

Swallow River

[21] Bureau of Mines VII. p. 200.

[22] Bull. Sci. Lab. Denison Univ. II., 1887, p. 119.

Swallow river and make another attempt to climb Tip Top mountain, probably the highest point in the Province of Ontario. At the mouth of Swallow river a small outcrop of conglomerate, very like the basal conglomerate of the Kewenawan was found, the most northerly we observed. It filled a small ravine in granite and contained boulders of the same rock. It looks as if lake Superior is now just finishing the work of exposing the ancient Pre-Cambrian shores by eating away all the softer rocks, leaving the Archaean basin as it was in long past days. There is a beautiful fall less than a mile up Swallow river, where the river springs 80 feet in almost a single leap over a wall of granite. As the river is shallow and full of rapids, my guide, Toussaint, thought it better to go on foot to the mountain, situated on the chart about 10 miles to the north.

Ascent of Tip Top Mountain.

Our path, which was crooked and often hard even for an Indian to follow, led over rough hills and valleys for about seven miles, when we once more touched the shore of Swallow river. Our course was considerably east of north. Here a night camp was made by one of the Indians, while the rest of us went north about five miles over rougher country than before. The mountain has a dome-shaped top and consists of Laurentian granitoid gneiss, with dikes of pegmatite and also diabase. A large mass of fine grained diabase forms the highest point. Some massive flat stones mounted on others in a way suggesting a rude altar probably served as bases for instruments during the American hydrographic survey, when this was one of the stations. The surrounding valleys are covered with thick forest growth, and most of the neighboring summits are covered with fair sized trees to the top, except where precipices are too steep to give them foothold; but the summit of Tip Top is covered with bushes only, or perhaps one should say with very stunted trees, none rising above 20 feet. The kinds observed were spruce, birch and mountain ash. It seems as if the unchecked violence of the wind and storms must cause the stunting, for the height, as found by aneroid checked for change of barometer, is only 1,525 feet above lake Superior, or 2,125 above sea level, far below tree line for other mountains at this latitude. It can hardly be due to cold, for blueberries were much riper on top of the mountain than on the lake shore 1,500 feet below. The view from the summit is fine, though not so fine as that from lower points ascended near the lake, where the sharp bare cliffs are so effective.

Rolling Hills and Spruce Forests

The general appearance is of rolling hills with a few slopes of bare rock, the only real precipices to be seen lying north of Spruce harbor several miles away. There is very little burnt country within the field of view, but little of the forest is of value except spruce for pulpwood, of which there appeared to be large quantities. No plains or terraces of cultivable land could be seen except a few small beaver meadows; nor were any bodies of water disclosed except three ponds, and the wide expanse of lake Superior seven miles to the west. It is doubtful if this region will ever support a population beyond a few fishing stations and a town or two working up pulpwood near some of the large waterfalls.

Caribou

A young caribou was seen on the way to camp, and these animals appear to be common. My Indians say they eat "moss," the gray arborescent lichen of the rocks; various herbs, some of which they pointed out, and mud! They certainly paw the moss away and leave bare spaces, probably not for the earth but for roots or bulbs of small lily-like plants to be seen growing about. They are said not to eat grass, and certainly the rank grass of the beaver meadows was untouched.

Reunion of the Exploration Parties.

Paying off the two Indians, who loaded their bark canoe with gull squabs from a rock off the harbor, we parted company, they to paddle along shore to Pic; and Stephen and myself to coast eastwards in the Peterborough to the mouth of the Pucaswa, where we expected to meet the fishing boat. Seeing no signs of the boat at that point, we pushed on towards Pilot harbor, meeting our friends half way and finding that all had gone well with them. As our supplies for the last two or three days had got down to flour and the trout to be caught in every stream, we were not sorry to secure better rations.

It was too late in the day to sail over to Quebec harbor on Michipicoton island, our destination, so we chose a Sunday's camp in a little bay east of Pucaswa.

The rocks at this camp consist of schist conglomerate, forming a fringe along shore for 1½ miles and including several small islands; and felsite or porphyrite on the hills inland, where the country to the north is very rugged. A small patch of Keweenawan conglomerate shows on a large island near by, one of many instances on this shore where a remnant of these easily attacked rocks has been preserved in a fissure of the older, harder rocks.

A remnant of Keweenawan Conglomerates.

During our trips across country, Mr. Coulthard in the Caribou had visited Caribou island, far south of Michipicoton island. He found the rock to be brown St. Mary's sandstone, like all the other islands in the southeastern part of lake Superior. The island is low and covered with scrubby trees, mostly spruce. A lighthouse and fishing station, occupied only in the summer, are on a smaller island just to the south of Caribou island, one of the loneliest inhabited spots on lake Superior.

Caribou Island

Michipicoton Island.

With the exception of St. Ignace, which protects Nipigon bay, Michipicoton island is the largest of the innumerable Canadian islands in lake Superior. It lies about ten miles due south of Pilot harbor, but its only inhabited port is Quebec harbor on the south side; and in spite of its indented shores as shown on the chart, it seems not to possess many well sheltered harbors. The island has long been known to be copper-bearing, and its rocks and mines are briefly described in the Geology of Canada[23]; where the whole island is shown to consist of Upper Copper-bearing rocks, i.e. Keweenawan, consisting mainly of various kinds of trap and sandstone or conglomerate, the whole footing up in thickness to not less than 12,000 feet.

Features of the Island.

Philipps and Quebec Mines.

We landed on the northwest side of the island, visiting the two mines once operated there, the Philipps and the Quebec mines. The shaft of the Philipps mine was found to be nearly full of water and no ore was to be seen on the dumps, only weathered amygdaloids. The Quebec mine two or three miles to the west had just been pumped out by Mr. Cozens of Sault Ste. Marie, who had control of it, that it might be examined. It has since been reported that the mine is sold.[24] We were however too late to meet the party which had unwatered and examined the mine. There are 15 or more well built houses for one purpose or another besides three shaft-houses and a large mill, the latter provided with a concentrating plant. There are two curious caves to the west of the camp, one over the other, the lower one being used as a powder house. This cave is 26 paces long, 12 wide and 15 feet high near the mouth, and a natural arch or bridge spans the space before the entrance. Its floor is about 15 feet above the lake, which lies only a few yards away; and the cave seems due to wave action at a time when the water stood higher than now. The second cave, 40 or 50 feet above the lake, is evidently an old sea cave also. The rock is dark diabase.

A fine set of terraces may be seen from the lake as one approaches Michipicoton island at the Quebec mine, and a good road leads across the island to the south shore passing over them. We measur-

Lake Terraces.

[23] 1863, p. 81 and also pp. 703-4. See also Macfarlane, ibid, 1865-66, p. 137, etc.

[24] Two specimens of ore from Michipicoton island, sent by Mr. Cozens to the Director of the Bureau of Mines and forwarded to me for examination, are good examples of the copper-bearing conglomerates of the Keweenawan of lake Superior. They are rather dark purplish gray rocks, consisting of pebbles and smaller fragments of felsite, quartzless porphyry and less often quartz porphyry, cemented by a small amount of a soft white or greenish substance, partly calcite and partly a zeolite, so far as can be determined without blow-pipe tests. Chalcedony approaching agate in structure occurs in one specimen. The most interesting mineral however is the native copper, which is untarnished and forms irregular plates and masses between the small pebbles of the conglomerate, and hence occupies the place of part of the cement of the rock. It is plentiful enough to hold together shattered fragments of the stone, and in these specimens is evidently present in quantities sufficient to make the rock a most valuable copper ore. In general appearance the specimens are of precisely the type of the copper conglomerate so extensively mined in northern Michigan, and as they occur in rocks of the same formation there is reason to hope that mining operations will disclose deposits of much importance.

ed four prominent ones at levels of 61, 191, 233 and 288 feet respectively; many less marked water levels occur also. On the 233-foot terrace there is a nice farmhouse and barn, now deserted. The soil looks rather poor in most parts. The road passes a lake of considerable size at the level of the farm, and another one at about the level of the next lower terrace. The region around the Quebec mine is very pretty, with a hill 900 feet high as a background and the terraces partly wooded but mainly cleared, rising up from the water. The road running south from the Quebec mine is rather grown up with bushes, part of the way being now little used. It comes out at the south shore where a black eruptive glass or pitchstone occurs, and also amygdaloids with some fairly good agates. Here the road turns east along the shore to Quebec harbor, a land-locked bay with a lighthouse at its mouth. There are several houses on the shore of the bay, but only two or three families of fishermen and the light keeper live there at present. There is a large clearing with a good crop of timothy hay just being cut on August 2.

Quebec Harbor

Volcanic Rocks.

Cruising round the island toward the east, much red quartz and also quartzless porphyry are seen, whole bays having their pebble beaches and shore cliffs of this richly colored rock. On other bays the rock is a black diabase, amygdaloid or pitchstone, forming beaches as well as rock walls, and giving a very somber effect. The rocks obtained will be described in another part of this report. On many of the beaches agate pebbles are found, and veins of quartz, chalcedony and agate occur in the diabase.

The island is a very interesting one, not only on account of the varied volcanic rocks which chiefly compose it, but also because of its rugged and picturesque shore line and mountainous interior, dotted with many charming little lakes. At present, however, its only regular communication with the mainland is by means of an American fishing steamer.

Michipicoton Mining District.

As Prof. Willmott reported on this district last year and is familiar with its general features, it has been thought best that he should prepare the following report of our work in the region during the past summer:

Schist Conglomerate and Granite.

"From the mouth of the Doré the schist conglomerate was traced for four miles to the east, to a point one mile east of Gros Cap wharf and 200 yards inland. The strike is very uniform, never varying more than 10° from 80°, The continuation of this course for four and a half miles farther would cross the Magpie river three miles from its mouth, and here a conglomerate was noticed last year. Two and a-half miles to the northeast a similar conglomerate with a strike of 75° is exposed at the northwest angle of Wawa lake. That these three occurrences are part of one band is very probable, although the one strike recorded for the rock on the Magpie (148°) is far from the general direction."

Tracing the Conglomerate Belt.

"At the second portage up the Magpie the boss of eruptive granite was again examined. It is very coarse-grained and consists of round blebs of quartz in a red felspar, with almost no mica or hornblende. In the river gorge, at the foot of the rapids, is a section showing 90 feet of green schists curving in a gentle anticline over a boss of the granite 30 feet in height. At the head of the rapid both sides of the stream are granite and continue so for half a mile upwards, when a banded schist is met. The schist is in part felsite, carries much pyrite, and seems in places to contain pebbles obliterated by being rolled out like those around Heron bay. The immediate contact with the granite was not found. A few hundred yards up stream the strike increases to 170°. About a mile above is the conglomerate noticed last year and striking 148°.

Eruptive Granite.

"One-quarter of a mile below the portage a small scrap of conglomerate was found striking 180° and containing pebbles of felsite and quartz porphyry. Apparently this boss of granite has come up through the schist conglomerate, dislocating a piece to the south and disturbing the strike of both.

"All the islands south of the Doré consist of conglomerate except the most south-

eastern one, where a small scrap of chlorite schist was found on the south side. On an island just to the north-east of this a dike of greenstone 20 feet wide has pierced the conglomerate, following the strike.

West of Gros Cap.

"On the mainland adjoining the conglomerate to the south is a chlorite schist. This is followed by a narrow band of quartz porphyry and this by an agglomerate rock. The same rock occurs just east of the wharf, where it is a compact green rock enclosing lenticular pieces which only appear distinct on the weathered surface.

Hematite Iron.

"South of the agglomerate on the west shore of Gros Cap is a band of chlorite schist which includes several narrow bands of quartzite. The extreme southwest of the cape is a diabase schist. Associated with the quartzites are considerable bodies of hematite and a number of test pits have been sunk on both sides of the cape. The most extensive workings were on the southeast coast, where the old dump may still be seen, although the trench is overgrown and the shaft filled with water. A description of the rocks was given by Macfarlane in his report of 1866 when operations were going on, and little can be added now when everything is overgrown with moss or covered by debris."

Early Workings at Gros Cap.

"The ore as found on the dump consists of compact hematite associated in layers with quartzite. A specimen analysed by Sterry Hunt[25] yielded:

Ferric oxide	86.80
Insoluble residue	12.75
Phosphorus	trace
Sulphur	.092
	99.642

Macfarlane gives the thickness of the ore bands as one-half to four or five inches, and the maximum thickness of the deposit at 60 feet. This was as he saw the early workings on the surface. Captain William Grierson, who sank a shaft to the depth of 64 feet (on the dip of the bed) in the winter of 1867 informed me that at the bottom the quartzite disappeared and that there was solid ore for the full width of the shaft, seven feet. No crosscut was made. Water came in the shaft and had to be baled out. All hoisting was done by hand. J. W. Johnston of Detroit was owner.

"The ore on the dump is all interbedded with quartzite, very little being solid hematite. The part of the bed which seems to have been worth working was about 25 feet wide. Two open cuts were made on the bed, each about 100 feet long, one near the level of the lake, the other a continuation of the first but higher up the hill. From the northern end of the upper cut the shaft was sunk. The vein bears about 135° and dips 45° to the southwest. On the continuation of this strike on the south side of Michipicoton bay I have noticed small seams of hematite in the schists, but evidently resulting from iron pyrites found accompanying them.

"Just northeast of the iron deposit is an irregular bed of sandstone a few inches wide enclosed in the chlorite schist. The sandstone is in places largely magnetite, in other spots a nearly pure sandstone and very friable. It has been so crushed and contorted that in places the chlorite schist seems to contain pebbles of sandstone unconnected with their neighbors. This crushed sandstone may be compared with that described by Dr. Coleman as occurring one mile west of Fort Frances. Some boulders from the conglomerate at the mouth of the Doré are exactly like this sandstone, and may have been derived from it. It is worthy of note that the sandstone is on the lake Superior side of the conglomerate, and is now dipping from it. The same chlorite schist encloses within a few hundred feet a bed of friable sandstone with magnetite and a bed of quartzite with hematite.

A Sandstone Band.

Gold Mines at Wawa Lake.

"One day was spent by Dr. Coleman and myself in a trip from Michipicoton Post to Wawa lake and some gold properties to the south of it. At the Jubilee Mine on locations 38 and 75 we found Mr. Douglas in charge for the Great Eagle Exploring Exploration and Development Co. The vein, which is a bedded [illegible] traced for a mile with a strike of

[25] Rep. Geol. Sur. 1866-9.

about 20°. The shaft was down 60 feet following the dip of the vein, that is about 45° east. According to Mr. Douglas the vein varies in width from 7½ to 10 feet. At the surface considerable free gold was found. Towards the bottom of the shaft some of the adjoining gneissoid rock becomes mixed with the quartz.

"The Diamond Jubilee mine is on location 92, a short distance southeast. Messrs. Tisdale and Boyd are owners. Considerable work has been done in stripping the veins, of which several have been found carrying free gold. Their surface workings were about at the level of a small lake, and to keep their prospecting pits dry it was found necessary to lower the level of the lake by blasting out the rocky barrier at its outlet. The veins are bedded in felsite or sericite schist, striking 25° and dipping 70° east. Eruptive gneiss occurs to the north and to the southeast of the workings. At the deepest pit, 12 or 14 feet, near the lake, the quartz looks quartzitic, is bluish white in color and carr es pyrite, pyrrhotite, chalcopyrite, a gray carbonate and free gold. An assay of a sample of this ore taken by ourselves gave 5.03 oz. per ton. To the south a vein of quartz occurs between granite on the west and chlorite schist on the east.

Diamond Jubilee Mine

"On the Ward property just south of this considerable prospecting has been done. Six openings have been made, the deepest being 15 feet, and some stripping has been done. The contact of the gray gneiss and green schist is well-shown on the long lake on which the camp is situated.

The Ward and Mackie Properties

"At the Mackie property on Wawa lake nothing has been done since the last report beyond the erection of two log houses. At Wawa city several frame buildings had been erected and others were being built.

Defining Rock Areas.

"On the map published last year the contact of the Laurentian and Huronian south of Wawa lake w[illegible]n excursion up the [illegible]er from the Michipi[illegible]er crossing a small band[illegible]a about a quarter of a mile in width, what appeared to be the main mass was met about one-quarter of a mile south of lake Leroy. The red granite at the second portage up the Magpie and the granite porphyries to the south of Wawa lake were thought to be later eruptives. It is now evident that the rocks southeast of Wawa are mainly granites or gneisses enclosing small scraps only of Huronian. It is moreover probable that the rock on the Magpie though differing in structure and composition belongs with these granites. This being so, the boundary of the two formations runs from the long portage of the Michipicoton to the second portage up the Magpie, and thence northeast along the axis of Wawa lake to a point west of Hawk lake. Included in this area, now transferred from the Huronian to the Laurentian, are a number of Huronian masses which were doubtless torn off from the main mass by the eruptive granite.

The Contact of Laurentian and Huronian Formations.

"One mile and a half south of the high falls of the Michipicoton a schist conglomerate was found a year ago. Apparently this is a continuation of the band met with on the Magpie nearly eight miles to the northwest. From here the band has been traced west for eight miles to the Doré, and from there a succession of scraps along the shore probably indicates its continuance for 11 miles to near the mouth of Dog river. Two miles up the latter stream it is found at Denison falls, a total length of 29 miles. For two-thirds of the distance an eruptive granite is in contact with the conglomerate."

Extent of the Schist Conglomerate Band

General Features of the North Shore.

Looked at as a whole the north shore of lake Superior from the Sault Ste. Marie to Peninsula impresses one by the magnificence of its scenery, often wild, rugged and mountainous; by the number and variety of its harbors, which are however generally small; by the multitude and picturesqueness of its islands; by the widespread ancient beaches, and by the general barrenness and desolation of the land.

Impressions of the Superior North Shore.

Leaving out perhaps 100 Indians, our cap ain estimated that on the whole shore line

of not less than 320 miles there are only about 350 people, of whom a large number are not permanent residents, but go to the "Soo" or elsewhere in the winter. If we commence the count at Point Mamainse, 45 miles from the Sault, we have only about 150 people scattered along a shore of 275 miles, and more than half of them are away in winter. Finally in the 70 miles from Ganley's harbor north of the eastern end of Michipicoton island to the mouth of Pic river there was not an inhabitant, white or red, when we passed up last summer. The men frequenting the shore at present are mainly fishermen in the employ of one or two large companies, their catch consisting chiefly of delicious whitefish and of salmon trout. The fish are taken partly in pound nets near the mouths of the rivers, and partly in gill nets set in fairly deep water in the open lake. Sayers, our captain, an experienced fisherman, says that nets are seldom set in water deeper than 100 fathoms (600 feet) because at a greater depth the cedar floats become water-soaked by the pressure and no longer keep the net upright. The fish caught at great depths are mainly very fat and large salmon trout. While the usual depth is between 10 and 100 fathoms, they sometimes, off Caribou island for instance, get one end of their net down even to 160 fathoms (960 feet). This is not far from the greatest recorded depth of soundings in lake Superior, 1,008 feet. Most of the rivers and inland lakes contain splendid trout, some of them true brook trout.

The Population and the Fishing Industry.

Northwest of Mamainse there is very little land suitable for cultivation so far as our observations go, though small areas may be found inland; and the only promising resources known are found in the water powers, the spruce forests and the copper and gold mines. The shore climate is generally cool, even in the warmest months demanding heavy clothing for comfort; owing to the vast body of cold water in the lake. Inland a few miles however the weather may be very hot even though hundreds of feet higher up. This difference is well shown in the ripening of wild fruit such as strawberries, blueberries and bilberries (or saskatoons) which we found very plentiful and quite ripe on July 23, 700 feet above the lake and 20 miles north of it; but still green on the hills at the mouth of the Pucaswa several days later. The coolness of the climate does not prevent the black flies, sandflies and mosquitoes from swarming in early and middle summer all along the shore.

Resources of the Mainland.

To one accustomed only to the wave action of comparatively small lakes, like Ontario, the power of the waves on exposed shores of lake Superior is very surprising. Boulders a foot in diameter are rolled by the waves up and down beaches which rise to a height of 20 feet above the normal water level, and are as beautifully rounded as the pebbles on lake Ontario beaches. The isolated islets and rugged stacks along the shores and the wave-cut caverns testify to the same thing.

The power of Wave Action.

The formation of well-rounded pebbles is very quickly performed in the case of soft rocks. Calcite fragments used in the cribwork protecting Silver Islet were found perfectly rounded ten years after the mine ceased working.

The elevated beaches so common on the north shore up to 300 or 400 feet above the present lake have their pebbles and boulders as well shaped as those on the beach of today. The question of these old lake levels will be discussed however in another section of the report.

On the whole the shores of lake Superior much resemble stormy sea coasts, the main difference being the absence of appreciable tides. Tides of a few inches magnitude do exist however, as well as irregular risings and fallings of the water (seiches) due to varying barometric pressure on different parts of the lake.

Near Michipicoton Post.

Development operations.

A short stay was made at Michipicoton Post on our return from the island of the same name; and the Collingwood skiff and its crew, after serving us well during the summer, returned to Sault Ste. Marie; while we made a brief examination of the Wawa gold region. As the geology of this region was partly worked out by Prof. Willmott last year and published in

his report on the Michipicoton Mining Division,[26] and has been further described by him in foregoing pages it is unnecessary to make further reference to it here. We found a considerable amount of building going on both near the Post on the river and at the new town on Wawa lake. A good deal of prospecting work also was being carried out on a number of properties ; but none of them had advanced far enough to be called mines. Several of them looked promising, but all require further development before their real value can be determined. British Columbia and the Klondike had attracted the attention of many away from the less dazzling prospects of a quartz mining region, but those who remained seemed hopeful and satisfied as to the prospects of the country around Wawa.

After visiting the mines we took the steamer Telegram at Little Gros Cap, to which a steam ferry now runs from the mouth of Michipicoton river, and returned to Sault Ste. Marie.

Thessalon District.

We now went by rail to Thessalon in order to complete the examination of the mines to the north of that town, and on the way spent a few hours examining the Huronian rocks along the railway between Bruce Mines and the harbor of Thessalon. A mile east of Bruce Mines we found a band of limestone, striking east and west and with a vertical dip. Half a mile beyond there was quartzite with pebbles of black chert, lying apparently horizontal; the latter rock, perhaps Upper Huronian, resting uncomformably on the upturned Lower Huronian. At Thessalon there are, as noted by Logan, amygdaloidal diabases belonging to the Huronian.

Huronian rocks along the Lake Shore.

Cheney Copper Mine.

From Thessalon we drove northeast about 20 miles to the Cheney copper mine on the Mississaga river. The road leads first over level plains of clay or silt, old lake deposits with good farming land, now pretty well cleared and cultivated. Then come hills with some rock exposed, especially Huronian quartzites and red syenite, followed by level terraces mainly of sand and gravel with rather light soil but fairly well settled. Finally a hill of slate conglomerate rising 490 feet above lake Huron must be ascended and then descended to reach the mine, which lies near a picturesque waterfall on the shore of the river. The road on the whole is very good, the mining company having spent $1,000 in putting the latter part of it in good shape.

On the Mississaga River.

It was known many years ago that copper ores existed up the Mississaga river, various localities where small outcrops occur being mentioned by Murray in the Geological Survey report for 1858[27] ; and the present location was taken up in 1864 by Mr. Borron, for a Mr. Ray of Indiana. It was then turned over to a Mr. Drake, who formed a company or syndicate to work the location. The members of the syndicate are mostly of New York State, and the property is held in the name of Mr. J. A. Powers of Lansingburg near Troy, N.Y., Mr. F. A. Cheney being managing director. The latter gentleman deserves our warmest thanks for the hospitality afforded us and for the information given as to the mine.

Extent of Development Work.

The earlier company had sunk an 84-foot shaft, but the present company, which took hold of the work more than a year ago, has straightened the shaft and sunk it to 168 feet, besides drifting at the first level 100 feet to the northwest and 20 feet to the southeast.

The vein was three feet wide on the surface, runs northwest and southeast through a country rock of slate conglomerate, and is said to have been traced 2¼ miles. It widens as it goes down and changes its dip from 5° to the northeast on the surface to about 20°. The foot wall is very distinct all the way down, but in the lower part the vein matter is much mixed with rock.

For the first 100 feet there was good ore, chiefly chalcocite (glance), at one point at that level forming a solid ore body as much as 40 inches wide. With the chalcocite a little bornite and copper pyrites are associa-

[26] Bur. Mines, 1897, pp. 184-206.

[27] Rep. Progress, 1858, p. 225.

ted. It is found that reddish or rusty quartz carries no ore, but that white quartz is productive. Unfortunately very little chalcocite has been found below the 100-foot level.

Between 65 and 73 feet in depth 8,037 lb. of glance was obtained by hand picking; and in all a car load of good ore, amounting to 20 tons and 400 lb., has been shipped east to the Orford company. The select ore runs from 22 to 40 per cent. of copper, the poorer ore not being treated at present. It was intended last fall to stope out and ship the rest of the rich ore disclosed above the 100-foot level. It costs $4.50 per ton to team the ore to the station, and $6 as freight to the east. If it should seem wise to put up a mill for the treatment of the ore there are fine falls on the river close by. The nearest, called the Baboon Falls, from the appearance of a baboon's head in the rocks, is close at hand and has a drop of 20 feet. Not far off there is an upper fall of 34 feet.

At the time of our visit 16 or 17 men were employed under Wm. Blewett as mining captain; and the buildings and equipment seemed adequate for the work on hand.

The Mississaga Placers.

Exploiting a Lake Terrace for Gold.

Some miles down the river from the Cheney copper mine there was an attempt at placer mining a year or two ago. On our way back to Thessalon, by round-about and bad roads, we visited the placer on Mr. James Ralph's farm, the south half of lot 3, con. 1, in Wells township. At this point a sand and gravel terrace is cut by the Mississaga river, showing a face of about 40 feet. Sluices had been arranged by Mr. Wilson of Toronto to wash the sands, a water supply being obtained from the hillside some hundreds of yards from the river. Near the foot of the cutting coarse brown sands cemented by brown oxide of iron were supposed to carry the largest quantity of gold. Samples of the yellowish sand above and of the brown cemented sand were taken with care, the amount making a number of pounds in all. Pan tests and also assays of both kinds of sand, made in the laboratories of the School of Practical Science, Toronto, yielded traces of gold, but only a few cents per ton. It seems very doubtful therefore if the placer ground will prove of value. If it should prove workable, the quantity of sand in this old beach deposit or terrace is very great, and might give rise to very important bench diggings.

It should be understood however that the sand and gravel deposits along all the rivers of the north shore of lakes Huron and Superior are lake deposits, many of them deltas, formed when the water stood at a higher level than now, and not ordinary river deposits. Most placer mines are on the gravels found in river valleys, ancient or modern. A few rather unimportant placers are sea-shore deposits; but few or none are known in true lake beaches.

So far as our information goes bed rock has never been reached on the Mississaga river, but whether this would prove any richer in gold than any other layer in an old lake deposit is doubtful.

Goulais Bay District.

Further study of the Huronian Rocks.

On August 11 Prof. Willmott and I set out for Goulais bay to complete our study of the Huronian rocks, while Messrs. George and Coulthard started for home, taking the Sudbury mining region on the way. Goulais bay may be reached by water, but there is no connection by road with the settlement inland along the river valley, so we decided to drive from the Sault Ste. Marie.

A Mountain Road to Goulais River.

The road leads west into the township of Korah, and then turns north till it reaches the river. The first five or six miles are excellent, largely over old lake terraces, the higher ones of gravel. On the northward part of the 20 miles journey, however, the country becomes mountainous and the road very stony and bad, the highest point as determined by aneroid being 800 feet above the Sault. The road climbs terrace after terrace, at first of clay, forming good farming land, now mostly occupied; then of sand and gravel; and at last crosses solid rock, more or less covered with boulder clay. Descending from the highest point one reverses the succession of terraces until the flat plain of Goulais river is reached. Here the soil seems fair though rather sandy, and a considerable number of farms are o

The rocks observed along the way are mostly Laurentian gneiss. The most comfortable stopping place in the settlement is at the house of Mr. McAu'ey, the postmaster, which is several miles north of the bridge crossing the crooked river, just at the southeast corner of Haviland township, between Goulais and Batchawana bays. A somewhat steep and stony road leads north and then northwest from this point to the settlement on the western side of Batchawana bay.

Formations on Goulais River.

The ground rises as terraces in McAuley's neighbourhood, affording level stretches of good but sometimes stony clay soil, now largely divided into farms and partly under cultivation. The rock observed here and to the north is Huronian, partly felsite in beds alternating with slate, partly Logan's slate conglomerate with eruptive masses of syenite or gneiss breaking through it. Some of the slate is very cleavable and might be of value for roofing.

King of the Mountains.

The highest point in the settlement, called rather absurdly the "King of all the Mountains," was ascended and found by aneroid to rise 1,320 feet above lake Superior, or 1920 above the sea. It was used as a triangulation station by the U. S. Hydrographic Survey, and remains of their tripod are still to be seen on its highest point. The rock of which it is composed is quartzite, the hardest and most resistant of the region. On the side fronting the settlement it is so steep as to be almost unscaleable, but a blazed path winding round behind the mountain top gives an easy ascent.

From the summit the view is very fine, more variety of surface being in sight than from Tip Top mountain, though the latter is about 200 feet higher. Some miles to the northeast one can see a mountain which looks distinctly higher than the King of all the Mountains, and it is possible that this may even surpass Tip Top in height. All round the peak there are forest covered hills with here and there bare slopes of rock, while in the valley the grass and grain fields about 1,000 feet below look like the squares of a checkerboard. The deep bays indenting this part of the shore of lake Superior show as splendid expanses of blue water.

The Settlement.

It was surprising to find so much cleared land in this isolated settlement, though much woodland still remains untouched. Grain of various kinds was ripening on August 12, and the crops looked well, though there is no object in raising more grain than can be consumed on the spot; since the terrible mountain road to the Sault prohibits teaming it out at a profit, and the lumbermen, on whom the settlement so largely depended in former days for its market, have practically finished their work in the region. The settlers are hoping to have a new Government road cut to the Sault, not only much shorter because more direct, but also avoiding the mountain now to be crossed. This would help them greatly in regard to markets, and would probably open up some fair land not yet settled upon. A road of about six or eight miles, cut to the landing place of the fishing station on the point west of Goulais bay, would also give them an outlet during the summer.

The forest of the region is mainly hardwood, such as maple and black birch on the drier and richer soils; and young apple trees in fruit at McAuley's looked very thrifty, showing that the climate is not bad. At present however the settlement depends mainly on its stock as a source of income. If the copper mines of Mamainse and Michipicoton island are developed with success there should be an excellent market for the people of the settlement almost at their very doors.

Pleistocene Geology.

A Feature of Terraces and Old Lake Beaches

The wonderful series of terraces and old lake beaches displayed in the region worked over last summer has attracted much attention from the days of Agassiz's journey to lake Superior to the present. The most extensive account of these old beaches is that of Dr. A. C. Lawson, published in the Report of the Geological Survey of Minnesota in 1893,[28] where he gives in detail the elevation of very many abandoned strands as determined by careful levelling. The precision of his determinations, usually given to fractions of a foot, is perhaps a little deceptive, since

[28] Geol. Sur. Minn., 20th Ann. Rep., p. 182, etc.

beaches and strand lines are quite variable things. The beach forming on the present shore of lake Superior varies as much as 15 or 20 feet in height, bays facing prevalent winds showing ridges of gravel and boulders, well rounded by wave action and free from any growth of lichen up to at least 20 feet. Nevertheless Lawson's work is of very great value.

The same strand lines with a few others observed by himself have been discussed by F. B. Taylor[29] in "Notes on the Abandoned Beaches of the North Coast of Lake Superior." He concludes that the beaches lying about 400 feet above lake Superior probably belong to lake Algonquin, and a lower series of beaches to Greater Lake Nipissing.

Lawson's table of elevations shows that the beach levels are very numerous, 32 or 33 in all. Our work during the past summer covered 21 points where good raised beaches were found, and wherever possible they were measured, mainly by aneroid, but in some cases with a hand level. The results have not the accuracy of Lawson's, but as two aneroids were generally read together and checked by lake level readings before and after the heights were determined, their results should be fairly correct. Where a number of readings were made the results given represent the averages.

Measurement of Elevations

With us as with Lawson beaches at relatively low levels were most often met, and were found to be so numerous as to present an almost continuous series. In many cases, especially where wave ridges were measured, it was found that there was a succession of ridges each a few feet lower than the previous one, often with 50 or more feet between the highest and lowest ridge. Such a succession of ridges must indicate a fairly gradual ascent of the land.

In the following sketch of the subject the localities will be taken up from southeast to northwest, the levels of the beaches being referred to the nearest great lake, Huron to the east and southeast of the Sault Ste. Marie, Superior to the northwest of that dividing point of the waters. As lake Superior is 602 feet above the sea and lake Huron 581, there is a difference of 21 feet between the two lakes, about 18 feet of the total fall occurring at the St. Mary's rapids.

Two sets of measurements, those at the southern end of the Georgian bay, stand by themselves, being 170 miles southeast of Thessalon, where the main series of measurements begins. From Thessalon onward the gaps between the series are usually not great.

[29] Am. Geol. vol. xx., Aug. 1897, p. 111, etc.

Beaches at the Southern End of Georgian Bay.

A number of old water levels were measured both at Owen Sound and Collingwood, but those at the latter point are all much higher than at the former. Three well defined terrraces were found at Owen Sound at heights of 18, 49 and 124 feet. They may be seen on both sides of the valley, and show no beach formation, being probably terraces cut by the river in a delta deposit. At 156 feet above lake Huron there is a ridge of coarse but well rounded gravel, probably a beach ridge.

Water Levels at Owen Sound and Collingwood.

The beaches near Collingwood are found at the foot or on the flanks of the Blue mountains, some miles inland. Between the bay and the foot of the escarpment there are three or four ridges, perhaps a beach formation, but possibly morainic. The presence of many scattered boulders in the fields is probably to be accounted for by lake action however, and it may be that closer scrutiny will disclose well defined beaches corresponding to those of Owen Sound. At the Kirkville mill stream one sees 20 feet of coarse stratified sand interbedded with fine silt, probably lacustrine deposit. An upper layer of the silt appears to have been crumpled by the grounding of ice floes.

The first undoubted beach is at the foot of the steep ascent of the mountain, 207 feet above the bay. There are less certain beaches at 288 and 468 feet respectively. The highest beach is 940 feet above lake Huron and is one of the best marked. A terrace large enough to contain several fields lies immediately below the sharp limestone cliff of the top of the mountain with a talus of great blocks tumbling down upon it. This cut terrace is well marked on the mountain flank

three or four miles to the south. Where we visited it the mountain top rises 113 feet higher than the terrace, and no doubt formed a large island in the vast body of water which cut the terrace. Spencer in his account of "High Level Shores in the Region of the Great Lakes" marks several isolated beach levels in the mountainous region south of Collingwood, three of them about 1,400 feet above sea level and one at 1,690 feet. The beach measured by us seems about intermediate, since our readings make it 1,521 feet above the sea. Our reading at the foot of the mountain, 788 feet above sea level, corresponds fairly with one of his beach lines, where a point 773 feet above the sea is indicated, a variation not too great in the shore deposits of a great lake[30]; but fits better with Taylor's determination[31] of the Algonquin beach at Barrie, about 780 feet above sea level. The higher beaches on the Blue mountains cannot at present be identified with any ancient lake or arm of the sea that has been described, unless they correspond to stages of lake Warren. The one 468 feet above lake Huron, or 1,049 feet above the sea, may fit into Spencer's highest or Ridgeway beach.

The comparatively low beaches at Owen Sound probably mark phases of Taylor's Nipissing water level.

Old Beaches near St. Mary's River.

Thessalon and Mississaga Terraces.

The next set of beaches examined runs from Thessalon and the country in its rear to Goulais river north of Sault Ste. Marie. Taking them up from east to west we shall commence with those near Thessalon. Going northward to the valley of Mississaga river four distinct water levels are encountered. The alluvial plain of clay north of the town stands 26 feet above lake Huron; and another level terrace of clay forming good farming land is found west of Little Rapids at 61 feet. The higher terraces are of sand aud gravel, one in the Mississaga valley forming a level sandy plain covered with farms, at 176 feet, and the highest of all 14 miles northeast of Thessalon, a terrace consisting of stratified sand and gravel rising 404 feet above lake Huron.

[30] Am. Jour. Sc., vol. XII., Mar., 1891, p. 202.
[31] Am. Geol., vol. XIV., Nov., 1894, p. 274.

North of Bruce Mines terraces are very numerous. One at Rydalbank forms a widespread clay with good farm land at 132 feet above lake Huron; the next is above Ottertail lake at 148 feet. The third in height consists of stratified sand rising to 191 feet; and the fourth of sand and gravel at 295 feet. There is a well marked gravel terrace at 375 feet; and a series of wave beaches forming a gravel ridge with well rounded pebbles and boulders culminates at 430 feet. There is another well marked terrace of the same materials, perhaps only the highest stage of the last one, at 453 feet above the lake 11 miles north of Bruce mines. The lowest terrace of all occurs below the Ophir mine about 20 miles north of Bruce Mines at 98 feet above the lake. It is well defined along the valley of a creek.

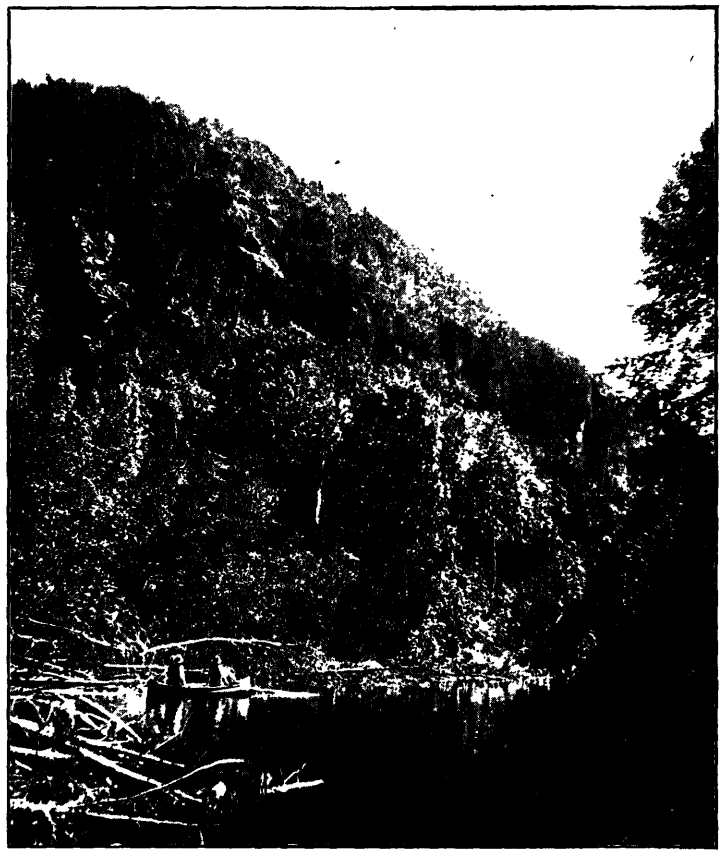
A single well marked terrace was examined on Sugar island in United States territory not far from Garden river, and was found to rise 142 feet above St. Mary's river, just before it enters lake George. Near Garden river to the northeast of the mission there are numerous terraces, but the weather on one of our days of work was unfortunate, the barometer varying rapidly. The highest terrace observed on that day probably reaches 435 feet. On another day atmospheric conditions were better and a series of lower terraces was examined, beginning with the sandy plain 22 feet above the river, on which the settlement stands. The section shown along the lower reaches of the river consists of sandy silt with fragments of wood and bark for eight feet, coarse brown sand forming the upper part of the bank. Other sandy and gravelly terraces rise 45 and 77 feet above the river, the latter one being an old beach. A group of rather ill defined terraces runs from 149 to 158 and probably 171 feet above the river; and there is a poorly marked terrace at 213 feet above lake Huron.

Terraces along St. Mary's River.

Near Sault Ste. Marie.

The Sault Ste. Marie is a most important nodal point in the great lakes, and its raised beaches have an unusual interest appreciated by several observers. Lawson has levelled a number of terraces, two within the town, the others to

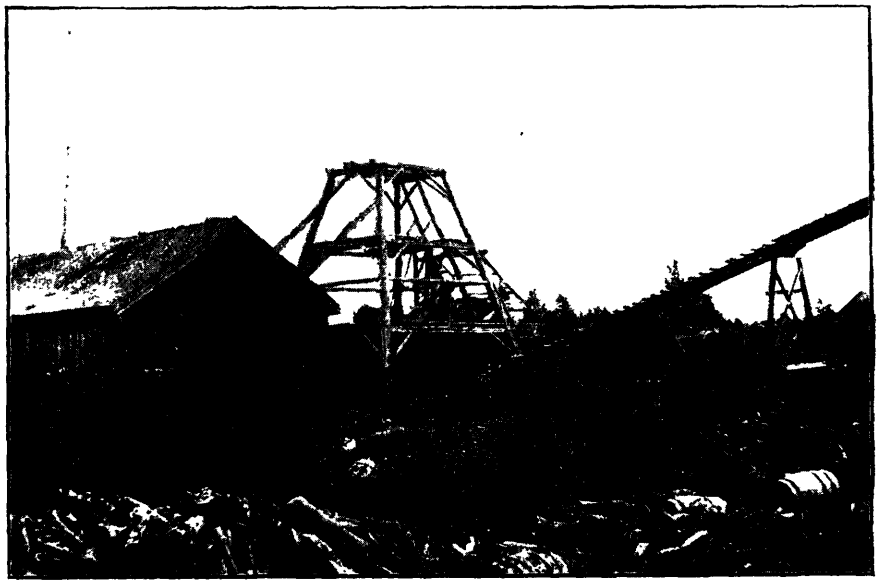
A long series of Raised Beaches.



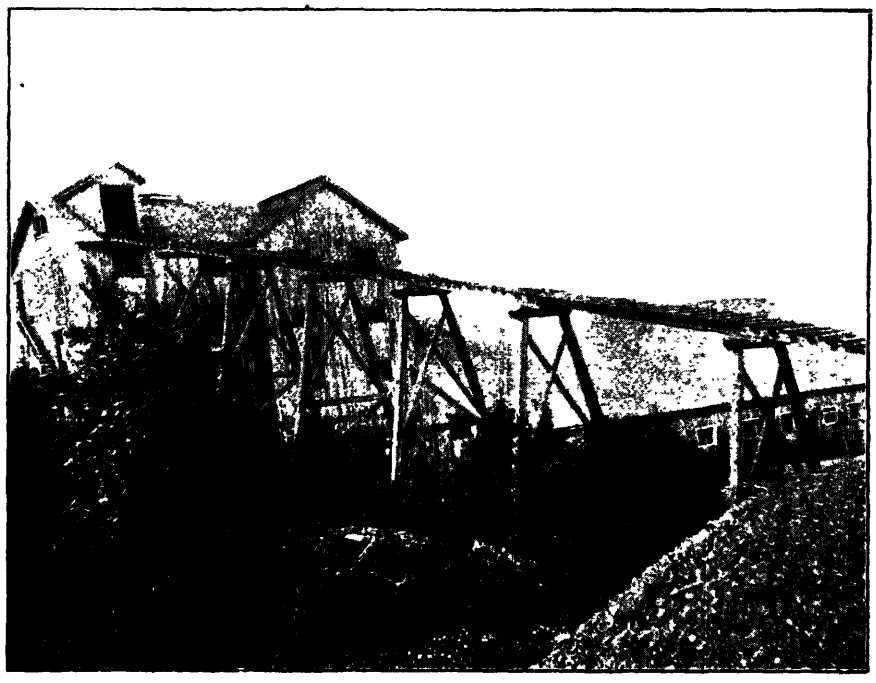
5 Cliff at north end of Echo Lake Murray's Green Chloritic Slate —Willmott



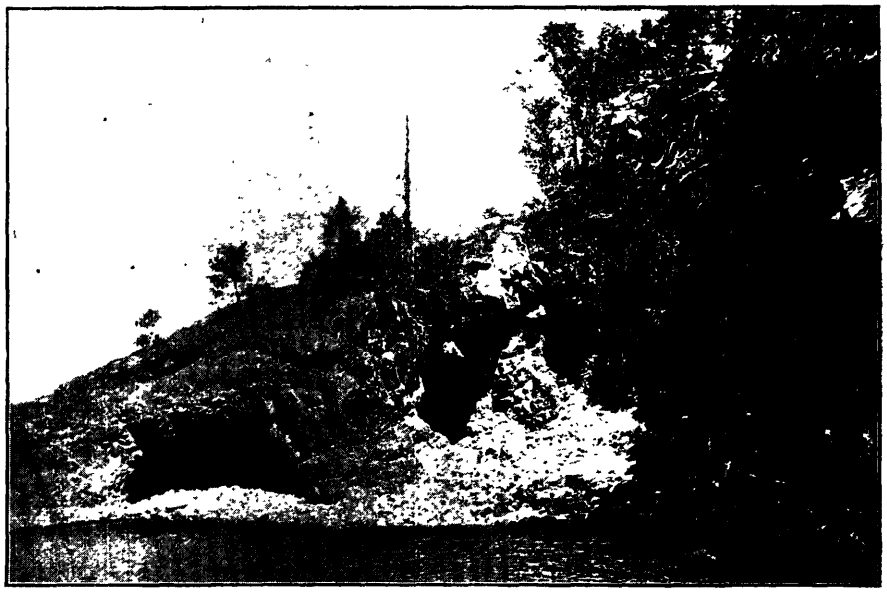
6 Cliff of Lower Slate Conglomerate on Echo Lake —Willmott



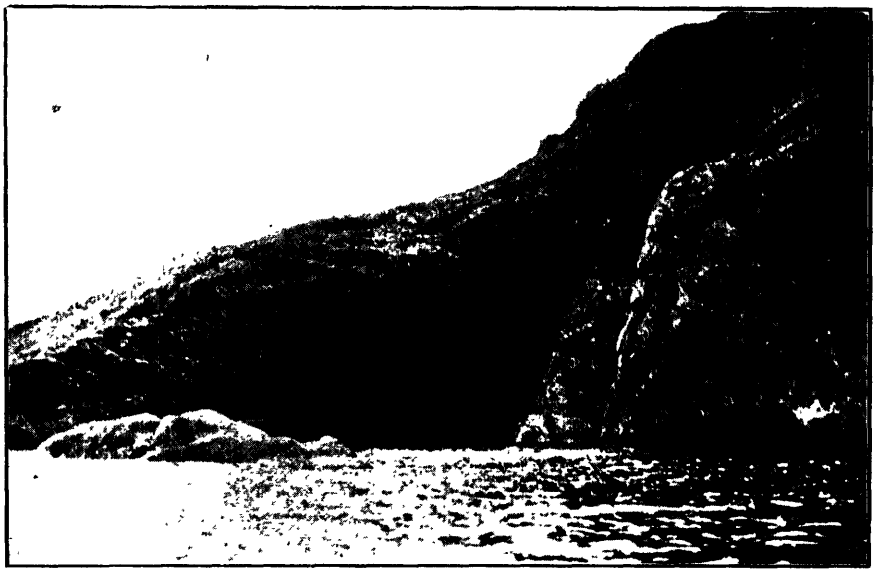
Shaft, Incline and Engine House at Mamainse, —Willmott.



Mamainse Copper Mill —Willmott



Caves in Amygdaloid at Roussain's, Lake Superior --Willmott



 Cave in Conglomerate, Granite overlying, north of Pointe aux Mines, Lake Superior Willmott

the north of it, rising at the highest point to 414 feet above lake Superior.[32] Our excursions in various directions north and northeast of the town gave opportunities for examining the terraces within 20 miles of the "Soo," but our results do not agree very well with Lawson's. We find a number more strands than he does, and some at distinctly higher levels, but only a few of our measurements fit with any precision the figures given by him. It must be remembered of course that the results of aneroid readings taken hours apart are not to be depended on within 10 feet, unless repeated a number of times with precautions as to changes of barometric pressure.

From Sault Ste Marie to Batchawana Bay.

Besides the two lower terraces in town there is a wide stretch of level clay land to the north, at about 90 feet above lake Superior or 110 feet above lake Huron, evidently an old lake deposit, apparently not referred to by Lawson. Four miles north of this in Tarentorus township he measured a great series of terraces, one at 311, another at 365 and several more between 400 and 414 feet, the latter shingle beaches. Our work northeast of the Soo, toward Ottertail lake and the Ophir mine, showed 18 or more strands, including a series of shingle beaches from 441 to 447 feet, perhaps identical with Lawson's upper series, though the difference of elevation is too great to be easily accounted for.

An excursion to Batchawana bay disclosed a similar set of beaches, first in climbing the mountain 800 feet high over which the road passes; then in descending the same towards Goulais river; and finally in ascending the height of land between Goulais river and Batchawana bay. Terraces were found at 39 and 57 feet, from 102 to 113 feet, at 136 feet, at about 190 feet, at 280 feet, at 304, between 327 and 379 feet, between 432 and 475 feet, and finally at 502 and 596 feet. The beaches between 432 and 475 feet were partly of rounded gravel, partly sandy terraces. They appear to stand about 30 feet higher near Batchawana bay than 15 miles south and nearer the Sault, though too much stress should not be laid on this where the determinations were by aneroid several hours away from the level of comparison. If the difference is real it indicates that this set of beaches has a quite rapid differential elevation towards the north.

[32] Geol. Nat. Hist. Sur. Minn., 20th Ann. Rep. p. 281.

Beaches on the Northeast Shore of Lake Superior.

Terraces from Gros Cap to Gargantua.

About 10 miles west of the Sault the fine promontory of Gros Cap rises where lake Superior opens out. The mountainous mass of rocks forming the cape protects two well marked sand terraces towards the east, at levels of 56 feet and 224 feet above the lake (determined by hand level). The higher one corresponds exactly to a beach measured by Lawson north of the Sault, but the lower one is a few feet higher than the main beach leveled by him in the town.

At Batchawana bay, along the river of the same name, two well marked terraces were measured at 25 and 104 feet respectively, the latter corresponding closely in height to a terrace south of Goulais river. At Mamainse 10 or 12 miles to the east Lawson indicates three beaches at levels above both of those just mentioned, his lowest being at 122 and his highest at 191; but we found two lower beaches with well rounded gravel at about 35 and 58 feet respectively, as well as a gravel beach with shore cliff 40 feet high at 184 feet, perhaps Lawson's highest. At Montreal river Lawson gives five beaches, the highest at 211.3, corresponding fairly with the highest measured by us (214). The lower ones on his list were not observed by us, perhaps because we kept to one side of the river only, but a stlll lower beach at 33 feet was found. At Sand river, a few miles north of Montreal river, Lawson mentions beaches at 75 and 118 feet, the latter not being well marked. Our observations probably extended farther inland, as we found well marked beaches at 72 feet, 144 feet and 234 feet, with well rounded pebbles at the lowest and highest beaches. The one at 234 feet has a distinct cut bank in the rear, and ascending this one finds a flat wooded plain, probably another terrace, 257 feet above the lake. None of these terraces except the lowest one seems to correspond to levels found at Montreal river. At Gargantua, ten miles to the northwest, a well

defined beach of rounded boulders was found at 72 feet; but no higher ones, although a neighboring hill rising 431 feet above lake Superior was ascended.

Terraces at Michipicoton.

Between Michipicoton Post and Wawa lake, at the foot of the deep Michipicoton bay, a fine series of beaches is crossed by the portage road connecting the two points. We measured eight fairly distinct ones and noted numerous minor beach lines between. The same series was measured last year by Prof. Willmott with accordant results for the lower terraces, but some differences for the higher ones [33] We found terraces on sand plains at 38, 75, 83 and 99 feet within a mile of the landing on Michipicoton river, the two upper ones being practically the same as Prof. Willmott's (84 and 100 feet). A fifth level at 136 may represent his third at 145; and a sixth at 240 his fourth plain at 224. Wawa lake stands at the level of a wide sandy plain 352 feet above lake Superior (328 Willmott), but is dammed by a terrace rising 20 feet above it. Another terrace rises to the north of Wawa lake to a height of 70 feet above its surface, according to Prof. Willmott, or 420 feet above lake Superior. Prof. Willmott finds a still higher beach (441 feet) near Whitefish lake to the north.

Terraces at Dog River.

A magnificent set of terraces may be seen from the lake along the mountainous shore near Dog river about 15 miles west of Michipicoton Post. These were measured by Lawson, who gives seven elevations ranging from 16.5 to 323.4 feet above the lake. Our measurements were made at a point where the lower terraces have been cut away by the present lake, so that the lowest reading of a distinct terrace is 119 feet, though several indistinct stages may be seen a few feet below, probably representing Lawson's level at 100.7. Another set of readings gives 252 feet (Lawson's 255.4) with several less distinct beach ridges below. Our highest level is 360 feet, with numerous ill-defined ridges beneath. It is probable that Lawson's measurements were made somewhat farther east, where the lower series appears to be more complete.

Measurements on Pucaswa and Swallow Rivers.

Lawson measured no beaches between Dog river and Jackfish, a distance of over 80 miles in a straight line towards the northwest, and we saw no high level terraces except at Pucaswa river. Along this river three terraces were measured at 99, 150 and 271 feet respectively, but with only one aneroid and a single reading each. More doubtful ones were found at about 430, 610 and 645 feet, near its headwaters. Beautiful examples of low level beaches consisting of well rounded but lichen-covered stones occur two or three miles west of Pucaswa, rising 16 and 42 feet above the water, but evidently forming a continuous series with the present beach, whose highest level of rounded boulders still uncovered with lichen stands six feet above the lake. At Swallow river ten miles northwest quite similar beaches rise 45, 54 and 63 feet above the water, with round lichen-covered stones. They are apparently quite recent, since no bushes nor other vegetation except lichens have obtained a foothold. They represent perhaps Taylor's Nipissing beach, or possibly his Sault beach. [34]

It is rather singular that no distinct high level terraces are to be seen on this part of the shore, since the valleys between the mountains seem as suitable to receive them as those to the east or those to the northwest. Excursions to high inland points near Swallow river and Spruce harbor disclosed nothing of the kind.

Beaches on Michipocoton Island.

A very interesting group of beaches is to be found in the western end of Michipocoton island, both on the north and on the south sides, easily examined on the road leading over the hills from the Quebec mine to Quebec harbor. There are several fairly distinct sets of gravel beaches, each having a number of ridges below the highest one. The lowest one is from 15 to 22 feet above the water and is marked by a fine sea cave whose floor is at the lower level. Next come indistinct beach lines running up to 65 feet above the lake, where a terrace affords space for several houses. Above this there are faint stages culminating at 78 feet, and then apparently a gap until

[33] Bur. Mines, Ont., 1897, p. 193.

[34] Am. Geol. vol. xx., Aug. 1897, p. 127.

128 feet, when fairly distinct wave lines begin and run up to 178 feet. At 204 feet there is a well marked gravel beach, perhaps just the highest stage of the last series; and at this level on the south side of the divide a lake is found, probably dammed by a beach deposit. Above this there is a wide terrace occupied by a farm, its highest point being 233 feet. There is a lake at this level also. The highest terrace observed reaches 295 feet. The terrace lying somewhat above the 400-foot level, found at so many points to the east and southeast, was not observed, but may yet be found among the higher hills of the island, which were not explored. A comparison of the series of beaches just given and those of Dog river 35 miles to the northeast, as measured by Lawson, shows comparatively few points of agreement, the only exact one being the level of the lowest beach in each, 15 and 16½ feet respectively. Whether there has been differential elevation, placing the beaches at Dog river higher than the corresponding beaches at Michipocoton island is hard to determine, particularly when one recalls that almost all of these beaches are composite and have a range of a number of feet.

Results of Observations.

The results of our observations summed up in the accompanying table giving 20 sets of beach levels near St. Mary's river and along the coast of lake Superior for 120 miles towards the northwest show a great number of slightly different levels. One may pass from the present lake shore up to beaches 475 feet above it with a succession of steps at one point or another, never exceeding 10 feet at a time; while the difference in level between the top of a storm beach at the present day and the subaqueous terrace of a delta now

Level of Raised Beaches (on L. Huron and L. Superior) above L. Superior.

Above L. Superior 0.	Swallow R.	Kilkenny.	Pucaswa R.	Michipocoton Island.	Dog R.	Michipocoton Post.	Gargantua.	Sand R.	Agiwa R.	Montreal R.	Mamainse R.	Batchawana R.	N. of Goulais R.	S. of Goulais R.	N. W. of Soo.	Gros Cap.	N. of Soo.	Garden R.	Sugar Island.	Bruce Mines.	Thessalon.	Collingwood.	Owen Sound.
		6		15								25					14				5		—3
		16		to22														23					
50	45	42				38				33	35	35			39		44				40		28
	54										58			57		56		56					
	63			65		75	72	72															
				to78		83														77			
100			99			99											89						
									111			104		102						111			103
					119									113					121				
				128					126									128		127			
						136									136			137					135
150			150					144										150			155		
				to																			
																				170			
200				178							184			187	191		185	192				186	
				204						214						224							
				233				234									229						
250						240											244						
					252			257													267		
			271																	274			
300				295									285		277								
															304								
350													333				327						
					360	352								362						354			
400						372											379				383		
						*420								432				*435		409			
																	441			432			
450			*430												442		447					447	
													463										
													475										
500																							
			610?												502								
			645?												596							919	

* About.

forming on lake Superior would certainly be more than 10 feet, and probably not less than 15. It must of course be remembered that heights determined by aneroid, particularly when the readings are two or three hours distant in time from the level with which they are compared, are not certain within the limits of a few feet.

Turning to Lawson's 48 feet precisely leveled beaches as given in his table of the terraces and beaches on the north side of lake Superior, the same peculiarity is evident.[35] The levels ascend to 260 feet without a gap greater than 14 feet, and in most cases by stages of less than ten feet. Lawson himself assumes that there may be a difference of level of 15 feet in different parts of the same beach, but then proceeds to group the abandoned strands in 33 sets, the levels of each set varying among themselves less than 13 feet. However in a number of these groups of levels the highest of one group approaches very closely to the lowest of the next above, and it seems doubtful if most of his horizontal strand lines are to be looked on as produced by sharply distinct stages of the water. It seems more probable that the change was on the whole a very gradual one, with few well marked halts in the fall of the water.

With regard to differential elevation toward the northeast the evidence is indeterminate. There is no well defined shore like the Iroquois beach around lake Ontario on which one may drive for a hundred miles, and so determine with precision the differences of elevation; and the usual occurrence of several wave-built ridges each three or four feet higher than the last one makes the comparison of one set with the next ten miles off very difficult.

An attempt has been made to distinguish the beaches representing Taylors's Algonquin, Nipissing and Sault water levels, but with little success on the whole. Probably the beaches running from 432 to 475 feet in the neighborhood of the Soo correspond to the Algonquin beach, though they seem somewhat too high, but the correlation of the others would be largely guesswork.

[35] Geol. Nat. Hist. Sur. Minn., 20th Ann. Rep. for 1891, p. 289.

Glacial Geology.

Owing to the immense amount of wave erosion along all the shores examined, often up to a height of 450 feet or more, the sheet of till which originally covered much of the region has largely been removed to be redeposited as stratified clay in the lower terraces; or else has been buried out of sight by lacustrine deposits. Typical boulder clay is generally to be seen however in valleys or sheltered spots above the beach lines; as, for instance, on the ridge 800 feet high crossed by the road from the Sault to Goulais river, and the similar ridge forming the water shed between Goulais river and Batchawana bay. At these points one sees stony till, sometimes with rough morainic shapes. Near Day's Mills, on the main road towards Thessalon, which lies some miles to the west, a very stony morainic ridge occurs, and has in part been worked over by wave action, all the finer materials being removed at the level of an old beach.

Erosion of the Till on the Shore Lines

Pebbles of the Glacial Drift.

The materials left by the ice include an immense variety of rock species, largely from neighboring localities; such as the splendid boulders of jasper conglomerate at Bruce Mines, evidently derived from the Huronian just to the north. The only rock undoubtedly brought from a distance is limestone, often accompanied by chert. Pebbles and small boulders of this rock were found at a number of points among the beach gravels, but nowhere south or east of Doré river. As many of these pebbles are fossiliferous a collection of the best specimens was made in order to determine the age of the rock, and if possible its source. The fossils were given to Mr. B. E. Walker of Toronto for determination, and his kindness in working over the material, most of which was fragmentary and badly preserved, is much appreciated.

Rock Materials

Determination of Fossils

Mr. Walker finds Atrypa reticularis, Favosites Emmonsi, Rominger, fragments of cyathophylloid corals, of stromato-poroids, a small pebble of a syringostroma, and a fragment of clathrodictyon, apparently C. laxum, Nicholson; forms belonging mainly or wholly

to the Devonian. The favosites is Upper Helderberg or Corniferous, while atrypa may be either Upper Silurian or Devonian,

Some limestone and chert pebbles were obtained also in the railway gravel pit east of Peninsula, and another pit west of Bremner. In the latter case there were many white limestone pebbles.

Source of Devonian Pebbles.

The source of these Devonian pebbles is probably the area of Devonian limestone near James bay, the nearest point of which as mapped by Dr. Bell is only 150 miles away in a direction about N 20° E, five degrees more to the eastward than the average direction of the striæ. Dr. Bell found similar pebbles in the drift to the north and east [36], and Logan found Devonian pebbles near Pic island.[37]

Glacial Striæ.

Records of Polished and Striated Rocks.

Glacially polished and striated surfaces are numerous, and many directions of striæ were noted by Murray on his map of the original Huronian region; the average of 38 readings being S. 15° W., two-thirds of them lying between S. 12° W. and S. 25° W. He notes one set of striæ running south and two running east of south (S. 2° E. and S. 30° E.), both in the Goulais Bay region. In our own work few observations of striæ were noted, as Murray had covered the ground so well, and only two need be mentioned. Near the summit of Tip Top mountain, seven miles east of Spruce harbor, striæ were found about 1,500 feet above lake Superior with a direction of S. 50° W.; and a point of quartzite on the east side of Echo lake was found to be splendidly polished and striated in more than one direction, in some cases with chatter cracks. The latest and strongest striæ run S. 70° W.; another set though somewhat variable are quite distinct and run S. 40° W.; while a few others point S. 55° W. The directions noted by Murray are S. 55° E. and S. 70° E. on the south side of Echo lake. The latter body of water is enclosed by precipitous hills almost deserving the name of mountains, and the chief direction of striæ corresponds to the direction of the shore, having been made perhaps during the retreat after the last advance of the ice, when the mass was no longer thick enough to over-ride local obstructions and so conformed in its movements to the direction of the deeper valleys.

At Rydalbank also, a few miles north of Bruce Mines, two sets of striæ were observed, an older one S. 20° W., and a later one presenting only a few striæ crossing the others with the direction S. 45° W.

[36] Geo. Sur. Can., 1870-71, p. 349. [37] Ibid. 1866-69, p. 353.

The Original Huronian Area.

As rocks generally called Huronian furnish most of the ore deposits of Ontario, the question of the character of the Huronian rocks and their relationship to the Laurentian is one of much importance, not only to the man of science, but also to all who are interested in the development of our mineral resources.

Logan's Huronian Region.

The Huronian area first described and carefully mapped by Sir William Logan and his assistant Murray extends along the northeast shore of lake Huron from Blind river almost to Sault Ste. Marie, another smaller area being shown between Goulais and Batchawana bays on the southeast corner of lake Superior. Laurentian rocks are represented as separating the two, but the interior of the country is left a blank. Later explorations by Bell and others connect these two areas and extend them as a broad band to the Sudbury region on the northeast.

The region was first examined by Logan and his assistant in 1848, a short report on the North Shore of Lake Huron being published the following year giving a preliminary sketch of the geology. Logan's attention was turned to the region on account of the copper mines then being opened up near Bruce Mines.[38]

The work begun by Logan was carried on by Murray in 1857 and 1858, the results with uncolored maps and sections being published in the reports of the Survey for those years. In the large report of 1863 Logan's views as to the Huronian are summed up and the results of his and Murray's work published with an excellant map which, though on too small a scale, was the most detailed map of any Canadian Huronian region up to

[38] Geol. Sur. Can., 1849.

the time of Dr. Lawson's work on the Lake of the Woods. Since Logan and Murray's time Irving[39] and Van Hise[40] have visited some of the typical localities and described critical points in order to correlate the corresponding series of rocks to the south and west of lake Superior. The Winchells also have visited the region and published descriptions of portions of it.[41]

Other Huronian Areas

While Logan and Murray's chief work was done in the region near St. Mary's river, they also examined areas which Logan describes as of the same age in various other parts of Canada, particularly near Doré river west of Michipicoton, and lake Temiscaming on the boundary between Ontario and Quebec. In fact in the account of the Huronian in the Geology of Canada, 1863, Logan begins with the Temiscaming rocks, goes on to the Doré section and ends with the original Huronian region. That he considered the three as of equivalent age is evident.

Rocks of the Thessalon Trough.

Measurement of the Series.

Logan's study of the Huronian, or Lower Copper-bearing series, began at Bruce Mines, but Murray followed up the work in various other parts of the region, especially along the lakes and rivers, tracing out in particular the easily recognized bands of limestone. He finds a rather complex series of faults intersecting the series, which are also thrown into two rather gentle folds with a dip ranging from 0° to 45° in a section worked out in the Thessalon trough. The series of rocks near Thessalon is given by Logan in ascending scale as follows :

1.	Gray quartzite	500 feet.
2.	Greenish slates	2,000 "
3.	White quartzite	1,000 "
4.	Slate conglomerate	1,280 "
5.	Limestone	300 "
6.	Slate conglomerate	3,000 "
7.	Red quartzite	2,300 "
8.	Red jasper conglomerate	2,150 "
9.	White quartzite	2,970 "
10.	Yellowish chert and limestone	400 "
11.	White quartzite	1,500 "
12.	Yellowish chert and impure limestone	200 "
13.	White quartzite	400 "
		18,000

[39] U.S. Geol. Sur., 7th Ann. Rep., "Classificationof the Early Cambrian and Pre-Cambrian Formations," R. D. Irving.

[40] Ibid., 16th Ann. Rep. "Principles of North American Pre-Cambrian Geology," C. R. Van Hise.

[41] 16th Ann. Rep. Geol. and Nat. Hist. Sur. Minn., 1887.

In addition there are overflows of greenstone, dikes of the same rock and eruptive bosses and dikes of granite.

Huronian and Keewatin compared

The series of rocks here presented is so widely different from the rocks usually classed with the Huronian in western Ontario that one readily understands why Lawson gave the western series a distinct name, the Keewatin, and doubted whether the two series are of the same age. It is proposed to describe briefly the various rocks of the series as examined by us last summer, comparing them with the so-called Huronian rocks of the Rainy lake region and drawing some inferences as to the conditions of the time and the relations of the Huronian to the Keewatin and Laurentian.

It will be convenient to take up the series in the reverse order, starting with the latest, and ending with the earliest.

White Quartzite, Chert and Limestone.

Logan's No. 13 and 12, white quartzite and yellowish chert and limestone, we did not see ; but similar rocks, probably No. 11 and 10, occur on the south side of Ottertail lake where the exposures are not very good. Besides the white quartzite there is a band of brownish rock looking like felsite, probably arkose, since under the microscope one finds all the customary minerals of granite. The thin section might easily be taken for a microgranite but for the rounded particles of quartz with a faint dusty margin suggesting a clastic origin. Impure limestone with brown chert occurs near the southeast corner of the lake.

No. 9, white quartzite, shows much better than the limestone just to the north of Ottertail lake, as might be expected from its more durable character. Good examples may be found near the south end of Great Lake George also. They are clearly granular though well cemented, and look quite different from any western quartzites or the friable sandstone of the Couchiching near Fort Frances. They are usually quite free from darker ingredients, and almost as white as marble.

Jasper Conglomerate.

The famous jasper conglomerate (No. 8) attracts the eye instantly with its blood red jasper pebbles and black pebbles of chert in a white ground mass of quartzite. Looking more closely, pebbles

of white quartz are seen also. The jaspers have not the oolitic look often found in the jaspers of the iron bearing rocks west of lake Superior. They are very unequally distributed, and but for their brilliant color would be neglected in naming the rock, since the portions sprinkled with them form really very subordinate parts of the rock and merge on all sides into ordinary quartzites, or quartzite conglomerates with white pebbles only. These rocks are fairly well displayed a few miles north of Rydalbank on the road between Ottertail and Rock lakes. The best example seen by us is one not shown on Logan's map, on the northern shore of Trout lake, a small body of water two or three miles north of Echo lake ; and they are found also a mile or two farther north on the pond called Iron lake. On Trout lake the band is 300 or 400 yards wide, strikes about 140° and dips about 35° to the northeast. It is probably part of a band lying roughly parallel to the one shown by Logan as running from Great Lake George past Rock lake to a point not far from Thessalon ; and may represent the same bed of rock on the north side of an anticline.

Red Quartzite

The red quartzite (No. 7) is really arkose, consisting of rounded grains of quartz, weathered grains of various felspars, dusty interstitial particles and sometimes iron oxides. Good examples occur just west of Rock lake and also three or four miles west of Campement d'Ours. This rock, where studied by us near Rock lake, passes by gradations into jasper conglomerate and sometimes contains jasper pebbles, which are however not very conspicuous in their setting of brownish red sandstone.

Upper Slate Conglomerate.

After passing Rock lake on the road north from Bruce Mines to the Ophir mine, Logan's upper slate conglomerate (No. 6) appears, rising as a steep hill. Parts of it contain few or no pebbles but other parts are more or less crowded with large well rounded boulders, mostly of red granite, less often of gneiss. The same rock may be studied on the southern shores of Echo lake, where greenish quartzite is seen first, and afterwards what may be called graywacke conglomerate, in general a fine grained gray rock with light and dark colors curiously mingled, in which large and small pebbles of red granite are common. Dark gray green pebbles coarser in grain than the matrix also occur, and a mass of quartzite with irregular outlines was seen partly enclosing a granite boulder. Paler greenish parts of the matrix seemed to be enclosed with bands of darker green, showing a grain like that of wood about a knot. One small pebble of red jasper and a pebble of buff limestone were found. It is probable that this graywacke conglomerate obtained part of its materials from the massively developed conglomerate of a similar kind not far to the north. The pebble of limestone probably indicates an interval of erosion after the consolidation of the next member of the series. Pebbles of limestone are more commonly found in the same band of graywacke-conglomerate north of Garden river, as reported by Van Hise.[42]

The Limestone Band.

One of the most interesting rocks in the whole series is No. 6, which consists of limestone. On Echo lake it forms two promontories on opposite sides of the lake, as if it withstood weathering better than the other rocks of the shore. Approaching it on the western shore one sees first greenish slate containing a few granite boulders intricately interfolded with brownish gray limestone, as if they had been interstratified. Turning the point there is a shore of wonderfully contorted limestone, "exhibiting on a small scale a beautiful representation of almost all the accidents that occur in stratification," to quote Sir Wm. Logan.

On weathered surfaces shaly bands stand out as darker colored ribs. In the middle of the band there is a conglomerate of small flat, but rounded, limestone pebbles in a limestone matrix, well seen on the weathered rock, but almost invisible on fresh surfaces. Some of the pebbles suggest shells, though clearly not of organic origin. In thin sections the rock proves to be a fine grained, fairly pure calcite with a few dusty looking strips of darker color, where black particles and tiny grains of quartz show themselves.

[42] Pre-Cambrian Geol., p. 777.

Several narrow dikes of diabase and one of amygdaloid cross the limestone.

The limestone band shows the contortions seen when a softer rock is squeezed and folded between bands of harder rock, so that the dip is not easily determined. The prevalent dip seems to be about 20° towards the south.

The quarry at Garden river presents a fine exposure of the same limestone, but there the dip is 70° or 80° towards the south. A similar band of limestone, classed on Logan's map with the ones just described, occurs near the Wellington mine, and is crossed by the railway at mile 142, a mile east of the Bruce Mines station. Here it contains flat black pebbles of slate, and has apparently a vertical dip.

In general these limestones are not very crystalline, and might be paralleled by many limestones of far later age. The limestones of Steep Rock lake above Rainy lake are very like them, both on the large scale and under the microscope.

Another band of rather less pure limestone occurs on the east shore of Echo lake, some distance to the northeast of the band shown on the map. The impurities are mixed more thoroughly through the rock and do not stand out as prominent ribs on weathered surfaces.

Lower Slate Conglomerates.

The lower slate conglomerate (No. 4) is seen to fine advantage north of the main limestone band on Echo lake, where it rises 500 feet as a steep cliff, with a talus of large blocks beneath. It is a graywacke conglomerate with some quartzite. The pebbles and boulders are very unequally distributed and consist of granite, felsite, quartzite and greenstone, no limestone or jasper being found. On the map the same conglomerate is shown along the shore at Bruce Mines. About three miles west of that village several finely glaciated "whaleback" islets display splendid sections of this rock with well rounded boulders, mainly of red granite in a dark green ground mass. Some of the boulders are three feet in diameter. Graywacke conglomerates of the type described under No. 4 are common farther northeast in the same great Huronian band, and may be seen in the Wahnapitae gold region near Sudbury. Parts of them are very like parts of the Shoal lake conglomerate of the Rainy lake Keewatin, though in general the Shoal lake rock is much more schistose.

White Quartzite No. 3.

Subdivision No. 3, white quartzite, is mapped as occurring along the shore between Bruce Mines and the peninsula west of Thessalon, and then as stretching some miles to the northeast till cut off by a fault. The point of the shore east of Bruce Mines consists of red quartzite or arkose, but the rest of the shore was not examined by us. Where the band is crossed by the railway as it approaches Thessalon from the west gray quartzite is found ($\frac{1}{4}$ mile east of mile 140) with some black chert pebbles as well as pebbles of white quartz and a few of jasper. At this point the beds seem to be horizontal, though the limestone band two miles to the west appeared to be vertical. East of mile 140 as far as mile 135 red quartzite is the main rock seen, often cut by large dikes of diabase. It contains red felspar and a few chert pebbles, and the bedding seems to be generally horizontal, though variations of dip from 0° to 45° occur. This subdivision is wanting north of Echo lake, the green slate coming in immediately after the lower slate conglomerate

Green Chlorite Slate.

No. 2, green chlorite slate, is mapped as a band running northeast of Thessalon to a line of fault, and also at the north end of Echo lake. At the latter point it rises as a splendid cliff, with what appears to be nearly horizontal bedding. The rock is a very cleavable gray green slate or phyllite, consisting of chlorite with some calcite (or dolomite) and angular particles of quartz with a few grains of magnetite. None of the rutile needles characteristic of most slates can be seen in a thin section. There are Keewatin slaty rocks of an exactly similar kind in the Lake of the Woods region.

The rocks mapped as of the same age near Thessalon are apparently all more or less altered basic eruptives or ash rocks. A dark green sausuritic rock with lighter parts of material richer in epidote presents various phases of crush conglomerates and agglomerates. In other parts little structure is to be seen, and in still others, e.g., at a point in Thessalon harbor, there are very distinct

beds of amygdaloid, generally thin and separated by beds of weathered diabase without the amygdaloidal structure. The amygdules are of darker green than the rest of the rock, and are filled with serpentine. These amygdaloids must have been successive flows of lava. No rocks of the sort have been described from the western Keewatin.

Gray Quartzite, Logan's No. 1.

The last subdivision (No. 1) recognised by Logan is mapped as forming a narrow band just beneath the green slate and between it and the Laurentian, starting at the shore three or four miles east of Thessalon and running in a northeasterly direction till cut off by the great fault to the north. He describes it as "gray quartzite, thin bedded in some parts; the thickness very doubtful"; and puts the thickness at 500 feet. We coasted somewhat carefully along that part of the shore and also crossed the strike of the band on the railway to the north, but saw no rock corresponding to the description. However a thickness of only 500 feet might be covered with drift and pass unnoticed. What we did observe was a basal conglomerate, overlooked by Logan, but well described by Irving[43] and Van Hise.[44] As this is a crucial point in reference to the relation of the Huronian to the Laurentian, we studied it with considerable care. A shoal of small islands along this part of the shore gives excellent exposures, making it the more surprising that Logan and Murray, usually so keen-eyed, should have overlooked them.

A Water-formed Rock older than Logan's No 1

The rock may be described as a graywacke conglomerate, in which the cement is dark gray and rather coarse, containing grains of quartz and felspar; while the pebbles and boulders are very unequally distributed, as in most graywacke conglomerates. The pebbles and boulders are mainly of granite and gneiss, evidently derived from the underlying Laurentian. In addition there are felsites or quartz porphyries and a few darker pebbles belonging to the hornblendic masses enclosed in the Laurentian. Very rarely one finds a small pebble of red jasper. The last point has some importance, as showing that this conglomerate is not the lowest of all sedimentary rocks. The inference drawn by Van Hise from the jaspers in the red jasper conglomerate of the Upper Huronian, that these are derived from the red jaspers associated with certain parts of the Lower Huronian[45] will apply here also. If jasper is necessarily Huronian the basal conglomerate near Thessalon represents the base of the Huronian at that point only; and in other regions Huronian rocks of an earlier age are to be found.

In order to study the contact at a fresh point we walked east from Thessalon along the railway and found it rising as rounded hills in a swamp south of the track about half way between mile posts 127 and 128. The graywacke conglomerate here presents the same character as on the shore, and is crowded with large and small boulders of gneiss and granite like the Laurentian rocks to be seen beneath it.

A hill lying about half a mile north of the road between Sault Ste. Marie and Garden river presents perhaps the same contact; but the evidence does not seem to me clear, since the conglomerate or rather breccia consists wholly of granitic material and is possibly a crush conglomerate formed by faulting instead of a water-formed rock.

The contact of Laurentian and Huronian was looked for north of Garden river in territory unmapped by Logan; but owing to the widespread lake deposits it was not to be seen. The first rock met after passing the "slate conglomerate" hill lying north of the Garden river limestone band is reddish gneiss or granite and a gray gneissoid rock penetrated by granite dikes, the whole no doubt Laurentian.

The eruptive rocks associated with the Huronian are considered by Logan to be partly contemporaneous flows, and so to be reckoned in with the general series, and partly later eruptives penetrating the Huronian. The large mass of greenstone in which the copper veins are found at Bruce Mines, Logan thinks to be an interstratified bed, and he speculates as to its

Eruptive Rocks in the Huronian.

[43] U. S. Geol. Sur., 7th Ann. Rep., p. 429, etc., with several full page illustrations.

[44] Pre-Cambrian Geology, p. 777.

[45] Pre-Cambrian Geology, p. 778.

thickness and the depth to which the veins may be followed in it as country rock.[46]

Our observations do not bear out this theory. On a point less than a mile east of the mine, and on an island just beyond, we found an eruptive contact of exactly similar diabase with red quartzite, many dikes of diabase branching off from the main mass into the quartzite, at times crossing it in parallel sheets with much regularity as if interstratified, at others cutting it irregularly. The Bruce Mines diabase, which is quarried and shipped to Cleveland as road metal, contains a little quartz as a micropegmatitic intergrowth with the plagioclase; and the same was found to be true of the striking hill rising a mile inland from the head of Great Lake George; so that quartz diabase seems to be the prevalent type. It is not certain that any of the diabase masses seen by us are surface flows, all the evidence observed being to the contrary. That there were contemporary lava flows and volcanic activity is however proved by the successive amygdaloid beds at Thessalon with their accompanying beds of ash rock and agglomerate.

Eruptive masses of granite penetrate the Huronian, as observed by different geologists who have visited the region, but none of them were particularly studied by us. In appearance there seems little or no difference between them and the eruptive granites of the Laurentian, though the large number of granite boulders in the graywacke conglomerates proves that granite was a very important constituent of the Laurentian before the Huronian was deposited.

Components of the Rocks.

Source of the materials of Huronian Rocks.

An interesting set of problems is presented in regard to the source of the materials of the typical Huronian rocks. Except at the small section east of Thessalon, where the basal conglomerate overlies the Laurentian and is made up of the rocks at hand, it is not at all easy to suggest an origin for them. If we sum up the various rocks of Logan's section, placing gray and white quartzite and jasper conglomerate together as having essentially the same composition, we have five main series, of which rocks formed mostly of quartz make up 8,520 feet; graywacke conglomerate, containing a good deal of quartz with some basic material as well as many granite boulders, forms 4,280 feet; red quartzite, largely arkose or crushed granite or gneiss, reaches 2,300 feet in thickness; slate, really phyllite or a chloritic slate, 2,000 feet; and limestone with chert 900 feet. When it is remembered that the Laurentian so far as known in the region contains no quartzite and few quartz veins, the origin of the many cubic miles of nearly pure quartz in the 8,520 feet of quartzite is not easy to find. If derived from granite and gneiss, at least four times the bulk of these rocks must have been ground up and the clayey and other materials removed. The 2,300 feet of red quartzite or arkose and the 4,280 feet of graywacke conglomerate with the more or less numerous boulders may be conceived to have come rather directly from the Laurentian. The 2,000 feet of chlorite slate or schist may represent the more basic and finer grained materials of the granites ground up to form the quartzite. The materials for the 900 feet of limestone could only be supplied by some of the basic silicates, such as anorthite or labradorite; for crystalline limestone has never been reported from the Laurentian of the region.

Suggestiveness of the Jasper and Chert Pebbles.

The most puzzling components of these rocks are however the pebbles of jasper and chert. While they occur especially in the 2,150 feet of jasper conglomerate, they are found to a greater or less degree right at the base of the series. We found numerous chert pebbles and some of jasper in Logan's white quartzite, No. 3, and a few red jaspers turned up in the basal conglomerate east of Thessalon, the lowest of all. Now jasper and chert or Lydian stone are unknown in the Laurentian. They are well known as members of the Animikie, classed by some American geologists as Lower Huronian. Both the jasper and the chert are found elsewhere as stratified sedimentary beds of the Huronian, but not in the Keewatin. The jasper pebbles though not of great importance as to bulk are present often in large

[46] Geol. Sur. Can., Report on North Shore Lake Huron, 1849, p. 45.

numbers and are very widely spread. Logan maps them as a continuous band 26 miles long, and adds another small area beyond, giving a total length of distribution of nearly 50 miles, and they are found more or less across a width of 15 miles.

The most probable source of these pebbles is some area of jasper like that west of lake Superior, but now completely removed, or lost to sight beneath one of the great lakes. Whatever the source of the jasper, these pebbles prove the presence of a non-Laurentian rock in considerable quantities before the earliest bed of the typical Huronian was laid down. The typical Huronian is therefore not the earliest sedimentary rock, nor is it the next rock in succession after the Laurentian.

The Laurentian of the Region.

Areas of Laurentian in the Region.

The Laurentian of the region was studied at various points with some care, particularly east of Thessalon where it rises from under the Huronian basal conglomerate. On the islands four miles east of Thessalon the Laurentian consists of red granite and granitoid gneiss of the usual type. In both rocks there are large angular fragments of a dark gray hornblendic rock just like the hornblendic schist often found on Rainy lake, where there is an eruptive contact of the Laurentian gneiss with a basic Keewatin schist. In that region on finding such inclusions one would expect to find the solid green schist shortly after. A thin section of a specimen of the schist inclusions shows the rock to be a quartz-hornblende schist with a little orthoclase very similar to some Keewatin schists near the Laurentian contact.

Along the "Soo" line railway at mile 127, just east of the basal conglomerate, typical, well-foliated Laurentian gneiss is found, once more containing many angular inclusions of green schist; and from mile 123 to Dayton wide bands of fine-grained gray schist very like Keewatin or Couchiching rocks occur in the gneiss, the latter making an eruptive contact. At some points granite erupts through both. If these rocks were found on the Lake of the Woods or Rainy lake there would be no hesitation in assigning them to the Keewatin.

North of Garden river, near the Victoria mine, Laurentian gneiss penetrated by granite dikes and enclosing masses of green schist occurs, but part of the green schistose rock appears to be a sheared dike of greenstone, and so may be later than Laurentian.

The Laurentian to the west of the typical Huronian region may be seen on the road across the mountains from Sault Ste. Marie to the Goulais River settlement, where a gray gneiss, often greatly contorted, contains strips or larger fragments of green schist resembling the Keewatin.

Huronian Areas on Lake Superior.

Besides the original and typical region of Huronian rocks north of lake Huron, there are a number of areas along the eastern and northern shores of lake Superior which have usually been classed and described as members of the same series. These latter have been studied by us with the object of comparing them with Logan's original Huronian on lake Huron and Lawson's Keewatin on Rainy lake.

The Goulais—Batchawana Contacts.

Between Goulais Bay and Batchawana Bay.

Logan maps an area of Huronian between Goulais and Batchawana bays near the southeastern end of lake Superior, coloring it chiefly as upper slate conglomerate, though a small patch of jasper conglomerate is shown on Goulais bay. We spent three or four days in the region, mainly examining the contact of the Laurentian and Huronian. Passing north from Goulais river by a road leading over a pass to Batchawana bay one finds quite a variety of Huronian rocks. At a school house south of McAuley's post office a steep hill consists of beds of felsite alternating with very cleavable slate, both having only a gentle dip. At McAuley's itself the rock is characteristic slate conglomerate. Two or three miles southeast of McAuley's the highest point in the region is found to consist of white quartzite, which apparently overlies slate showing a well defined cleavage nearly at right angles to the equally well-marked bedding.[47] The quartzite rises to a

[47] Geol. Sur. Can., 1863-66, p. 127. Macfarlane briefly describes the Huronian rocks near Goulais bay and mentions quartzite.

height of more than 1,300 feet above the lake and must be several hundred feet thick.

Half a mile north of McAuley's, as one ascends the pass, felsite schist is observed with a strike nearly north and south and a dip of about 45° to the east. On the steep wooded hillside to the left of the road, coarse syenite gneiss is found in contact with a felsitic rock, probably the same as that seen along the road. The gneiss is not markedly foliated, but seems to strike about 60°. It encloses large masses of felsite and also green schist resembling the Keewatin. The felsite schist just referred to looks very like certain Upper Keewatin rocks of the west, and is not mentioned by Logan as belonging to the typical Huronian. Its exact relation to the graywacke conglomerate at McAuley's was not clear, the intervening ground being drift-covered. The gneissoid rock is clearly eruptive as regards felsitic and also chloritic schists; the latter may however be of earlier age than the main mass of Huronian, and may correspond to the Keewatin-like bands observed in Laurentian gneiss east of Thessalon.

North of Great Gros Cap.

Part of the shore to the north of Great Gros Cap was carefully coasted so as to examine the area mapped there as Laurentian. Rounding the point, which is formed of red Keweenawan porphyry and diabase of unknown age, one finds coarse red granite or syenite, sending dikes into a foliated hornblendic rock, in some places forming a giant breccia. Still farther north, well-foliated gneiss shows on the cliffs and encloses dark lenticular inclusions. The gneiss here dips 40° to 70° to the west. Beyond this the shore consists of low, flat-lying St. Mary sandstone.

At Batchawana Bay.

On Batchawana bay much of the shore near the mouth is of sandstone, but going farther in on the southeastern shore slate conglomerate is found, the sparse pebbles being chiefly granite, though greenstone and quartzite also occur. Bosses of red granite penetrate it. Not far from this, as observed by Professor Willmott, a band of porphyritic granitoid gneiss cuts across the slate conglomerate eruptively, perhaps the band mapped by Logan as syenite. "The gneiss holds angular inclusions of basic schists, the whole closely resembling the Keewatin contacts of the Lake of the Woods." Similar coarse red porphyritic gneiss appears at a point on the east side of the bay, and there includes green schistose hornblendic rocks, the gneiss showing a rough fluidal structure enclosing the greenstone masses.

On the north shore of the bay a patch of Huronian conglomerate consisting of boulders of granite, cemented by a greenish matrix, rests against the southern flank of a range of Laurentian hills. The Laurentian is a coarse, slightly porphyritic, gray gneiss. Just south of the conglomerate there is a black slaty rock with some quartzitic bands. The contact looks eruptive, and the boulders of the conglomerate as far as observed do not resemble the adjoining gneiss; while at one point the rock at the contact is slaty, not conglomerate. The rock exposures here are however not clear enough to give absolute evidence.

A Laurentian Habit apparent.

On the whole the results of our examination of the Goulais-Batchawana Huronian contacts suggest that the Laurentian here has an eruptive relationship to the Huronian. As the supposed Laurentian gneiss has not been studied on a large scale, however, it is possible that the rocks referred to that group might be described by another observer as foliated granites later than both the Laurentian and Huronian. The fact that large bands and angular inclusions of basic schist closely like the western Keewatin are included in gneissoid rocks of Laurentian habit cannot however be disputed. A clear example of a typical Huronian rock, such as a quartzite, a jasper conglomerate, or a graywacke conglomerate, being enclosed eruptively in Laurentian gneiss has not been observed by us in the region; though three cases have been found of what appear to be eruptive contacts between Laurentian-looking gneissoid rocks and rocks that appear to be true Huronian, one near McAuley's, another on the south side of Batchawana bay and the third on the north side.

The Huronian of Dore River.

Logan found several areas of Huronian on the north shore of lake Superior and pays spec-

ial attention to the rocks of Doré (or Pickerel) river, five miles west of the mouth of Michipicoton river. He gives an elaborate section of the slate conglomerates which occur there, describing them in detail up to a thickness of 1,700 feet; the rest of the series, in all several thousand feet, being too much covered with trees and moss to examine satisfactorily.[48] We employed two or three days in the study of the Doré section, which is a continuation of the Huronian rocks of the Wawa lake gold district. The rock on the shore so carefully described by Logan is a characteristic schist conglomerate such as could be matched at many points in the Keewatin of Shoal lake or Lake of the Woods. The boulders observed are granites most frequently, then quartzites or sandstones with pebbles generally small, next green schists, then felsite schist and porphyroids, and finally a few gneisses, but none of the Laurentian type. In many cases the softer pebbles are greatly flattened and even bent around their harder neighbors. The most interesting of the boulders, or rather pebbles, for they are not often large, are the quartzites or sandstones. They are usually white, but sometimes yellow or brown, are fine grained and often so soft as to be pulverulent. Some of the smaller ones are nearly black and are probably the chert-like pebbles mentioned by Logan. Precisely similar pebbles occur in the Keewatin conglomerate of Shoal lake near Rainy lake; and the parent rock must have been such a sandstone as that of the Couchiching near Fort Frances. It is interesting to note that Professor Willmott found bands of such sandstone two or three miles to the east on Little Gros Cap, near a deposit of iron ore. Very seldom a boulder of conglomerate occurs, the ones examined having the look of schist conglomerates. They are well rounded and somewhat flattened, like many other of the boulders adjoining. Two specimens collected may be described. One is six inches long by two inches in thickness, and consists of pebbles of felsite or felsite schist, yellowish to greenish in color, imbedded in a darker paste containing some smaller rounded fragments of the same rock. It seems to be a water-formed conglomerate, not an autoclastic rock. The other boulder when complete was about a foot long, but less than two inches thick, once well rounded but now rolled out somewhat flat. It consists of small pebbles of the bluish or white sandstone mentioned above, and of glassy quartz with a small amount of chlorite schist as cement.

Features of the Dore River Section

The sandstones are distinctly stratified rocks, under the microscope often but not always showing a structure of grains having brownish or dusty partings from one another. Dark colored ones contain many black particles attracted by the magnet. A few scales of green chlorite are scattered through the quartz. One thin section contains a considerable amount of a carbonate. The other varieties of rock occuring as boulders do not require a particular description.

Off the shore from the mouth of Doré river are a few small islands of the same conglomerate. Including these, we made the width of the band of conglomerate about 2500 feet by micrometer. As the dip ranges from 70° to 90°, the thickness of the band is not very much less, so that the 1700 feet given by Logan may be increased by more than a third.

Doré river is very difficult to navigate from the succession of falls and flat rapids which it forms as it approaches lake Superior and was ascended about two miles only. The conglomerates continue along the crooked river for 2,200 feet, and allowing for curves this gives about 650 feet in addition; so that the whole thickness of conglomerate cannot be less than 3,000 feet. Beyond this the rocks observed are mainly felsite schist with some green schist interbedded and a little very fine grained gray gneiss at one point, all having a strike about east and west or parallel to that of the schist conglomerate, and a nearly vertical dip, the lowest inclination observed being 75° to the south. The distance across the strike examined by us was about 1¼ miles inland from the conglomerate. The rocks found can all be matched in the western Keewatin, none of them having any similarity to the typical Laurentian. The gneissoid rock mentioned is very like some of the Rainy Lake Couchiching. The felsite

[48] Geol. of Can., 1863, pp. 53-54. See also Macfarlane, ibid. 1863-66, p. 127.

schist here described probably represents the "reddish yellow felspathic layers" of Logan; which caused him to say that "towards the lower part it assumes more the character of the gneiss which usually succeeds it." Neither Logan nor ourselves examined the inland boundary of the Huronian.

Extent of the Dore Conglomerate Band.

As shown in an earlier part of this report, Prof. Willmott has followed the Doré conglomerate four miles east, almost to the peninsula of Little Gros Cap, with practically the same strike as at Doré, and in the gold region several miles farther to the east he has found areas of schist conglomerate which probably form a continuation of the Doré band. About a mile west of the river the schist conglomerate is penetrated by masses of diabase and greatly crumpled, the pebbles being rolled out thin, and fragments enclosed in the eruptive rock show vague outlines fading into the diabase as if partly fused. Beyond this point felsite breaks through the conglomerate, disturbing its strike and making the pebbles almost indistinguishable. Still beyond these is red granite, perhaps the parent mass of the intrusive felsites. Farther west along the shore large masses of schist conglomerate were seen enclosed in the granite, one containing a boulder of actinolite schist three by one and a half feet in dimensions. The largest mass of conglomerate is about 50 by 100 feet.

At Denison falls, near the mouth of Dog river, schist conglomerate again occurs, having a strike of 140° and dip of 80° to the east. These rocks have a more felsitic matrix than those at Doré however, and may not represent the same band.[49]

Conglomerate is found again near Eagle river and between Pilot harbor and Pucaswa river, in the latter instance running as a narrow band for 1½ miles along shore, the rock inland being felsite or porphyrite. It is not improbable that originally a band of conglomerate extended along the whole shore from Michipicoton river to a point east of Pucaswa river, a distance of at least 45 miles. The conglomerates being softer than the felsite schists have been eaten away on many parts of the shore, and are interrupted also by eruptive masses of granite and diabase.

The general band of Huronian comes to an end at Otter cove, ten miles beyond the last observed outcrop of conglomerate. The gneiss apparently forms an eruptive contact with the Huronian near Otter head, but there are masses and dikes of granite penetrating both rocks more or less at that point, making the inference somewhat uncertain. No basal conglomerate was found.

Relativity of the Conglomerate.

It is worthy of attention that the Doré conglomerate, like that of Shoal lake, is not basal as regards the Laurentian. It is some thousands of feet above the base of the series of schists in which it is found, and contains no boulders that are distinctly Laurentian, only rocks belonging to the schists generally called Huronian and the eruptives often found in them.

The Doré conglomerate has been somewhat fully described, because it presents a perfect parallel with the Keewatin schist conglomerate of Shoal lake in the west, is like it in every way so far as general appearance, lithology and the steeply tilted position of the bedding are concerned, and yet is unhesitatingly placed in the Huronian by Logan. If this area is Huronian, as asserted by the founder of the system, it is hard to see why the western Keewatin should not also be included.

It must be admitted that the Doré rocks have on the whole a more ancient look than the typical Huronian north of the lake of the same name, and present very few points of similarity to them either from the stratigraphical or the lithological side. There are no jasper conglomerates, graywacke conglomerates nor limestones among them, and the schists which they present are more thoroughly crystalline than any in the original Huronian unless perhaps the chlorite "slate" near the base of that series. On the other hand some of the Doré schists are very like examples of the dark schists enclosed as bands or angular fragments in the Laurentian gneiss underlying the basal conglomerate of the Huronian east of Thessalon.

[49] The Dog River conglomerate is referred to in the Bulletin of Denison Univ., vol. 2-4, p. 123.

It seems tolerably certain that Logan included in his Huronian two series of rocks of quite different ages, the Huronian of lake Huron being probably much younger than the rocks so named on lake Superior. This conclusion is in agreement with Lawson's view, in accordance with which he gave the name Keewatin to the Lake of the Woods schist,[50] and compared them with the Doré rocks, distinguishing the latter from the original Huronian.

Schists of Heron Bay.

On the Shores of Heron Bay.

Another large area of schists mapped by Bell as Huronian, but not described by Logan, occurs 35 miles to the northwest around Heron bay, where the Canadian Pacific railway first touches lake Superior. Two days were devoted to a study of these rocks on the shores of the bay and along the railway to the west between Huron bay and Peninsula.[51] These rocks are first met at the point turning northward from Pic river to Heron bay, where they consist of green schist and felsite schist with variable strike and dip, probably from the influence of the adjoining eruptive gneiss or granite which sends dikes into them. Rounding the point one finds schist conglomerate with a strike of 110° to 120° and a nearly vertical dip. These rocks are greatly sheared, so that the forms of the pebbles are almost indistinguishable except where lapped by the waves. A little way off they look very gneissoid. The conglomerate contains pebbles and boulders of all sizes up to blocks two feet long, mainly reddish or yellow granite or quartz diorite or porphyry, and green and dark gray basic rocks and schists. The matrix is generally dark green and more easily weathered than the boulders. In most cases the pebbles are considerably rolled out, and in parts they show only as bands of slightly varying color, or turn to felsite schists in which no pebble can be seen.

The strike and dip vary greatly, the former from 60° to 120° with an average of about east and west; and the latter from 40° or in one place 30° to the north to verticality. The breadth across the strike is about four miles, from the point turning towards the mouth of the Pic to the railway station; and the distance followed along the strike is about 2½ miles. Going towards Peninsula the schist conglomerate is followed by green-gray, very fissile slate or phyllite, then a band of felsite schist with faint traces of flattened pebbles, then a band of dark gray slaty rock, a series of hard green agglomerates and near the Peninsula gravel pit by a large eruptive area. All the schistose rocks have dips running from 45° to the north to vertical. They are however a good deal disturbed by dikes of both acid and basic rocks. Whether the slates are lower or higher in the scale than the schist conglomerate was not settled. The unusual width of the conglomerate beds is worthy of remark. It may result however from close folding and not represent a continuous sequence of beds. The schistosity conforms in general to the bedding as shown by the bands of more numerous and less numerous pebbles. The rocks just described conform to the Keewatin rather than the typical Huronian type.

Impressions as to the true Sequence of Archæan Formations.

The general impression left by our summer's work in the region is that Logan has included two series of rocks of very different ages in his Huronian; that the series on lake Huron, the most carefully studied and the only one mapped in detail, is of later age than the Doré rocks and probably also than the western Keewatin (or Ontarian); and that in the typical Huronian region the Keewatin is probably represented by the bands and fragments of green and gray schists enclosed in the Laurentian gneiss and granite. If these impressions are correct the true succession in time is Keewatin, Laurentian, Huronian; the term Laurentian being confined to the areas of granite and granitoid gneiss corresponding to the Ottawa gneiss of eastern Canada, and having eruptive relations with the Keewatin. The suggestion just made implies an immense lapse of time between the Keewatin and also the Laurentian and the overlying Huronian. The gap between the Keewatin and the Huronian was long enough to permit of the Laurentian

[50] Geol. Sur. Can., 1885, cc.

[51] Geol. Sur. Can., 1870-71, p. 328. Bell mentions "slate conglomerate" with dark green trap as the rocks east of the mouth of Pic river, but does not describe them.

gneiss erupting through the Keewatin rocks, and throwing them into closely folded synclines ; after which the granite and gneiss consolidated at great depths and the whole mountainous region was carved down to a peneplain. On this the basal conglomerate of the typical Huronian was deposited.

The basal complex recognized everywhere as underlying the ordinary sedimentary rocks is considered by us to consist of two very distinct groups of rocks of quite different ages, the older one mainly of basic green schists but including also immense beds of schist conglomerate, the later one consisting mainly of moderately acid eruptives.

The Keweenawan Series.

Characteristics of the Series

In the field covered by last summer's work the Keweenawan, Logan's Upper Copper-bearing series, includes many basic eruptives such as diabase and amygdaloids, some acid eruptives such as quartz porphyry, quartzless porphyry and felsite, and also sedimentary rocks such as sandstone, shale and conglomerate ; in fact, most of the rocks described by Irving as occurring in the Keweenawan of the United States.[52] One variety of conglomerate, basal and made up chiefly of the underlying Laurentian rocks, has apparently not been found south or west of lake Superior, though not uncommon on the northeast shore. As a very full list of authorities on these rocks is given by Irving it will be unnecessary to refer to them in detail here. The northeast shore Keweenawan has been described more or less fully by Logan,[53] Dawson and Macfarlane and needs no lengthy account.

Localities of the Keweenawan on Lake Superior.

Following up the shore from Sault Ste. Marie, rocks of this age are first seen at Gros Cap, where red quartz porphyry rises through the Laurentian, interesting from the fact that it has carried up in its eruption fragments of coarse quartzite, no doubt belonging to some Huronian bed beneath. Round the point a patch of typical amygdaloid rests against the foot of the Laurentian mass ; and the same rock occurs at three points on the east side of Batchawana bay. The area at the northeast of this bay seems to be considerable, a range of hills of amygdaloid running east and west for some distance. At one point a small patch of green amygdaloid is seen to form a breccia, ramifying among the granite blocks at the point of contact.

Next comes the large area of Mamainse, so fully described by various writers because of the copper mines located upon it. Amygdaloids occur once more on the north side of Pointe aux Mines, and connected with them a basal conglomerate or breccia containing large boulders of gneiss or granite forming the bottom of the series.

Beyond this for some distance no large stretches of Keweenawan are found, but that these rocks once occupied the region and probably still exist beneath the lake is shown by occasional patches of the basal conglomerate filling old chasms of the Laurentian. As their greenish cement is soft, the conglomerates are more readily acted on by waves than the Laurentian rocks around, and the Keeweenawan shore line is being restored by the waters of the lake, the ancient boulders being set once more rolling after their long rest.

To the south of Gargantua there are curious red shaly rocks with numerous cavities almost like amygdaloidal openings, and at the extremity of the cape amygdaloids resting directly on gneiss without the usual basal conglomerate.

Beyond this, undoubted Keweenawan rocks were found only at two points, between Pilot harbor and Pucaswa, nearly north of Michipicoton island ; and at Swallow river about 15 miles northwest ; in both cases remnants of basal conglomerate preserved by having been deposited between Laurentian walls in narrow ravines. Each of them shows a brownish-purple ground mass more or less crowded with granite and less often diabase pebbles.

It is probable that many of the very numerous diabase dikes to be found all along this shore are really of Keweenawan age,

[52] Copper Bearing Rocks of L. Sup., U. S. Geol. Sur., 1883.

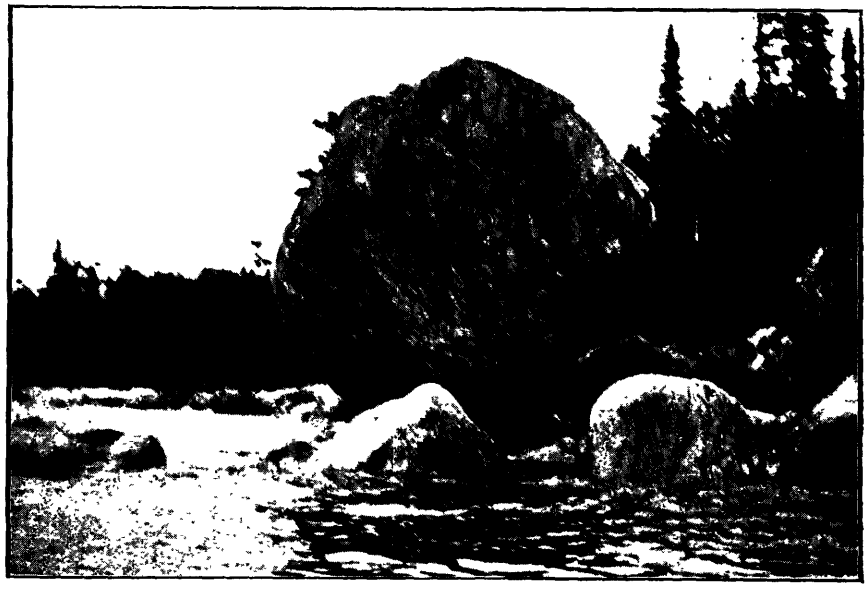
[53] Geol. Can., p. 67, etc., Logan ; Can. Nat. and Geol., vol. II., 1857, p. 1-12, Dawson ; Geol. Sur. Can., 1866, 115-143 ; Can. Nat. and Geol., 1866-8 (2), vol. III., pp. 177-202 and 241-257 ; and also 1879 (2), vol. IX., pp. 91-102, Macfarlane.



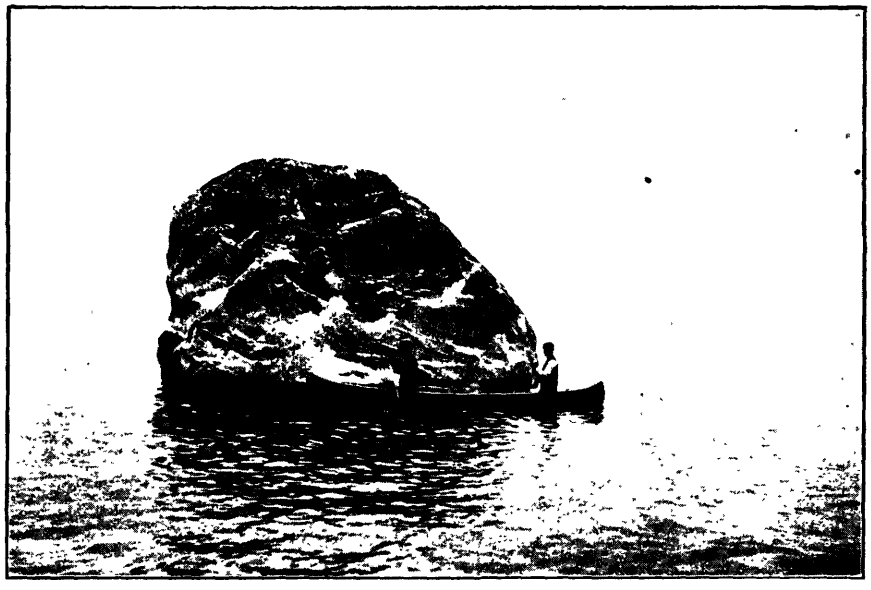
Cliff north of Pointe aux Mines, Lake Superior —Willmott.



9 Eroded Keweenawan Conglomerate, one mile north of Point Mamainse, Lake Superior —Willmott



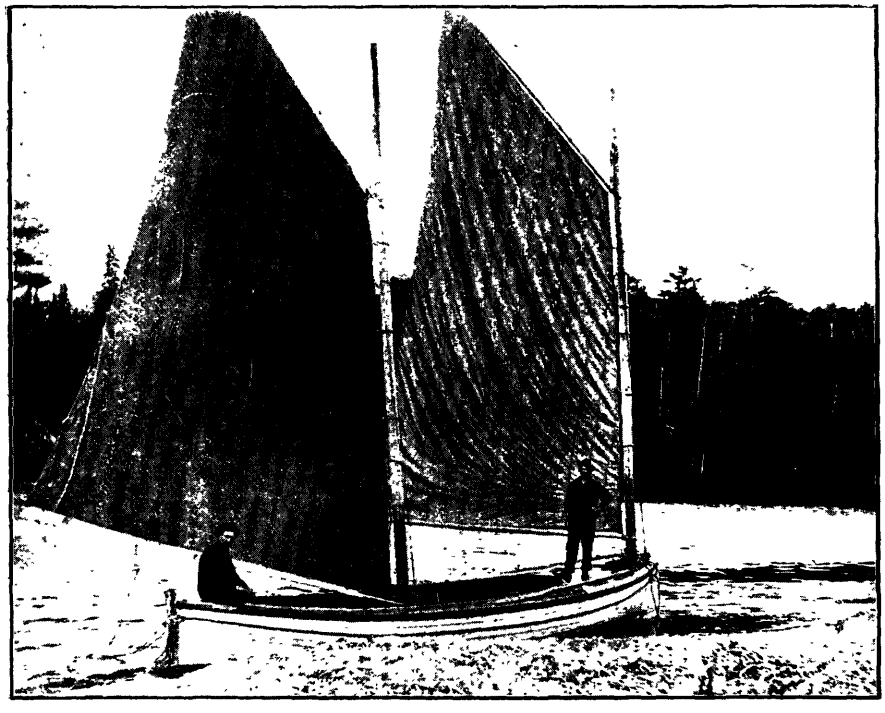
Remnant of a Dike north of Pointe aux Mines, Lake Superior, 15 ft high —Willmott.



10 Boulder near Shore, two miles north of Point aux Mines, Lake Superior (canoe=16½ f). —Willmott



Gravel and Sand Bar at mouth of Dog River, Lake Superior Length of Bar on lake side ⅝ m., width at centre 140 ft An old Channel lies along the base of the wooded hill in rear —Willmott



The Caribou, at mouth of Montreal River —Willmott.



Denison Falls, two miles up Dog River, showing the lower part of the main Fall —Willmott



12 An eroded Dike north of Spruce Harbor, Lake Superior; 200 yds long, 25 feet wide, and 10 to 20 feet deep. —Willmott.

though this is hard to prove. Some of them however are of greater age, since Keweenawan basal conglomerates rest upon Laurentian and diabase dike alike, and contain boulders of the latter.

Dikes of the Region.

The dikes of the region are distinctly of two kinds, one with pronounced columnar structure, the other without. It is probable that the columnar dikes are of Keweenawan origin and the others older.

The splendid series of basic and acid rocks of Michipicoton island have been described by Logan and Macfarlane; and thin sections of them have been studied by Irving, so that nothing need be said of them here.

Notes on Petrography.

During the summer numerous rocks of petrographic interest were collected, particularly eruptives, and the petrographic characters of the more important ones will be briefly described. Some of the eruptives form beds interstratified with the sedimentary rocks of the Huronian and of the Keweenawan series, having been contemporary lava flows, as proved in some cases by the presence of amygdaloidal layers. In other cases the rocks form large masses which have erupted through the Huronian sediments; and in many instances specimens have been collected from dikes, generally of later age than the Huronian.

Eruptive Rocks in the Huronian and Keweenawan.

Eruptives connected with the original Huronian region will be taken up first; then eruptives belonging to the Keweenawan; and finally eruptives associated with areas mapped as Huronian on the north shore of lake Superior.

Eruptives of the Original Huronian.

Only two undoubted sections of eruptives interbedded as contemporary lava flows in the series of Huronian clastics have been studied, both from near Thessalon where dark green diabase forms numerous beds separated by amygdaloidal layers. They are very fine grained, and appear to be connected with ash rocks and agglomerates of the same composition farther towards the east. The amygdules are sometimes large and scattered, at others small and crowded. The filling is usually dark green serpentine, in large amygdules sometimes enclosed by a band of epidote. Chalcedony and calcite occur only sparingly. In thin sections the amygdules show as pale green areas, at times with concentric bands of radiating fibrous serpentine showing dichroism. With crossed nicols no double refraction is observed except in the radiating fibrous layers which show pale violet when not parallel to chief sections of the nicols. The rock as a whole is greatly weathered, but the tiny lath-shaped felspars are still readily seen giving a characteristic ophitic structure. The only other minerals recognizable are magnetite, serpentine and a little green hornblende.

Lava flows at Thessalon.

Eruptive masses both basic and acid are common in the original Huronian, and wherever examined by us appear to be of distinctly later age, showing eruptive contacts with quartzite, etc. Of the basic rocks two diabases may be referred to, the first the mass in which the well known copper-bearing veins of the Bruce Mines occur. This mass was looked on by Logan as being interbedded, but our observation of eruptive contacts near Bruce Mines indicates the contrary. The diabase at Bruce Mines is being quarried as road metal for use in Cleveland, Ohio, so that fresh specimens are easily secured.

Diabase at Bruce Mines

The rock is dark green gray, of medium grain, with a distinctly ophitic structure. There are a few plagioclase phenocrysts of dull green color. Under the microscope the felspars, which are quite fresh, show a complicated twinning zonal structure, and extinction angles suggesting labradorite. In spite of the rather basic felspar there is an appreciable amount of quartz present, partly as small blebs but mainly as micropegmatite radiating in delicate intergrowth with felspar from well formed crystals of the latter mineral. The augite is mainly weathered to dull green hornblende, and this with a little brown biotite and some magnetite form the rest of the rock.

A hill rising several hundred feet not far from the north end of Great Lake George consists also of diabase, but much more weathered. A thin section shows a larger amount of quartz with a coarser intergrowth as a rule.

An Area of Grano-diorite

A large area of rather dark red rock, coarse grained and syenitic looking, occurs between Thessalon and the Cheney copper mine near Mississaga river. Under the microscope it proves to contain a considerable amount of quartz, having a rough intergrowth with felspar ; orthoclase in small amounts, often having very long and slender microperthitic inclusions ; plagioclase with narrow twin lines and low extinction (oligoclase), quite often with long prismatic forms very well shaped. Dark brown highly dichroic hornblende and also pale green secondary hornblende occur in considerable amounts, and a little biotite and magnetite. The plagioclase felspar distinctly outweighs the orthoclase, though the rock has the look of a syenite or granite. It may perhaps be called grano-diorite.

Dikes in the Limestone

Several narrow straight dikes cut the limestone band on Echo lake, standing up an inch or two above the surface, since they resist weathering better than the enclosing rock. Two of these dikes are only from one to five inches wide, but distinctly coarser grained in the middle, where also a few tiny fragments of jasper are enclosed in the black matrix. A thin section shows a dull grayish brown ground mass, with a few brightly polarizing needles which seem to be of augite, not of plagioclase, from their high double refraction. The ground mass was probably glass at first. There are white spots of some secondary mineral with quite high colors between crossed nicols, and a very few phenocrysts, one of olivine turned to serpentine, others of augite. The rock may be called a weathered picrite porphyrite.

A larger dike is 33 inches wide and shows a curious banded structure, at the edge very fine grained, then growing gradually coarser with white or honey-colored spots like amygdaloids. Then an inch of black fine grained rock followed by a few inches of amygdaloidal rock again, with a fine grained black strip in the middle. Beyond this the arrangement is reversed, giving a ribband-like look to the dike. It is probable that the fissure occupied by the dike has been opened several times, splitting down the only partially cooled middle and allowing a fresh flow of molten material. The only specimen taken was from an amygdaloidal layer. Under the microscope one finds much augite, some of it in slender strips, a large amount of brown biotite in distinct phenocrysts, often with browner margins, and magnetite. The finer grained parts of the rock are vaguely doubly refracting and perhaps represent devitrified glass. No plagioclase could be found, nor anything looking like a decomposition product of it. The amygdules are filled with a dirty white mineral, feebly double refractive or not at all so, probably a zeolite. No olivine was distinguished, so that the rock may be named an amygdaloidal biotite pyroxenite. It may be however that the apparent amygdules are the result of the replacement of a former mineral, when the rock should be described as pseudamygdaloidal.

Keweenawan Eruptives.

Basic Eruptives at Mamainse

A large proportion of the Keweenawan rocks at Mamainse and on Michipicoton island are basic eruptives, which have been poured out as lava sheets having many layers of amygdaloids between beds of diabase. Some of them are black glassy rocks, pitchstones ; others rather coarse grained. Most of the basic eruptives so elaborately described and figured by Irving occur in our region, and a portion of his specimens came from Michipicoton.[54] Owing to the completeness of Irving's work not much time has been devoted to the basic eruptives, and only a very few will be referred to here.

A quite coarse grained diabase forming part of the country rock of the vein at the main shaft of the Sand Bay copper mine is of interest because of the peculiar arrangement of the radiating fibres of pale green serpentine filling certain spaces, probably pseudamygdaloids, between the other minerals. Some of these radiating masses are spherical and show a very distinct black cross in polarized light, but the arms of the cross are not straight. Each arm is a little bent near the centre, giving a form suggesting the "swastika" as figured by ethnologists. In other masses the concretion is not round but elliptical, when the arms of the cross are unequally spaced, having an X form.

[54] The Copper Bearing Rocks of Lake Superior U. S. Geol. Sur., 1883.

A variety of diabase or melaphyre like that figured by Irving[55] and described as consisting of large augite anhedra crowded with microlites or small laths of plagioclase, and separated from one another by more easily decomposed material, originally glass, is very common at Mamainse. The rock weathers rapidly in the interstitial parts, leaving the augites as fine gravel formed of rounded fragments of the size of peas or beans. His description applies to our rocks with the one exception that no olivine has been observed in the latter. The interspaces between the augites, which are quite fresh, are filled with brown iron oxide and serpentine containing laths of plagioclase, but no outlines nor remnants of olivine, so that the rock should be called diabase, not melaphyre.

The glassy variety of the Keweenawan basic eruptives has much the look of Lydian stone, and is very opaque, so that sections are with difficulty ground thin enough to be transparent. The rock consists essentially of fresh brown glass crowded with slender microlites of plagioclase, and also of augite with many small grains of magnetite. A few larger crystals of plagioclase are to be found, generally having inclusions of glass. The rock closely resembles in thin sections a melaphyre from Goldspitz in Bohemia. It is perhaps better called a basic pitchstone.

The amygdaloids of this age are usually very badly weathered, so that sections were made of only a few. Those examined have the character of fine grained diabase, generally somewhat porphyritic. One contains numerous skeletons of iron oxide having the form of olivine crystals, though no olivine remains. This may be called an olivine diabase. The amygdules, so far as studied, contain calcite, chalcedony, pale green serpentine and a grayish, scarcely doubly refractive mineral, probably a zeolite. Native copper occurs in the amygdules, though rarely.

The Amygdaloids

The acid eruptives among the Keweenawan rocks include a series of flesh red or dark red porphyries or felsites. The fine promontory of Gros Cap consists mainly of dark red quartz porphyry with many bright red felspar phenocrysts and a few blebs of quartz in a compact ground. Thin sections show that the felspars are largely plagioclase, though sometimes unstriated. Their advanced stage of weathering, rendering them turbid and clouded with particles of hematite, makes it doubtful in many cases which felspar is present. The ground mass is made up almost wholly of an intergrowth of quartz and felspar, chiefly unstriated so far as can be determined. This intergrowth is of a peculiar character. Sometimes a quartz area is filled with separate small felspars not always oriented alike, forming a poikilitic structure. At others the quartz forms slender ramifications suggesting frost work, in a mass of felspar that seems to be continuous. Larger quartz portions may branch off into this structure. Some parts of the intergrowth have the appearance of micropegmatite, and perhaps the whole of it might be brought under that designation. The rock in that case may be called a micropegmatite porphyry. Irving describes and figures somewhat similar rocks from Michigan,[56] and regards the quartz as secondary, saturating the rocks and sending projections into the felspars. As practically the whole of the rock consists of this intergrowth, and from $\frac{1}{3}$ to $\frac{1}{2}$ consists of quartz, this theory demands too much. It is very improbable that $\frac{1}{3}$ of the weight of the rock could be introduced from without in the form of quartz and so uniformly disseminated as we find it. The more likely explanation is that the magma, in which a few crystals of felspar and still fewer blebs of quartz floated, having much more than the right proportion of silica to form felspar, consolidated into micropegmatite. That there are secondary micropegmatites is probable, but in this case it is more reasonable to look on this widespread intergrowth as primary.

Acid Eruptives of the Series.

Handsome specimens of quartz porphyry as well as quartzless porphyry are found on Michipicoton island, and several have been studied. They show a similar intergrowth of quartz and felspar in the ground mass, though much less elaborate and striking. The porphyritic felspars observed are mainly striated and have the

Porphyries and Felsites.

[55] Copper Bearing Rocks of Lake Superior, pl. IX.

[56] Copper Bearing Rocks of Lake Superior, p 112, etc.

characters of oligoclase. Flesh colored felsites occur in considerable quantities at Mamainse, but the specimens obtained do not differ materially from those collected by Mr. Blue at the same locality in 1893 and described in his report for that year.[57]

Dike Rocks near Heron Bay.

Dikes in the Schist Conglomerates

The Heron Bay schist conglomerates, which may be considered of Keewatin age, are penetrated by a number of dikes well displayed in the railway cuttings west of the station. Thin sections have been made of a number of these, and a few of the more interesting will be described. A dike several feet wide of very dark gray diabase porphyrite is of interest as showing very well the transition from the edge, which is exceedingly fine grained with some devitrified glass, to the coarser grained diabase in the center. Large and fresh tabular plagioclases form phenocrysts in each and a few porphyritic augite crystals occur in the marginal part of the rock.

Besides the diabase dikes there are several varieties of acid dike rocks, some of an interesting kind, which will be briefly described, though some points in connection with them are not yet fully worked out.

One large dike is of grayish flesh-colored quartzless porphyry, having a microgranitic ground consisting of quartz, orthoclase, plagioclase and muscovite, and large very well formed crystals of felspar, mainly plagioclase, though a few unstriated crystals, sometimes Carlsbad twins, occur. The plagioclases have extinction angles indicating andesine to labradorite.

Some rather flat-lying bright red dikes observed near the head of Heron bay a half mile or less from the railway prove to have a curious structure. Practically the whole rock is made up of radiating masses of reddish feathery crystals, probably of felspar, giving an imperfect black cross with polarized light. The felspar is much weathered and gives only faint gray polarizing colors when thin enough to be transparent. No quartz was observed either as micropegmatitic intergrowths or as separate blebs. A small amount of more transparent material, calcite and serpentine, so far as determinable, lies between the roughly spherical felspar masses.

A new Analcite rock.

A dark brownish red dike, well displayed at a cutting near mile 804, west of Heron Bay station, shows less perfect radiating structures, probably of felspar, faintly polarizing and crowded with particles of red iron oxide. The rays are few in number, not feathery, and have a low angle of extinction from edges of the narrow lath-shaped crystals, in many cases not distinguishable from parallel extinction. With an immersion lens some of these felspar laths are resolved into strips having slightly different angles of extinction, as if oligoclase. In the general ground there are some wider plates of similar felspar, not observed to be striated. There are also imperfectly radiating groups of a green mineral, having a distinct dichroism, green and yellowish green, and bright polarizing colors. The mineral was at first taken for hornblende, but most of the prisms have parallel extinction, or only a very low angle of extinction. The latter character suggests that the mineral is ægerine, but the crystals are too minute to be separated for special examination.

The most interesting feature of the rock is the large amount of glassy ground mass enclosing the radiating structures. As this appears to be quite isotropic it was at first held to be glass. It is free from the brownish particles of many volcanic glasses, but resembles some acid pitchstones. However under high powers this basis proves to have delicate but well marked cleavages, often crossing at right angles and suggesting a mineral of the isometric system. In a few parts an exceedingly faint reaction is given with polarized light, much fainter than that of lencite ; but in most parts this was not observed, and where found it may result from strain. The refractive index of the mineral is lower than that of most felspars. It is possibly analcite, though the general characters of the rock are very different from those of analcite rocks hitherto described, the latter being black and basaltic looking.[58] Some greenish spots in the rock prove in thin

[57] Bur. Mines, 1893, pp. 71 and 72.

[58] Pirsson, The Analcite Group of Rocks, Jour. Geol., vol. IV., No. 6, p. 679, etc. ; and Whitman Cross, vol. V., No. 7, p. 684, etc.

sections to consist mainly of vaguely radiating masses of felspar, apparently not striated, with a smaller amount of dolomite. None of the isotropic mineral is seen in these areas.

The complete analysis given below was made by Mr. H. W. Charlton, his results being put in column I. In column II an analysis by Dr. Mann of cancrinite-ægyrite-syenite from Siksjö-Berg in Dalarne[59] is given because of its rather close resemblance to No. I; and in column III an analysis of analcite-basalt from the Basin, Colorado, by W. F. Hillebrand.[60]

Comparative Analysis

	I	II	III
SiO_2	52.73	51.04	45.59
TiO_2		.29	1.32
ZrO_2			.03
Al_2O_3	20.05	20.47	12.98
Fe_2O_3	3 43	1.89	4.97
FeO	.99	2.19	4.70
MnO			.14
CaO	3.35	2.62	11.09
SrO			.12
BaO	.11		.13
MgO	.17	.97	8.36
K_2O	4.77	3.52	1.04
Na_2O	7.94	11.62	4.53
H_2O (at 100°)	.69	5 85	.51
H_2O (at red heat)	4.85		3.40
P_2O_5	trace	.27	.91
Cl			.05
CO_2	.93	.62	
	100.01	101.35	99.87
Spec. Grav	2.466	2.46	

A little more than 46 per cent. of the rock remains unaccounted for by the partial analysis; and if we suppose the whole of the potash to belong to orthoclase and the unused portion of iron oxide (1.40 per cent.) to belong to ægyrite, we have left silica, alumina, lime, and soda nearly in the proportions required for labradorite (Ab. 2 : An. 3) though the lime and soda are about one-third in excess of the amount required, the excess being less than 1 per cent. however.

Summing up the results arrived at, the minerals forming the rock have the following percentages:

Analcite	47.00
Orthoclase	28.24
Labradorite	13.00
Ægyrite	4.04
Limonite	3.59
Calcite	1.96
	97.83

In this computation moisture removed at 100°, unimportant percentages of magnesium and barium oxides, etc., amounting in all to 1.47 per cent., have been neglected.

The composition of the rock as shown by the analysis differs widely from that of analcite-basalt, as may be seen from a comparison of columns I and III, the latter being more basic, containing less alumina and alkalies, and far more lime and magnesia. It corresponds fairly well however to the composition of nepheline syenite, the only important difference being in the amount of water. The syenite from Dalarne, whose analysis is given in column II of the table, having its nepheline weathered to a hydrous mineral, resembles this rock closely in composition, the only important difference being the larger percentage of soda. In their unusually low specific gravity, 2.46, the two rocks are alike.

One naturally expects to find the dike containing the rock above described in connection with some boss of nepheline syenite; but the slight examination hitherto made of the region by Dr. Bell and myself has not disclosed any area of that rock.

If the analcite rock of Heron Bay had a granular texture, it would appropriately be named analcite-syenite, after the analogy of nepheline-syenite; but its peculiar structure of spherical groups of orthoclase embedded in a ground of analcite containing radiating bundles of plagioclase laths and ægyrite needles sets it quite apart from the syenites. It will probably be wise to give it a separate name, and Heronite, from the name of the locality where it occurs, is suggested as suitable.

A new name suggested—Heronite

Heronite may be defined as a dike rock consisting essentially of analcite, orthoclase, plagioclase and ægyrite, the analcite having the character of a base in which the other minerals form radiating groups of crystals. The analcite clearly represents the magma left after the crystallization of the embedded minerals; and it is evident that it can be formed only from a magma highly charged with water, and therefore under pressure. It is equally evident that Heronite, like other analcite rocks, cannot be an effusive, since under those circumstances the water would

[59] Neus Jahrbuch fur Mineralogie, 1884, II, p. 193; as quoted by Zirkel, Lehrbuch der Petrographie, Band II, p. 410.

[60] Whitman Cross, an Analcite-Basalt from Colorado, Jour. Geol., vol. v, No. 7, 1897, p. 689.

escape ;[61] and that its nearest relatives among effusive as well as plutonic rocks are to be found in the group containing nepheline.

Associated with the last rock is a reddish brown rock thickly filled with greenish black spots, looking somewhat like amygdules. It is hard to get thin enough sections for microscope work, and the general mass of the rock is too far weathered to settle anything positively, particles of a carbonate being mixed with brown iron oxide. The spots looking like anygdules have deep red rims of iron oxide, and consist within of dolomite, chlorite and a few portions of felspar like that mentioned in the previous rock. It is probable that this rock represents a more completely weathered state of the one mentioned before; and that the apparent amygdules are only pseudamygdules formed from the greenish concretionary spots of the previous rock.

[61] Cf. Pirsson, Analcite Group of Igneous Rocks, Jour. Geol. vol. IV. No. 6, pp. 686-688.

THE NIPISSING-ALGOMA BOUNDARY.

By William Arthur Parks.

Introduction.

EARLY in May, 1898, I received instructions from Mr. Archibald Blue, Director of the Bureau of Mines, to accompany Mr. Alexander Niven, who was despatched to extend the Nipissing-Algoma boundary line to Moose river. My instructions were to examine and report on the geological features of the district, its timber resources, agricultural possibilities and all matters of an economic nature. In order to enable me to cover as great an extent of territory as possible I was provided with a canoe, and I was given the assistance of Mr. W. E. H. Carter of the School of Science, who proved quite efficient.

Instructions for the Work.

Basin of Nighthawk Lake.

The whole party, 20 in number, left Haileybury at the head of lake Temiscaming on May 21. On May 23 we crossed a seven-mile portage to the Montreal river, whence a route was followed to Nighthawk lake, the terminal point of the old line. The first 120 miles had been run by Mr. Niven in 1896, and it extended a short distance north of Nighthawk lake. As Mr. Burwash accompanied Mr. Niven on that occasion, an account of this region may be found in his report. Two weeks were spent in reaching this point, via the Montreal river, lake Matachewan and a chain of small lakes and Nighthawk river to the southern point of Nighthawk lake.

Reaching the Base of Operations.

Tributaries of the Lake.

Nighthawk river below the portage is a sluggish stream of from one to two chains in width, expanding in places into marshes of considerable extent. Its shores are low and clad with scrub spruce and tamarac, passing into poplar near the lake. No exposures are seen on the river, but a massive green diorite crops out on the lake shore to the west of its mouth. This rock shows distinct glacial striae S. 15° E. and is overlaid by eight to ten feet of stratified clay.

Nighthawk River.

From this point to the mouth of the Redstone river the lake shore presents, in places, bluffs of stratified clay rising as high as 40 or 50 feet. Its continuity however is interrupted by numerous deposits of fine sand, which appear to occupy denuded valleys in the clay. Occasional outcrops of rocks are seen on this western shore, consisting of more or less altered diorites interstratified with fine grained quartzose schists carrying pyrite. One and a half miles north of the mouth of the Redstone coarse hornblende and mica diorites crop out on the shore. Near this point also occur fine grained gray hornblende schists with veinlets of quartz. Three miles farther north are seen rather hard hydromica schists with veinlets of quartz and showing a pronounced schistosity N. 30° E.

Geology of the West Shore

About seven miles north of the Redstone river the Porcupine enters from the west, above which stream a long point stretches into the lake, extended by an island. On the north side of this island is a fine grained massive diorite, while to the south occurs a typical chloritoid schist, striking N. 70° W. In addition to these rocks a fine grained crushed granite with pyrite occurs on the small island off the mouth of the Redstone river. From this river to the outlet at the northern extremity of the lake, with the exception of the above mentioned exposures, the shores are clay. High banks of the same material occur directly across the lake, forming the most conspicuous point in the landscape.

Nighthawk lake is very shallow, according to Mr. McLeod, who has spent several years in the region, not exceeding 12 feet in depth. Its waters are very muddy, and had on June 6

a temperature of 60°. Extensive marshes occupy many places on the shore line, but otherwise its banks are green, being timbered with small spruce, poplar, tamarac and birch.

Redstone River

The Redstone river enters Nighthawk lake not far from the 123rd post on the boundary. This stream is of brown water, with an easy current as far up as the crossing of the line (two miles); beyond it becomes rapid, flowing over a bed of boulders. No exposures were observed either on the river or on the line in its vicinity.

Porcupine River.

Another stream entering the lake from the west is the Porcupine, which has its source in a lake of the same name, lying five or six miles west of Nighthawk lake. The total length of this stream is 30 miles; it is therefore found more convenient to reach Porcupine lake by a portage of five miles, which is broken in the middle by a small lake. The first stretch of this portage starts from the south bank of a small creek entering the Porcupine two miles up. The portage is about two and a half miles long and maintains a general direction of s. 20° w. over level clay soil, very swampy in places and timbered with poplar, spruce and tamarac of moderate size only. About two-thirds of the way across is an exposure of diorite followed by fine grained quartzose schist, weathering into white patches owing to decomposing felspar crystals. The lake at the end of this portage is known as Red Willow lake, from the fact that that shrub is abundant on its shores. It has clay banks and muddy water, which is discharged at the north side through a small stream showing evidence of the activity of beaver. A ridge of dioritic schist thirty feet high constricts the lake towards its eastern end.

The head of the next portage is rather difficult to locate, but once found the trail is easily followed. It holds a general direction a little south of west, and at first is dry and well timbered with spruce. The greater part of its length however traverses a tamarac swamp, very wet and difficult to travel. The end is on a small creek entering the Porcupine from the southeast. Above the portage this stream is very tortuous, and filled with driftwood derived from a burnt area a short distance to the southeast. Ten chains below the portage we enter the Porcupine, and two miles down pass into the lake.

Porcupine Lake

Porcupine lake is two and a half miles long and a half to three-quarters of a mile wide. Its shore line presents several exposures of rock; on the north side occur outcrops of a soft soapstone-like rock, with crystals of magnetite and veinlets of chrysotile. Under the microscope this rock appears to be made up of indistinct fibres of this mineral mixed with quartz. It is evidently a much altered example of the basic eruptive series. A creek of a very tortuous course flows in from the southeast; on it occur exposures of a gray to white quartz schist, weathering quite white with streaks of quartz and pyrite. Considerable birch and pitch pine are found on this stream. A rocky point of some elevation is seen on the south side of the lake, consisting of altered diabase and gray schist, with asbestiform partings and veinlets of quartz. An overland trip south from this point shows that the rock disappears as soon as the water is left, the country being low and wet, with tamarac, spruce, poplar and cedar.[1] This latter tree obtains a diameter of 14 to 20 inches in this vicinity, and appears to be plentiful. The temperature of the water in these swamps was 36°, while in Porcupine lake it was 58°.

Rocks on the Porcupine River

On leaving the lake Porcupine river flows through a marsh half a mile in width and bends northward for 15 miles. It then turns east and south, and crosses the line at 130 miles and 66 ch. It is navigable throughout, but several short portages are required in the upper stretches. The following outcrops of rock occur on this river:

Three miles below the line, a much altered diabase with asbestiform hornblende and green hornblende schist.

Four miles below the line, a very fine grained schist, almost pure silica

Five miles below the line, the rock becomes very ferruginous. Just beyond, the river forms small rapids over fine quartz schist, hydromica-like in places.

One and a half miles from Nighthawk lake there occurs dark gray slate-like schist, weathering white with bands of quartzite. Strike N. 60° E. Dip 30° from vertical

[1] That this low land gives place to rocky ridges farther south has since been ascertained. An account of these outcrops will appear in a future report.

A short distance west of the 29th mile post is an outcrop of diorite, associated with schists containing seams of quartz, which gave on assay a minute trace of gold. The only exposures seen on the line between Redstone and Porcupine rivers were two bands of schist near the 126th post. With this exception the line crosses a level clay district thickly wooded with spruce, poplar, tamarac and a little birch, but none of any considerable size. The same features are dominant along the Porcupine river and along Nighthawk lake. Large areas in this region would make excellent farm land, particularly near the lakes and rivers. The country inland is much wetter, and I am inclined to believe increasing in this respect farther to the west.

Large areas of Farmland.

Frederick House Lake and River.

The river from Nighthawk lake flows almost due north a distance of six or seven miles to Frederick House or Hollow Sand lake. It is about two chains wide and is unbroken by any rapid. No outcrop occurs on its banks or on the west shore of Frederick House lake until we near the outlet at the northern end. Here are exposures of diorite and diorite schist with quartzite. The eastern shore is less well protected by clay and sand, and outcrops are more numerous, the following series being presented from north to south :

Rock exposures on the Lake

One and a half miles from the north end, fine-grained porphyrite with pyrite, striking southeast and dipping 30 degrees from the vertical.

Two and a half miles down are fine dark-gray schists with streaks of pyrite and a coarse green rock, apparently highly felspathic. This dark schist shows a banded spheroidal weathering and seems to consist of nuclei of a jasper-like variety enclosed in the darker bands. This passes into the ordinary gray and white schists. That these schists are, at least in part, of volcanic origin is well shown at this point.

Frederick House Lake.

Frederick House lake is of much the same character as Nighthawk, but contains fewer islands ; like the latter lake it is very shallow, and its waters have the same turbid appearance. The Indian name is Wanatangua, meaning Hollow Sand. I am inclined to think that this name is derived from the fact that the clay shores are covered in places by a layer of sand which gives way on being pressed by the foot. The southern and eastern shores also are overlaid by extensive deposits of clay. These are interrupted by areas of sand both to the north and east, where gravels and glacial accumulations begin to occur.

This lake is subject to violent storms from the east and southeast, the evidence of which is seen in the fallen trees and scarped clay banks on the western shore.

The country inland from Frederick House lake was examined by means of a series of portages running west from a point four miles north of the mouth of the river from Nighthawk lake. They join a succession of small lakes, for the most part of beautifully clear water, notably the second, which is known as Clearwater lake. These portages all traverse high, sandy and burnt hills, consisting of very coarse sand with Huronian and Laurentian boulders. Some deep depressions resembling kettle holes are seen on the third portage. By level, Clearwater lake is 60 feet above Hollow Sand, while the intermediate pond is only five feet up.

The Inland Region.

The last lake of this chain is Ice Chisel lake, which has sand for its eastern and northern boundaries but falls into clay flats to the south and west. For a mile and a half east of the lower bulb of this lake the country is sand with some pitchpine, broken in places by muskegs. A two and a half mile trip from this lake to the west reached the line at the 135th post. This trail crosses a rough and wet country of tamarac and spruce, broken by a single ridge of burnt sand 20 chains inland. The line traverses a similar country, alternating from half dry clay land to very wet muskeg. West from the 136th post the swamp increases in wetness and finally becomes impassable ; a typical bog.

Frederick House River.

The water of Frederick House lake passes out at the north end by a river of the same name. It is two or three chains wide at the head, with an easy current. About a mile and a half down, it bifurcates around an island 40 chains in length and continues a little west of north to the first falls, about seven miles down. A

Descent of the River.

barrier of rock crosses here N. 10° E, causing a succession of cascades with a total descent of 46 feet. An island divides the river, and, in all, it may be said that there are three tiers of three cascades each, with a total width of five chains. A rather steep portage of three chains on the east enables us to pass the obstruction. The rock at this point is a much altered porphyrite weathering in white patches, and a fine gray homogeneous siliceous schist. Below the falls dioritic and basaltic rocks occur, of which a much altered example shows decomposed felspar crystals surrounded by chlorite. On the east side this ridge follows the river up stream for a half mile, when it becomes less pronounced.

Northeast from here the land gradually falls to low swampy flats, with almost impassable windfalls. Southwest a ridge occurs on the shore, followed by a valley and a second ridge of clay soil well timbered with poplar, spruce, birch and balsam. This is succeeded by a muskeg with scrub spruce and tamarac.

Below the falls the river holds a course a little west of north, receiving a tributary two miles down. This stream is ten feet wide and flows from a lake a short distance to the west. A trail from the river to the northwest leads past the lower end of this lake to another beyond, crossing the line at 47 chains on the 146th mile. This latter lake is doubtless in connection with others to the west. On its shores occur some beautiful sulphur springs. In this district fair sized poplar and spruce are abundant and the land is quite dry. As may be seen on the map, several other small lakes are scattered over this region, all of which are connected by trails giving evidence of their use as hunting grounds. From signs observed, otter, fisher and beaver must be abundant in this region.

Below the above mentioned creek the river turns to the east of north, until its navigability is interrupted by three bad rapids at a distance of four miles from the falls. The first of these is passed by a portage of a chain on the west side. The fall in this rapid is five and a half feet over a rock composed almost exclusively of serpentine impregnated with much magnetite. The second portage of a half chain is also on the west side of a western division of the river, around an island. The fall is only two feet, but it is much too rough to be run. Five chains below is the third rapid of 30 chains, with a fall of 14½ feet. The portage here is also on the west side and is somewhat hilly. The rock at all these portages is the same as that described at the falls. The direction of the river is about north, but it is hard to determine as a compass is almost useless owing to the presence of so much magnetite in the rock.

Below these rapids rock outcrops are more common than on the upper river. A ridge of white weathering fine-grained schist causes a small ripple about 50 chains down. This is easily run as the fall is only one foot, but small canoes can make a lift-out over the rock on the easterly shore. Below this ripple there is an outcrop of dark highly hornblendic diorite on a small island. Two small tributaries enter from the west, and a little lower a considerable creek of 20 feet from the east. This was followed southeast for a mile, but was found to be jammed with driftwood. Besides small streams, a large creek enters from the west two miles below this one. The water of this creek is very brown and dirty, while its banks show numerous otter slides. It also is choked by debris 60 chains up. A mile below this stream the line crosses at the 157th mile post. Near here a tributary of one chain enters from the east. It has clay banks with evidence of high water two feet above the ordinary level. The river continues a little west of north for four miles more, when it is again broken by a long rapid over coarse gray mica schist with garnets, passing into granite, and beyond into Laurentian gneiss. This evidently represents the Laurentian contact and the end of the Huronian belt thus far traversed. The probable direction of the contact is N. 60° W. as the gneiss shows a general schistosity in this direction. From this point to the mouth of the river, a distance of 25 miles, gneiss is the only rock observed. The first ten chains of this rapid at the contact is easily run to a portage of 15 chains on the east side. Below this rapid is three miles of swift water to another rapid

The Huronian-Laurentian contact

The next seven or eight miles of river is almost continuous rapids, but can easily be run in fair sized canoes, excepting the point marked "chute" on the map where a portage on the east side over the rock is necessary to effect a passage. The river is very narrow here and the fall about ten feet over gneiss and gray mica schist. Trips at this point proved the existence of fair sized spruce for a half-mile inland. Twenty chains lower a rapid of 50 chains may be run down by keeping in the middle, or ascended by hugging the shore and poling. Another 20 chains brings us to a small ripple easily run in any canoe. In the next four miles there are several small islands, while the current is smooth and easy to a fall of three feet, broken in the middle by an island. The easterly side can be run with care, and it may be ascended by passing a line on the island. A few outcrops of gneiss and mica schist occur at this point. A small creek enters over a bed of boulders below this rapid, as also do several others. The river maintains a direction a little west of north with an easy current for five miles, when it passes into the Abitibi river at the big bend. At its mouth the Frederick House river has a width of three or four chains.

Frederick House Lake to Abitibi River.

A tortuous course to Black River and the Abitibi.

The description now turns back from Frederick House river to the lake at its source. East of Frederick House lake and in connection by a narrow pass is a lake of about two miles in length known to the Indians as Quaquaquitchwanook or "The-lake-whose-water-runs-both-ways." The barrier separating the two lakes is composed of glacial accumulations and coarse sand. The shores of the smaller lake are of sand, covered with good spruce and poplar and a few red and white pine. The water of this lake is much clearer than that of Hollow Sand, and fish are more plentiful. It seems to be the fishing ground for the Indians of the region, as many drying places were noticed on its shores.

A small creek enters from the southeast, a short distance up which is the head of a portage leading S. 30° E. to a clear lake with highly calcareous water and having its shores composed entirely of sand. From this lake a portage leads southeast for about two miles over a level sand upland with small pitch pine to a second lake about one-half mile long. South through this lake brings us to another portage of two miles over similar country, but with the pitch pine in part replaced by small spruce. This portage constitutes the height of land separating the waters of Frederick House river from those of the Abitibi. The route then crosses a small pond of 15 chains which receives some beautiful springs of ice cold water. Leaving this lake the trail turns northeast and traverses 60 chains of heavy poplar and spruce timber, then passes into a burnt area for about the same distance. Beyond this the trail makes an abrupt descent of about 60 feet, and passes through 60 chains of low, very wet spruce swamp, extremely difficult to portage over, ending in a small pond of 15 chains. Besides the lakes mentioned there are in this sand area numerous sheets of water of small size. A creek which the route follows flows out of the southeast corner of the last mentioned lake; it is very tortuous and narrow in places, having however a general width of 10 or 15 feet, and a depth of five feet. This stream traverses a low-lying tract, in places very swampy. The river bed itself is almost choked at intervals by a dense growth of alder and other marsh shrubs. In a straight line the distance to its mouth is three miles, while its total length is eight or ten. Through a large marsh this river enters an open lake two miles in length by one in width, with brown water of no considerable depth. The shores are low and swampy for the most part, but a point on the east side contains many boulders of Laurentian origin imbedded in a sandy clay matrix. The river out of this lake rises in the northeast angle; it is 30 feet wide and flows southeast for a short distance, when it turns north and maintains that direction with uninterrupted navigation for 10 miles. Throughout this stretch the shores are low and somewhat marshy, with ash, poplar, tamarac and spruce in clay soil. Farther down, the river is badly choked with driftwood, in many places, making the navigation very difficult. About 12 miles down occurs

a small rapid over Huronian schists, the first outcrop on this river. A mile down is another rapid requiring a portage of 10 chains on the west side; at this point is an outcrop of fine greenish quartzose schist. In the course of the next mile are two small rapids which can be run; the lower however is provided with a portage on the east side. We now come to a series of small rapids extending for two and a half miles in the following way:

Rapids Run, or portage on the east side.
One quarter mile of open water.
Rapids Run, a poor portage exists
One-half mile of open water
Rapids Run.
One-half mile of open water.
Long rough rapid with chute at end; portage on west side. Rock, a hornblende microcline granite.
One quarter mile of open water.
Last rapid. Falls, portage of three chains to west

There is a log jam of a permanent nature provided with a portage on the west, a short distance below the last rapid. From this point one and a half miles in a northeast direction brings us to the mouth of the stream in the Black river, which joins the Abitibi a few chains lower.

The Black river near its mouth has a width of three chains, with dirty brown water. Up stream we travelled in a direction a little east of south for 13 miles without interruption. On this stretch there are several exposures of fine Huronian schists and diorites with pyrite. Two considerable creeks enter as shown on the map, but are not at all navigable. Sandy clay soil predominates, clothed with the characteristic spruce and poplar. A large, recently burnt tract, with trees still standing, is cut by the river for six miles, but terminates before the first rapid is reached. The river at this point falls 12 feet over a dike of massive diorite striking northwest. A good portage of two chains affords a means of passing on the east side. A mile farther up is a small rapid over a ridge of diorite schist striking N. 35° W. The fall is only about six inches. Five chains above this ripple is an exposure of fine gray to black schist with pyrite interstratified with diorite, the whole showing rhomboidal jointing. Ten chains above this exposure another rapid occurs with a portage of five chains on the eastern side. The hill here rises to a height of 30 feet and presents exposures of schists and diorites at both ends of the rapid, while its central part is occupied by a boss of hornblende granite. On the opposite side of the river is an outcrop of a dark rock, with round white spots of one-quarter inch diameter, exhibiting fluidal structure in the magma. It is probably an amygdaloid, but the specimen brought is too much altered for exact determination. Here also occurs a rock which is probably a much altered porphyry.

Huronian Schists on the Black River.

Beyond this point rapids become more numerous, there being three in the next four miles. The first two require no portage, but the last is a fall of eight feet over diorite and is passed by an eight-chain portage on the east side. About two miles more brings us to a fall of 15 feet, with a portage of three chains on the west side. The water here is forced through a narrow gorge, in schistose rocks splashed with quartz and alternating with diorite belts. The land runs up to an elevation of 50 feet on both sides, with clay at the top; inland, however, it soon falls into muskeg.

After passing the falls the river becomes almost continuous rapids and I did not consider it advisable to follow it farther. Indians however go through this way to the head waters of the Rivière Blanche, and thence to lake Temiscaming. I was also informed that a portage leaves this river somewhere near the first falls and connects with a route to the Matachewan waters.

Among the small rapids at the head of the stream were found exposures of pyroclastics with three inch inclusions, also dark schists with diorite and splashes of quartz, associated with a little hydromica.

While camped on this river on July 1st a heavy thunder storm following a hot day raised the water two feet in one night. W. S. Ritchie, who had camped the same night on the small island below Iroquois falls on the Abitibi, found his canoes washed away in the morning, although they were six feet above the water line at night.

An expedition east from the highest point reached on the river revealed the existence of a hill of diorite fully 100 feet high. Clay

observed many goose-, raspberry and currant bushes. The fruit in all cases was small, and in no way to compare with the same in other parts of Northern Ontario. West from this rapid there is a narrow strip of swampy land, followed by clay upland for half a mile. Beyond is a small creek in a depression which is succeeded by a large belt of fine birch of 12 to 18 inches diameter.

The Long Sault Rapids.

For six or seven miles below this point the river continues a little west of north, receiving numerous small streams and three of larger size, but none navigable. The current here begins to stiffen, and we pass a small island which may be considered the head of the Long Sault. Below this is 20 or 30 chains of rough and swift water, to a second small island of Laurentian gneiss and mica schist. The river drops three feet, necessitating a portage of a half chain over the island for small or heavily freighted canoes. Rough, swift and shallow water continues to a fall of six feet, passed by a 40-yard portage near the water's edge on the west side. The rock is gray mica gneiss and mica schist. A bay of a few chains in width with rough water must be passed to the next portage of seven chains, also on the west side. This portage can be avoided by large canoes going down, but the rapids are heavy and dangerous. Our party lost a canoe at this point in an attempt to run the rapids.

From the first of the Long Sault portages an expedition was made southwest to the line, at 170 miles. The trail traverses at first a mile of river bank with spruce and poplar badly affected by windfalls, and then continues for three miles in flat clay country with spruce and tamarac. This area is wet, but could scarcely be called muskeg. Returning I left the line at the 174th post and found the land high and dry to the river. It is well timbered, but the value is much reduced by windfalls. On the east side of the river an expedition northeast showed alternate narrow belts of muskeg and clay upland. The trail ended on a small lake with clear water and poplar shores. Below the portage the river is shallow, swift and rough for 40 chains and shows a stiff current for a mile more.

Six miles below the portages the line crosses at the 179th post. A mile farther down an expedition west showed a clean open bush of poplar and spruce for a half mile, then a mile of low wet land with red spruce. It is rather remarkable that no trace of windfall was seen in this immediate locality. A short distance below another trip west for two and a half miles showed the usual high shore with a continuous wet tract beyond, cut by several creeks and dotted with beaver ponds. Opposite the 178th post the river bank is about a hundred feet high, but the characteristic wet land occurs half a mile in.

At 179th post the Line crosses the Rivei from right to left Bank

Tributaries and Rapids.

Three or four miles below the crossing point of the line the river turns sharply to the west and receives at the bend two streams, known as the Jawbone creeks. The westerly one rises in a small lake near the 200th post and flows approximately south. It is very rapid and shallow, and presents some exposures of gneiss. The easterly and larger stream is also a succession of rapids and falls, but is used as a canoe route. At one point it passes through a gorge in gneiss with walls 50 feet high. As far as could be observed the course is from the southeast. Among the gneiss boulders are found many limestone erratics, with Zaphrentis, Heliophyllum, etc. Around this bend in the Abitibi and on the Jawbone creeks high and dry land extends for a considerable distance inland, is exceptionally well wooded and free from brulé and windfall. Below the bend the river is ten chains wide and shows a strong current for five miles, when it forks around a small island and falls three feet. There is a portage of a couple of chains on the island, but the rapid can be run in fair sized canoes. The rock here is light gray gneiss and tender mica schist, striking w. 10° N. and dipping 45° northward. Below the rapids the river expands to a half mile in width and contains several small islands. Five miles down it contracts to one and a half chains and plunges with great violence down an incline of four feet over a barrier of gneiss running east and west. The portage is on the south side, and must be used with any

Jawbone Creeks

canoe. The current is stiff below this portage, which is known as Kettle Falls, and several islands occur before the river bends north at the point where it is joined by the Frederick House river. Five miles below the junction of this river the Abitibi receives a tributary known as Driftwood creek. A burnt tract occurs near the mouth of this affluent and stretches three miles down stream; on ascending the creek however we soon pass into green bush. The general course of this stream is somewhat east of north. It has banks reaching an altitude of 100 feet three miles up, and presenting bluffs of 40 feet of fine stratified sand covered by stratified clay. A half mile beyond is an exposure of mica schist and quartz, striking northeast and southwest. Within the next mile are two portages on the south side, the first of 15 chains and the other of five. They are necessitated by rapids over gneiss. High hills with boulder clay occur at this point. A mile and a half of good water brings us to another 20-chain portage on the southeast side; above we cross a pond and make another portage of five chains on the west side past a falls of eight feet. Open navigation continues for five miles, when we arrive at a small rapid easily poled. A mile beyond is a very rough rapid with a fall of 20 feet passed by a portage over a high hill on the west side. No further obstruction occurs for two and a half miles, when a lift-out is occasioned by a fall of four feet. This is succeeded by four miles of good water to a long rapid not provided with a portage. At this point I was forced to return, but am of the opinion that a route of which this stream forms part is followed by the Indians into Mattagami waters. An extensive valley of denudation has been formed by this stream. A study of its banks proves that the stratified layers of sand and clay have in places a thickness of 100 feet. It is also to be observed that sand is becoming more noticeable than farther south, and that boulder clay begins to be conspicuous.

Driftwood Creek

Five miles below Driftwood creek Singed Marten creek enters the Abitibi from the same side. It is about a half chain wide at the mouth, with low marshy shores. With the water at the summer level it is impossible to force a canoe more than half a mile up stream, but in high water it may be more navigable. To the north and west of this stream is an extensive spruce flat with areas of bad windfalls. A fair sized creek enters from the east about six miles farther down. It seem to flow from the south, but is so badly jammed with driftwood as to be entirely unnavigable. On its shores are seen coarse sand and clay, with gravel and limestone boulders.

Singed Marten Creek.

One and a half miles below this stream the river contracts and forms two bad rapids, with a bay to the east between them. Both portages are on the east side and are only a few chains long. This is known as the Three Carrying Places. It probably gets the name from the fact that a third portage on the west shore runs past both rapids. At the first fall the barrier is 75 or 100 yards long and runs due north and south, the descent being 10 feet. The lower rapid is less severe, but probably has a drop of six feet. Both barriers consist of rough mica gneiss, hornblendic in places.

The Three Carrying Places

From this point an excursion was made to the line, a distance of 13 miles. The first two miles is hilly and well timbered with poplar, but beyond extends a low level spruce area alternating with muskeg to the line. Two or three small creeks were crossed and several lakes seen. These all show signs of having been frequented by beaver. A large number of these lakes are found in the swampy land inland from the river; none of them are of large size, nor can any of them be reached by canoe. The beaver however have tempted the Indian hunters, who have connected most of the dams by trails with the river. All along the Abitibi small creeks enter with great frequency. Judging from the country seen it may be that many of them have their origin in small lakes, possibly a long distance inland.

The line after crossing Jawbone creek follows a similar country. At the point where the trail met it (the 194th mile post) the soil was fairly dry and somewhat sandy; but this character is not persistent, as wet bottom land or muskeg prevails on the line as elsewhere.

Below the Three Carrying Places the river widens and contains many islands, while the current is stiff. Two miles down it narrows to a chain and a half, presenting a heavy current but quite smooth. Again it widens and has 10 or 15 islands for three miles, when a constriction and heavy rapids occur. This fall is in two sections : the upper part can be run by keeping the west shore and running into the bay beyond. However a short portage is provided on the west side. The lower rapid is much heavier and is broken by an island. Nearly all the water follows the the eastern channel ; in fact in low water all of it. In high water the bay to the west referred to above would not exist, and it might then be more difficult to cross to the Island portage, which is on the island and is about two chains long.

At both these rapids the rock is gneiss, but just where the portage crosses the island is a peculiar lens-shaped inclusion, ten feet wide at the north end, but pointing out on the south shore. It apparently dips 45° westwardly. The inclusion is in places quartzoze, in others highly altered, with much pyrite and magnetite. Under the microscope the rock shows augite as the prominent constituent, with a little quartz and plagioclase. The quantity of these is so trifling that the rock may be regarded as a pyroxenite. In the vicinity of this outcrop the gneiss itself is highly garnetiferous.

For the next 12 miles the river has a fair current and is bordered with clay and sand bluffs, the latter increasing in importance northward. These shore banks are, for the most part, clothed with young poplar. At the end of this 12 miles a considerable creek,

Red Sucker Creek

known as Red Sucker, enters from the west. This stream was ascended two miles, in which distance three rapids were met. Beyond for two miles it is a continuous rapid over gneiss. The shores on both sides rise to the height of 100 feet and are composed of fine sand at the top and coarser materials below. Some pitch pine is found on the top of this ridge. A trip west from the foot of the long rapid, after passing the elevation, brings us to a long level spruce tract. Two small lakes were encountered, which, differing from the swampy lakes previously seen, present shores of fine sand and shingle. From this fact and from the drier nature of the spruce flat it may be concluded that the whole of this region possesses sandy soil.

Three and a half miles below Red Sucker creek the river turns to the west with increased speed. One and a half miles lower it plunges down a declivity, necessitating the Lobstick portage of a half mile on the east side. An interesting series of rocks is shown here. On a small island above the rapids are seen tender mica schists striking northwest and southeast and dipping 20° N. This is followed by a dark, highly garnetiferous rock, which appears to be an altered augite-syenite. At the brink of the fall the rock is a distinct augite-syenite. On the east side, at the portage, we have a dark fine-grained rock of a schistose nature, followed by what appears to be a quartz porphyry. This is replaced by a typical augite-syenite with pyrite. Below the rapids is gneissoid mica schist, very rough and with pronounced jointing. The conclusions are, therefore, that a barrier of augite-syenite crosses the river east and west, inducing certain modifications in the gneiss and being itself rendered schistose at its borders.

Lobstick Portage.

Below the Lobstick portage the river must be crossed in dangerous water to the Burntwood portage on the opposite side, which passes by a trail of 300 yards a very bad piece of rapids. A mile of fair water succeeds and different routes seem to be followed beyond, some portaging on the east and some on the west side. A high clay hill gives the name of Clay falls to this rapid, and there is a portage along the face of the cliff on the east side of the river, and another but little used a short distance beyond. The river at this point is wide and filled with islands. The hill at the Clay falls referred to above shows in ascending order—

20 feet fine sand interstratified with a coarser part and gravel.
One foot of stratified clay.
20 feet of stiff boulder clay with limestone erratics
20 feet of fine stratified sand.
10 feet of stratified clay.

A half mile lower is a level easy portage known as the Birch portage, on the east side



13 Camp near Night Hawk River Sand Area, with Pitch Pine —Parks



Surveyor Niven's Party at Luncheon, on Montreal River —Parks



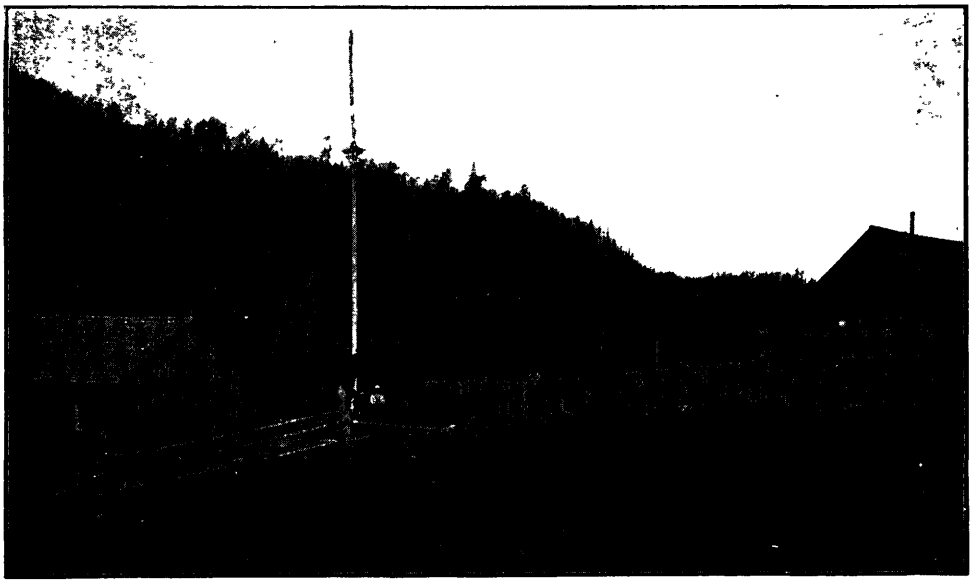
 H B Co Factor and Family at Fort Matachewan, Montreal River —Parks.



High Water Scene on Night Hawk Lake —Parks.



 Bernard McLeod, Trader, and Chief Buffalo, at Night Hawk Lake Parks.



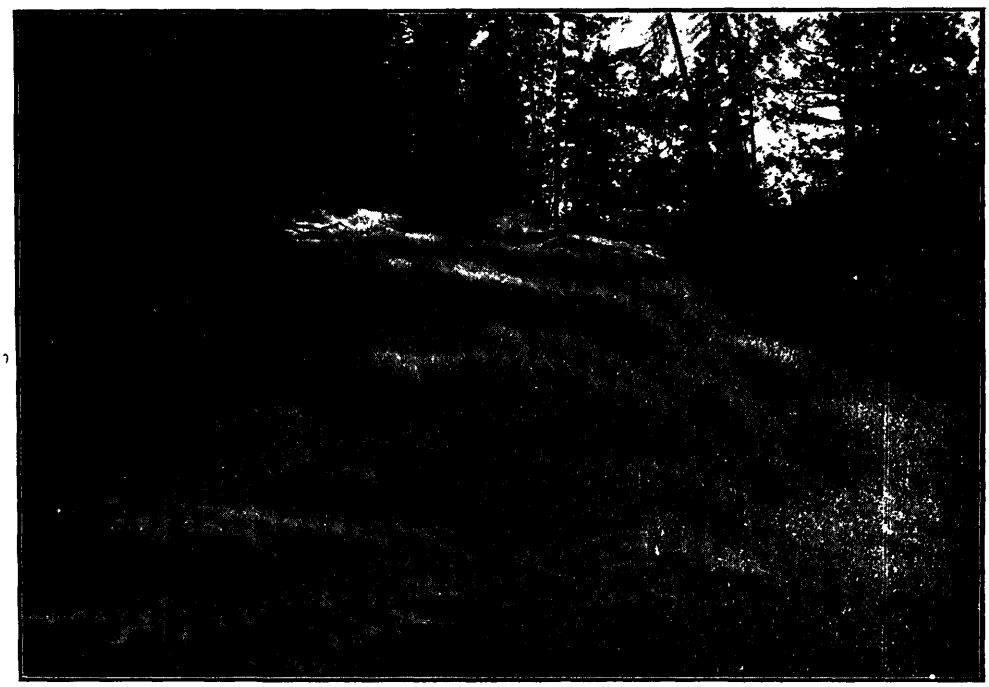
Fort Matachewan, H B Co —Parks



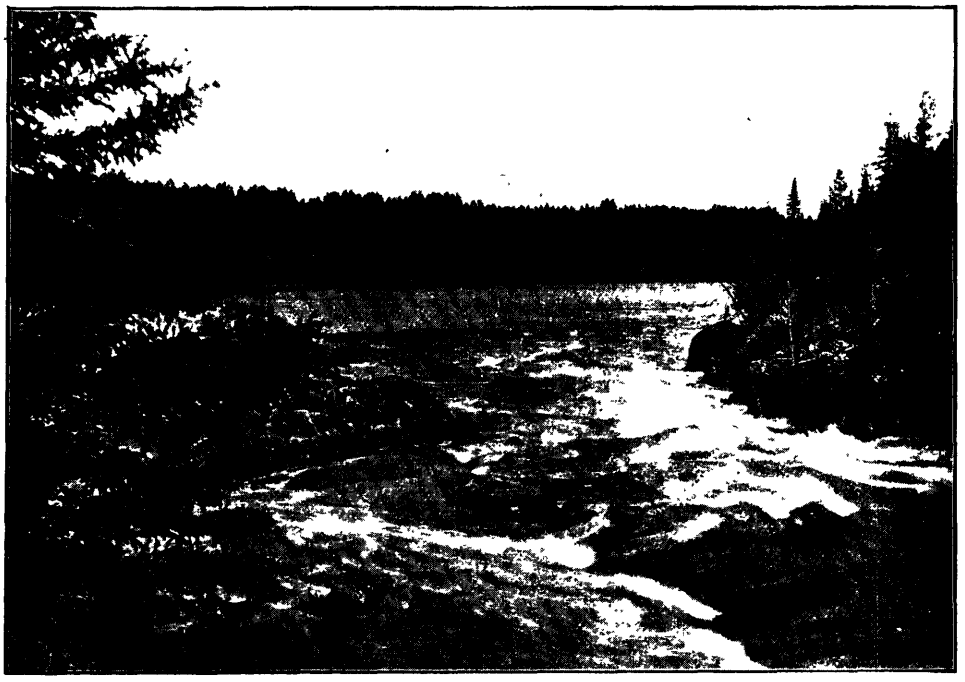
16 Packing Supplies over Height of Land, Montreal River to Night Hawk River —Parks



First Falls, Upper Western Cascade, Frederick House River --Parks.



First Falls, Lower Middle Cascade, Frederick House River - Parks



Below the last of the Three Portages, Frederick House River --Park



Iroquois Falls, Western Cascade, on Abitibi River —Parks



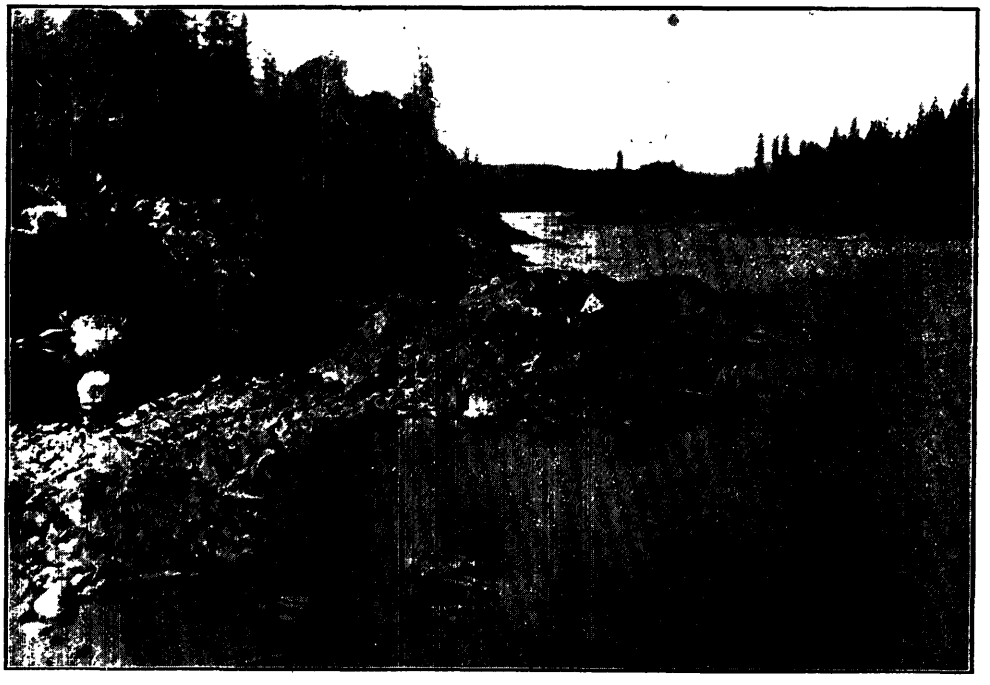
Indian Packer at the Long Sault, Abitibi River —Parks



Running the Long Sault, Abitibi River —Parks



Supplies at the Long Sault, Abitibi River — Parks



Below Island Portage on Abitibi River. —Parks

One mile in, hornblendic gneiss is seen on a creek. Large poplar and spruce cover the whole district. From this point to New Post, a distance of six or seven miles, there is an occasional outcrop of gneiss, while sand banks are continuous for the stretch, showing terraces at 20 and 100 feet. New Post is the only trading station of the Hudson's Bay Co. on the Abitibi, and is the only place where supplies of any kind can be obtained between Fort Abitibi and Moose Factory. Mr. Jobson, the factor in charge, has a flourishing garden in which are turnips, onions, potatoes, corn, cabbage, lettuce and radishes, all doing well. Early Rose potatoes were rotting in the ground, but white late varieties do well; 300 bushels were grown last year. Corn will ripen some years, but it fails on other occasions. Mr. Jobson has several head of cattle, the winter fodder for which is gathered by the Indians, and consists of the marsh grass abundant along the river. The soil is fine sand, argillaceous in places. As an example of the vagaries of the river, Mr. Jobson informed me that in the spring of 1897 the water rose to the foundation of his house, a distance of 29 feet. The Indians attached to this post are rapidly succumbing to the attacks of consumption and scrofulous diseases, and owing to the decrease of partridge and rabbit are sometimes at sore straits for food. As the rabbit fails the lynx also disappears for want of prey, while the beaver is almost hunted out in this district.

New Post Trading Station.

Little Abitibi River.

Half a mile below New Post a stream enters from the east. About two miles up this creek brings us to a very beautiful fall where the water drops 90 feet, almost vertically over gneiss. A portage from New Post 50 chains in length connects with this stream above the falls. In high water only can this river be ascended, as it is very swift and shallow. By dint of great exertion it was ascended 20 miles in a southeast direction. From here a portage of one and a half miles, broken by a little lake, leads into the Little Abitibi river. This latter stream was found to be a succession of rapids, but was descended 10 miles and a trail made from there to the line, a distance of 12 miles. The usual poplar and birch were encountered on the shore of the little river, sinking into wet muskeg with scrub tamarac and spruce, which continues unaltered to the line. Three creeks and several small swampy lakes were met with, and the line intersected at 232 miles and 40 chains.

An excursion to the Little Abitibi.

From New Post to the Otters the current is fairly heavy, but smooth. The banks are sandy and high, with gravel beaches and terraces, a feature never seen on the upper parts of the river where the vegetation reaches to the water line. The timber on this stretch (14 miles) is small poplar and spruce, with a little pitchpine.

The rapids at the Otters are extremely rough and picturesque, the river being forced between narrow banks and having considerable descent. The rock is red gneiss and bands of dark schist with pyrite. The portage is on the east side and is a wide open trail, with corduroy, evidently constructed by the H. B. Co. for the transport of large boats. The soil is sandy clay with gravel. The trail is crossed by two creek valleys, and there are two sharp descents at the north end. The portage is two miles long, but it may be shortened a half-mile by taking the river for that distance in the middle. The trail does not show that this is often done however.

Rapids at the Otters.

A Region of Devonian Rocks.

Below the portage is a barrier of boulders requiring care to pass. A mile farther are two small islands and swifter water passing into rapids. There is a portage of 20 chains on the east side which does not appear to be much used. I found it necessary with the small canoe to portage part of the load. At this point outcrops the lowest member of the stratified deposits, being represented by a coarse red sandstone conglomerate. Twenty chains lower on the west side is 20 feet of the same deposit, interstatified above and capped with a dark shale dipping west and about ten feet thick. This is succeeded by ten feet of soft felspathic sandstone, with a highly calcareous matrix and with crystals of calcite in the cavities. The whole is covered by a strong stony clay. Many landslips expose

Sandstone-Conglomerate and Shale.

at a point where the river narrows to a chain and runs with great violence. A short distance lower is the Oil Can portage, which enables the traveller to pass a strong fall. Both these portages have a length of 300 yards. At the foot of Oil Can portage the rock is augite-syenite or gabbro. As it contains both species of felspar it is difficult to decide, but it is probably the former as the outcrop at the Lobstick is evidently that variety. This rock strikes N. 30° W. and has a gray appearance, but the fresh fracture shows a distinct syenitic structure. Fine streaks of calcite and bands of a dark fine grained material traverse it in all directions. Above the Oil Can the rock is much coarser, with a highly syenitic appearance. At a sharp bend to the west 20 chains above the portage small quantities of a much altered diorite with sphene and mellilite occur. Here also are distinct veins of a hard black schist dipping 30° west, but not persistent in strike. Above the Birch portage the rock is highly felspathic, and at the place where the river widens contains veinlets of crushed granite crossing in all directions and presenting beautiful examples of dislocation on a small scale. With small canoes and especially when ascending the river it is found advisable to follow another route in passing this series of rapids. The head of this trail leaves the river just where it turns west and the current stiffens about a mile and a half above the Lobstick portage. The first portage is one and a half miles long in a direction a little west of north; it is quite level over sandy soil and crosses two creeks. This ends in a lake which we cross nearly due north 25 chains. The next portage is only 100 yards, a little north of west to a lake of 13 chains. A 400-yard portage west of north over fine sand connects this lake with the next, a 15-chain pond. Then succeeds a 700-yard portage west of north followed by another 15-chain lake. A 100-yard trail over fine sand brings us to the last lake. From here a trail leads to the bay below the Oil Can portage. It traverses sandy soil and rises to a considerable height, falling suddenly as it approaches the river. Aneroid readings gave the top of the hill as 120 feet above the foot of the Oil Can portage and the last lake 104 feet above the same point.

Birch and Oil Can Portages

Canon of the Abitibi and the Otters.

We next cross a bay of a few chains on the east side of the river to a portage of two miles, leading past the canon of the Abitibi. This gorge has a height of 100 feet with precipitous walls, while immediately inland the country rises to an elevation recorded by aneroid of 200 feet. In this chasm the river is narrowed to about a chain or less and rushes with great violence throughout, causing a deafening roar in the confined space. The upper end of the canon presents rocks of the same nature as those described at the portages above. One half mile down occur segregations of anorthosite, and at a mile the rock is a weathered gabbro with stringers of crushed granite containing pyrite. The rocks here reach the greatest height on the gorge and are much mixed, with blebs and strings of associated materials. As we near the foot of the gorge we meet with large masses of crushed granite sheared north and south. As gneiss was seen a short distance below the canon we may conclude that the contact is very near the end of the rapid. Thus we have a belt of eruptive crossing the river a little north of west. Its southern part seems to be more acid, being represented by augite-syenite at the Lobstick portage. To the north it is more basic, passing into gabbro at the canon. Throughout the belt shows evidence of having been much contorted and broken by secondary minor eruptions.

Rocks of the Great Gorge.

Twenty chains below the canon the river is shallow and swift, presenting a rapid a quarter of a mile in length, but easily run. Expeditions east and west were made a short distance below this ripple. That to the east showed a bank of fine sand over a hundred feet in height, clothed with scrub poplar and birch, evidently an old brulé. This is cut by numerous small streams which have dug out deep valleys of denudation. Without much descent this gives place two miles inland to the usual succession of clay flat and muskeg. At an elevation of 75 feet occurs an outcrop of gray mica gneiss to the east of the river. The soil is sand, intersected by creek valleys.

the face of the cliff, and blocks of other rocks not seen in situ are revealed at the foot of these slips. A little higher up the river, opposite the last described rapid, the sandstone is covered by 15 feet of hard gray clay, with boulders roughly stratified at the bottom, but not so apparent above. This is covered with sand and gravel. Almost immediately inland we pass into muskeg.

The next rapid, the Sextant, is almost a continuation of the last; it is broad and shallow, a character shown by almost any rapid from here to the sea. This is of course on account of the difference between the stratified deposits and the harder Laurentian rocks. On the west shore at the Sextant a peculiar band of dark shale runs from the water's edge up to a height of 20 feet. It contains the remains of several species of algæ. The Sextant portage is one-quarter mile long on the east side. At its foot the red ferruginous sandstone occurs covered by shaly dolomitic limestone to a height of 50 feet; these limestones are arenaceous in places, and contain fossils of Ambonychia, Orthis and Modiolopsis. As nearly as I could determine there is a dip northwest of 23 feet in 60 chains.

Dolomitic Limestone.

One and a-half miles down is another rapid of the same character as the Sextant, with a half mile portage on the east side. The river drops six or seven feet, but the portage rises to a considerable height over clay soil. The rock here is a thick bedded limestone with numerous fossils, for example:

Favosites polymorpha.
Favosites turbinata.
Favosites hemisphærica.
Heliophyllum Halli(?).
Zaphrentis gigantea.
Zaphrentis prolifica.
Eridiophyllum.
Cyathophyllum.
Crinoid columns.

Below this rapid the river maintains a northeasterly direction, is swift and shallow but not at all dangerous. Its banks are low for the most part, with clay and roughly bedded gravels. Six miles down we enter the Pudding rapid. The river here is 400 yards wide and correspondingly shallow. I believe the route for large canoes lies along the east shore, but I proceeded down the west side, running part and wading through others. A mile or two of this brings us to a large island, showing thin-bedded limestones, and at its northern end a dark soft shale with fucoids apparently dipping north. Beyond this island is two miles of swift but easily canoeable water, filled with islands. The lower part much resembles the upper, and has a large island in much the same relative position. This island is bent into sharp anticlines and synclines, rendering it impossible to ascertain the strike or dip. Below the island the swift water continues, and the river is finally thrown with some violence against the west shore by a point from the east side. This is a well marked spot and constitutes the end of the Pudding; the water is not too rough for large canoes. With small boats it is safer to track on the east around the point.

The Pudding Rapid.

Plum-pudding island lies a mile below the rapids; it presents clay shores much torn by river ice. Three miles more of somewhat shallow water with stiff current brings us to the Little Abitibi river on the east side. At its mouth this stream is 100 yards in width and a foot deep. Its water is brown, and its shores low, with young poplar. A description of the succession of rapids on this stream would be tedious; with the exception of a few short stretches it is all rapids as far as it was ascended, a distance of 30 miles. The more important of these are marked on the map. This distance cost nearly three days hard work to ascend, but, thanks to some heavy rains, we were enabled to run the whole way down in six hours. Limestone exposures occur on the lower reaches, a very fine one three miles up. This rock strikes N. 10° E. and rises into an anticline at the rapids. Fossils:

Little Abitibi River.

Fossils of the Limestone

Rhynchonella sp.
Pentamerus sp.
Renslaeria ovata; very numerous.
Dentalium sp.
Zaphrentis prolifica.
Alveolites sp.
Monticulipora sp.
Michelinea convexa.
Holopea?
Orthoceras sp.
Gomphoceras sp.

These are evidently different beds from those described on the Abitibi at the rapids below the Sextant. There the fauna is strongly corraline, while here it is more mixed, the brachiopoda being the most prominent group.

A Laurentian Island in the Devonian Sea.

About a mile above this outcrop an exposure of gneiss occurs on the river, forming a strong rapid and rising into burnt hills on the east. The contact here is beautifully shown, with corals growing on the ancient gneiss sea-floor. This gneiss exhibits a vertical dip, and is laminated northeast and southwest. The next rapid above is also over Laurentian rock, beyond which no outcrop occurs in many miles, when Devonian strata again appear with

Atrypa reticularis.
Cyathophyllum sp.
Michelinea convexa.
Several species of Orthoceras and numerous small gasteropods and lamellibranchs.

It is therefore apparent that the gneiss outcrop must represent a Laurentian island in the Devonian sea, or an elevation of the gneiss from which the Devonian rocks have been denuded. At the end of the trip, 30 miles up, there is an apparent outcrop of gneiss which probably represents the contact. The rapids above are very hard and the river beyond is a constant succession of rapids to a large lake, the Little Abitibi, said to lie some distance to the southeast. The line crosses the river at the 212th post. Near this point gulls and flying loons were heard, so it is probable that the lake is not far distant from the crossing point of the line. A portage leads from the Long Sault rapids to the Little Abitibi river, whence the ascent is made to the lake. Along this stream high banks of clay and sand occur in many places.

To the west of the contact the hill rises 75 feet, and is composed of boulder clay at the bottom and gravel and sand at the top. Inland is a level sand area with pitch pine for 10 chains. Beyond this the country consists of muskeg with spruce and tamarac. This was traversed for three miles and found to become gradually wetter westward. To the east there is 30 feet of a clay hill followed by 15 chains of six-inch spruce on dry soil. Wet muskeg succeeds, crossed by a ridge of dry land not far from the river.

The Little Abitibi may be said to occupy a valley of denudation in a very level tract of territory, having boulder clay at the bed rock and sand, gravel or stratified clay at the surface.

Below the mouth of the Little Abitibi the Abitibi is 200 yards wide with low shores. Three miles down is Barebone island with 100 yards of river on each side. This island is 20 chains long with stratified clay overlaid by sand. The clay is peaty, but a washing of it gave no indication of its having other than a recent origin.

Lignite in Clay.

A deposit of Lignite in Boulder Clay.

Two miles below the island is swift and shallow water which continues to the Blacksmith rapids another two miles. The west shore here was carefully examined for a mile above and below the rapids in order to locate the deposit of lignite reported by Dr. Bell and Mr. Ogilvie. There is absolutely no exposure of shale or limestone above the water line. Lignite was found however in boulder clay, which was itself black with carbonaceous matter. The deposit was traced about 20 chains down the river. At the foot of the Blacksmith rapids on the east shore it outcrops a little above the water line and presents a more compact appearance and a roughly bedded aspect, striking E. 10° S. and dipping by 15° N. From the fact that it occurs in boulder clay, and also because the dip and strike are quickly variable, I conclude that no inference can be drawn from these features. The deposit on the west shore bears 40 chains southwest from this outcrop. Seven miles down, on Little Cedar creek, and a mile up that stream, were found isolated pieces of the same lignite. These could not arrive there by glacial movement from the Blacksmith rapids, nor could river ice carry them that far up the small stream. It is therefore safe to conclude that deposits of the same nature occur in that region also. It is seen under the same conditions over 100 miles west, on the Missanabie river. The largest block found was two feet long by ten inches wide and thirteen inches thick. The

woody nature is quite apparent, but it is sufficiently altered to break readily across the grain. In the beds examined the separate trees were always apparent; in no case was consolidation observed. In the camp fire it was consumed by the aid of wood, emitting a disagreeably pungent odor. Analysis of a dry specimen gave—

Moisture, 8.016 p.c.
Volatile matter, 38.63.
Fixed carbon, 50.408.
Ash, 2,945.
Heating power, 6995 calories.

The occurrence in boulder clay would not indicate a local origin in the deposit; the carbonaceous nature of the clay itself points to considerable friction of transportation. These considerations lead us to conclude that the material will never prove of much value, but a more extensive examination is necessary in order to establish its ultimate importance. A few men with shovels and picks would be able in a few days to disclose enough of the lignite to settle the question of its value.

From two miles above the Blacksmith rapids trips were made inland with the following results:

East. Rise of 20 feet, sand hill with spruce and poplar. Creek north, 20 chains clay flat. Very wet muskeg.

West. Rise of 30 feet, 50 chains of level spruce and poplar land; 60 chains of dry spruce country to a stream flowing north, the Onakawana river.

The River below the Lignite Deposit.

The Blacksmith rapid probably takes its name from these deposits of lignite; it is shallow and 300 yards wide, with the deepest water to the east. It can easily be run. One and a half miles below the rapid a stream enters from the east, known as Big Cedar creek. At the time of my observations no canoe could enter it, although it may be navigable in high water. It is a stream of some length, as it extends still with considerable size south of the latitude of New Post. Two shallow rapids of no importance intervene between this stream and the Onakawana on the west side, three miles down. This river is very shoal, and 60 yards wide at the mouth. Rapids are almost continuous. Its immediate entry is from the northwest, but it soon turns south and runs not far distant from the Aitibi. It occupies a valley of denudation in boulder clay and does not reach bed rock as far up as observed. The rapids occur over boulders of gneiss and limestone which are more numerous where the banks are high as might be expected. A little poplar is seen on the shores, but the muskeg begins immediately inland.

Big Cedar Creek and Onakawana River.

To the southeast, opposite the Onakawana, there are two belts of high poplar land, followed by muskeg of spruce and tamarac with a heavy undergrowth of alder.

On the main river two miles of smooth water is followed by swift and shallow rapids to the mouth of Little Cedar creek on the east side. A careful study of the surface geology was made at this point. There is 12 feet of level stratified clay at the river's mouth; three chains up this clay rises to a height of 15 feet and is underlaid by a hard stratified clay of a totally different aspect for four feet; this in turn, is underlaid by four feet of stratified sand and gravel. Below all is eight feet of boulder clay. Ten chains up boulder clay rises to the top of the hill; 20 chains up coarse gravel occurs over boulder clay at a height of eight feet. One half mile up we have 25 feet of stratified clay overlaid by two feet of boulder clay, in the top of which are found shells identical with species now living in James Bay. For example:

Tellina Greenlandica.
Maconea fragilis.
Maconea calcarea.
Saxicava rugosa.
Mya sp.
Several gasteropods and a species of Pecten.

Five chains above this are 25 feet of stratified clay, and 20 chains beyond boulder clay rises to the same elevation. The fossiliferous clay is black like the lignitic clay, and is overlaid by coarse gravel with cardium, gasteropods, etc. Across the Abitibi are 15 feet of stratified clay, apparently alluvial. At higher elevations is found a hard chalky stratified clay. It is therefore apparent that the rock is covered by boulder clay, which is overlaid irregularly by stratified deposits of recent date. In addition to these there is a belt of varying width following the river, consisting of alluvial deposits of still later origin.

An expedition was made overland, a distance of 12 miles to the line and five miles

beyond to the French river. Between the river and the line nothing was seen but flat wet muskeg and 12 small creeks flowing north. This trail crosses the line at the 275th post, in the middle of an exposure of gypsum having a diameter of three miles in all directions. The same muskmeg country continues to the French river, but is even wetter and is dotted with several ponds.

An Exposure of Gypsum.

For five or six miles below Little Cedar creek the river continues swift and shallow, with numerous small rapids showing ridges running about east and west. A trip east from here revealed a river bank only ten feet high, followed by half a mile of level land with eight-inch spruce ; this passes into continuous wet muskeg with small red spruce. At various points in this muskeg I endeavored to ascertain the depth of the moss, but could not penetrate beyond a depth of three or four feet owing to lack of appliances and to flooding by water. At that depth the moss was quite perfect, no sign of decay being apparent ; fragments of birch and small twigs of spruce were also well preserved. The moss is chiefly sphagnum, and as it extends over an enormous area, with unknown depth, it is safe to conclude that we have here an immense reserve supply of fuel in the form of peat. Regarding the extent of this supply it may be said that the deposits in question cover the whole region for 100 miles around the south and southwest sides of Hudson Bay. The line for the last 100 miles traversed an almost continuous tract of this kind.

Enormous area of Sphagnum Moss

The scenery through these immense stretches is unutterably dreary and monotonous ; the whole region is perfectly level, without the slightest elevation to relieve the eye. Travel through such a country is of course very arduous, owing to the continual exposure to wet and to the immense swarms of mosquitoes and black flies engendered by the large stretches of swampy land.

The spruce over these muskegs does not average six inches in diameter, and can be of little use even for pulp wood. I do not wish to convey the idea that no spruce of value occurs in this northern region ; as before stated, larger trees are found along all the rivers and lakes.

From the mouth of Little Cedar creek it is 25 miles in a northeast direction to the mouth of the Abitibi. The river has numerous islands and several rapids, all of which can be run down and poled up. The line crosses half way down this stretch, at the 288th post. For purposes of navigation the following list may be found useful :

The Abitibi re-crossed by the Line.

One mile, island of 25 chains.
Four miles, several 20 chain islands.
One and a half miles, shallow rapids and islands.
One mile, 30 chains of bad shallow rapids.
Two miles, pass three small islands.
Two miles, island, hard rapid, channel east side of west branch.
Four miles, shallow and swift, not rough.
Two miles, several islands and some shallow water.
Four miles, three large islands.
Three miles, islands and swifter water where the river widens and passes into the Moose through several mouths.

At the end the rapids become heavy. It is advisable to run down the west shore as far as possible and make a portage past the worst part. The portage is about ten chains long and avoids a very bad swell. Care is required below the portage, as there is still rapid and shallow water. The rock here is a thick bedded non-fossiliferous dolomitic limestone, 12 feet in thickness.

Moose River and James Bay.

The Moose river at the mouth of the Abitibi is over a mile wide, is shallow and fairly swift. A clear sight N. 40° E. (mag.) bears on a green point on the south side. In this distance are two long shallow rapids which can be best passed by crossing to the north side of the Moose as soon as possible after leaving the Abitibi. This manoeuvre also enables the traveller to avoid a long bar stretching into the river from the above mentioned point on the south side. From here the course lies 66° E. of N. for six miles to a point on the north side. In this stretch are two small rapids. A mile below the point, at a bearing of 80°, is the last rapids and the head of tide-water. Throughout this distance the north side is preferable, both for the reason already given and from the fact that the clearer waters of the Mattagami and Missanabie keep to that side and do not mix with

Courses and Rapids of the River.

the muddy water of the Abitibi to the south. Below the last rapid it is seven or eight miles to Moose Factory. A chain of islands occupies the middle of the river, which widens to two or three miles. Moose Factory is on the south side of Moose island; the traveller should keep along the north side of the islands un il seven miles down and then turn south between them. All along the Moose river and on the islands appear deposits of boulder clay or of strong stratified clay. Inland the country is very flat and shows the characteristic muskeg. With gradually increasing width the river continues 12 miles below the Factory and enters James bay. It is impossible for a ship of any size to approach nearer than this to the Factory. The Company's vessel, the Lady Head, anchors at this point and discharges her cargo into lighters which are towed by a small tug to near the port, where a second transhipment into small barges is necessary in order to effect a landing. Outside the anchorage are bars which require all the skill of the pilot, taking advantage of high water, to pass.

Head of Navigation on the Moose.

Features of James Bay.

James Bay is so shallow that 15 miles of shore is said to extend between high and low water a few miles north of Moose river. That this shallowness is due in part at least to the fact that the whole region is gradually rising may be seen from the following observations:

The Rising Region of James Bay.

1. On Little Cedar creek at a height of 25 feet above the stream, which probably represents 100 feet above tide water, were found shells of animals now living in the bay.

2. Old inhabitants of Moose Factory unite in saying that islands in the bay, which were mere specks within their memory, have obtained considerable size, though seldom, if ever, covered by the water.

3. A marshy island opposite Moose Factory, which is now at least a half mile long, is well out of water at high tide, although covered with water only at the time of the spring freshets. Within the memory of men now living at Moose Factory it did not exist at all.

4. A river of the size of the Moose would have cut a channel some distance inland had not some such secular movement negatived its action.

The shallowness is in part owing to the silt which is borne into the bay by many of the rivers entering it. Whether the bars now existing are constant in position is hard to determine on mere information. In conversation with men at Moose Factory I received the most contradictory information on this point. This is a matter of importance because, if shifting in nature, these bars would require constant dredging in order to keep a channel open. If constant in position I would conclude that the rush of tide and current would tend to keep them open.

Whether a harbor is possible at Moose Factory is a question entirely outside the scope of this report. I give these few facts and must let the reader draw his own conclusions. I am certain however that it could be done only at a great outlay.

Commercial Aspects.

There are no fish of any account in the Abitibi. Whether or not they are numerous in the bay is again a questionable point. I have heard that fish were so scarce that it was difficult at any time to obtain a mess. On the other hand, schools of fish were so compact as to impede the navigation of small craft. The most reliable information seems to point to the scarcity of fish of any commercial value. The fur-bearing animals do not seem to be seriously decreasing. Otter, fisher, marten, fox (red, silver and cross), mink and beaver are still numerous, and the annual yield is about the same as formerly.

Fish and the Fur-bearing Animals.

Moose Factory is over two hundred years old, and has been for some time the main point on James bay. Here are situated the head offices for the region; as the vessel from England lands all supplies here it becomes the centre of distribution for the whole bay. The population is about 200, consisting exclusively of H.B.Co. employés and their families. Several hundred Indians are connected with the post. The company has a small sawmill which manufactures lumber (spruce) for all the posts on the bay. A boat building shop is also maintained, which has turned out vessels capable of crossing the open bay.

Moose Factory.

Moose Factory also constitutes the headquarters of the Church Missionary Diocese of Moosonee. A substantial church has been erected, as well as a residence for the bishop. Outlying stations have been established at Fort Hope, Fort Albany, York Fort, Rupert's House, etc. The Indians are all, nominally at least, Christians; most of them are able to speak English and to read and write in their own language (Swampy Cree). They use a system of phonetic spelling well adapted to the language. South of New Post the Indians are Ojibways, and adherents of the Roman Catholic church. These Indians do not use the phonetic writing, but can write in the ordinary characters as taught by the Catholic missionaries.

Missions to the Indians

French River.

On the south shore of the Moose, opposite the last rapid, the French river enters. Its course is a little east of north for the last 32 miles. Above that point it divides into two streams, which again bifurcate and reach more more than 100 miles inland. To the east, by means of tributaries and small lakes, a route leads to lake Sagima, which enters James bay by the Forty Mile river that distance east of the mouth of the Moose. To describe all the rapids and other features of this 32 miles would be very tedious. Suffice it to say that the river is 100 yards wide on an average, expanding in places to a half mile and filled with islands. The current is strong all the way, but no portages are required as all the rapids can be poled. The more important of these are indicated on the map. The shores resemble those of the Abitibi in the same latitude. Many limestone outcrops occur. Some high banks are seen in which are fossils resembling those found on Little Cedar creek. Above the fork the east branch was first ascended. Five miles up it is a large deposit of gypsum, 20 chains long and 12 feet thick. This is the thickness of the exposure, but the whole thickness of the bed is indeterminable. This deposit is mostly gray in color, but pure white granular gypsum also is seen as well as patches of well crystallized selenite.

Drainage system of the River.

Gypsum deposit in the East Branch.

Six miles above the junction the stream breaks into two, the Ka-wuk-e-ka-mas-tuk to the east and the Wa-kway-ow-kas-tik to the west. Both were ascended a short distance and found to become more shallow and rapid. The eastern main branch was also ascended six or seven miles and found to be the same as the other two. It is crossed by the line several time , as shown on the map, and is known as the Kah-pah-nay-ow-sis-tik.

Summary of Exploration.

The region covered by this report may be considered as the basin of the Abitibi river, including the district around Frederick House river and Nighthawk lake. A detailed description has been given, and in the following summary will be found a general description under various heads.

Abitibi River.

The word Abitibi has a somewhat obscure meaning. It is possibly best translated as the river whose waters shine white at a distance; referring to the muddy nature of the water. From the two portages to the Otters, while there are many rapids, the intermediate stretches can be ascended without the use of a pole. Below the Otters, over the limestone area, the river is much more shallow and continually swift. It has already been noted that the general appearance of the upper river is in sharp contrast to the lower portions. This is best seen in the fact that the river is deeper at its margins above, permitting a canoe to approach close to the shore while the vegetation reaches to the water's edge. Below, this is entirely different, as the margins are shallow, forcing a canoe some distance into the river in order to float with safety, while beaches extend all along the limestone region.

Characteristics of the River.

Soil and Agriculture.

Large areas of dry clay soil extend around the Upper Abitibi and in the region of Nighthawk lake, while sandy tracts occupy the districts northwest of Frederick House lake and the height of land between this lake and the Black river. Throughout this section, on passing inland, we come to extensive level tracts, wet in places but underlaid by firm clay soil. If these stretches can be drained in the process of clearing it would open up

Areas of Clay, Sand and Muskeg.

the major part of the country as far north as the Big Bend for agricultural purposes. All along the river as far as this point the river-bank itself, with a width of two miles, is now sufficiently dry to take the plow. North of this Bend the country is decidedly wetter at any distance from the river, and cannot be described as other than muskeg. The river bank is still dry and high, but is not composed of as good soil, being far more sandy and covered with a less luxuriant vegetation. No considerable areas of arable soil exist on the lower river. The line itself for the last 100 miles traverses almost continuous muskeg. The climate permits the raising of roots, but it is a question if cereals will ripen. Barley has been raised at Moose Factory, but its maturing cannot be depended on. For stock raising I think certain parts of the country would prove excellent, as grass grows well and the crop of roots would furnish good winter fodder.

Timber Resources.

With the exception of a few small isolated trees no pine was seen in the whole district. Along the rivers and on the shores of lakes the timber is uniformly poplar and birch, the rough bark variety of the former tree increasing to the north. In the wet clay flats spruce of fair size extends over large areas. This timber will eventually be of great value for pulp wood. Trees of a large size are not numerous, the average being about ten inches. In the muskegs very small and useless red spruce predominates, extending over hundreds of square miles in the northern part. Some cedar is seen, but not enough to warrant a permanent industry. Alder, hazel and several species of willow are the characteristic shrubs.

Poplar, Birch and Spruce are the leading varieties.

Mineral Resources.

Excepting on the rivers no outcrops of rock are seen in the whole region, so well is the country covered with soil. Where observed the rock is barren; only two substances of economical value being seen—the previously described lignite and the deposits of gypsum. At the head waters of the Black river rather better looking rocks were seen; I understand that some finds of gold and copper have been reported on the Riviére Blanche. It may be that prospecting in this region might be rewarded.

Few exposures of Rock.

Water Powers.

The volume of water in the Abitibi, while subjected to enormous variations, is always sufficiently great to develop power at several places. On this river at the Iroquois falls is an ideal location, with a vertical drop of 24 feet. Another excellent place is the first falls on the Frederick House river, where we have a 46-foot descent in the distance of two chains. Where vertical falls are not the rule on these rivers, we have sufficient descent within a few chains at the Oil Can portage, the Lobstick portage, the Three Carrying Places, and possibly the Sextant.

Locations on the Abitibi and Frederick House Rivers.

Fur and Game.

Small game, as partridge and rabbit, are not numerous. Duck are said to be plentiful on Nighthawk lake in the spring, but they are very wild in autumn. Very few are seen on the lakes and rivers farther north, but the Indians report them to be numerous on the bay, although very shy and hard to obtain. In the southern parts of the district moose are coming in from the west; red deer are almost absent, while caribou are rare. The small swampy lakes which abound in the level clay areas have at one time swarmed with beaver, which, though still plentiful, have suffered considerably from the improvidence of the hunters. As a whole the region may be considered a fair producer of the ordinary fur—fox, otter, fisher, marten, mink and muskrat.

Duck, Partridge, Moose and the Fur-bearing Animals.

Geological Features.

Huronian rocks, consisting of altered diorites, pyrites, gray quartz schists and some soft decomposed schists occupy the country to the south, extending as far north as the head of the first long rapid on the Frederick House river. The line of contact of this belt crosses the Abitibi below the Iroquois falls. From this point to the Lobstick portage Laurentian gneisses and mica schists crop out occasionally. The narrow Huronian belt from the Lobstick to the foot of the Canon or Long portage consists mainly of augite-syenite,

Archæan and Devonian Formations.

passing into gabbro to the north. Beyond this portage Laurentian gneiss extends to the Devonian contact above the Sextant rapids. The whole region surrounding James bay is occupied by Devonian strata of sandstone, shale and limestone, the latter rock predominating. In these limestones Dr. Bell has reported gypsum and clay ironstone; the former only of these substances was seen.

Superficial deposits

Regarding the surface geology, the superficial deposits in the southern part is uniformly stratified clay. Farther north boulder clay is overlaid by sand and stratified clay. The mantle is of considerable thickness, reaching to 100 feet or more.

Missanabie River.

The return trip was made via the Missanabie river. In the following paragraphs will be found a short synopsis, dealing chiefly with the navigation of the river:

In the Devonian Belt.

Navigation of the River.

From Moose island to the mouth of the Abitibi has already been described. For 16 or 17 miles above that point the river is wide and shallow, with many swift places and three that might be called rapids, the last a fairly heavy one. Numerous islands occur here and the river is wide. Five miles up, after passing a mile of continuous shallow rapids, is an open stretch for a mile and a half through an extensive deposit of gypsum known as the White Rocks. Above these beds the river narrows and contains some large islands. I followed the northern channel and passed two hard rapids. Six miles above the White Rocks is Gray Goose island, past which the water runs with a stiff current, but is not shallow or rough. To Poplar isle and the junction of the Mattagami is about six miles of fair water. Above the fork the river is continuously shallow and swift for eight miles, beyond which is ten miles of fair water, but showing a good stiff current. Four miles more is a strong rapid and a mile beyond another with constant bad water to a small creek three miles above the last rapid. Above this creek are three rapids and then better water past the mouths of three rivers on the north side known as the Waboose, Atagawan and Ash rivers. Beyond the last of these is swift water and a rapid one-half mile up. A mile or two beyond the Poplar river enters on the south side. This is a stream of considerable size and serves well as a landmark. To two streams entering close together on the north side is ten miles. On this stretch bad water extends for a mile above Poplar river, followed by a piece of good water to three rapids separated by hard stretches of a mile each. Above these streams fairly smooth water extends for two or three miles, when we pass a small island. For four miles good and bad water alternate to a fairly hard rapid. From here to the Wabiska-gami river on the north are ten miles of good water. Coal river enters from the south 10 or 12 miles on. In this reach the water is good, broken only by two minor rapids about half way. The banks here are high and consist of clay, scarped in places, and showing deposits of lignite resembling those on the Abitibi. Eight miles beyond the Coal river the Missanabie turns abruptly to the south. Two miles beyond it passes out of the Devonian area and enters a Huronian belt.

In the Huronian Belt.

Landmarks of Rapids and Portages.

In the course of six miles southward we have a rapid, then two miles of fair water to three bad rapids. Above these is still another strong one which is best passed on the west side and a crossing made above to the foot of the Long portage on the east side. This portage is one and a half miles long and is fairly level. Above it, it is necessary to pole one and a half miles to the Stone portage of one-half mile on the same side. Between the Stone portage and the Riverside portage on the opposite side (three miles) are several hard stretches requiring poling and tracking. The Riverside portage passes a very picturesque gorge in which the river narrows to less than a chain; it is a half-mile long and level. Twenty chains of easy poling bring us to the Conquering House portage, also on the west side; it is short and easy. A few miles of good water extend above this portage, when we enter a series of rapids, consisting of four main ones and some minor ripples. Good water extends to the mouth of a river of some size from the west known as the

Mattawishquaia. Four miles farther brings us to Lower Skunk island, before reaching which we ascend three rapids. There are three of these islands, known as Lower, Middle and Upper Skunk islands. From the lower it is five miles to the Kettle portage, below which are some rapids. The portage is on the west side, and short. Above are almost continuous rapids, then a mile of fair water to the Black Feather rapids, which are rather heavy. The lower part was poled, but with the small canoe it was found necessary to portage the upper part. Five or six miles of good water, broken only by one or two ripples of no importance, bring us to the Rock Island portage of three chains. From this portage good water extends seven miles to Kakagee rapids. They are fairly heavy ; a lift-out was found necessary at one point.

Between Kakagee and Sandy bay, a distance of six miles, are four rapids, the first two light, the third heavy and the last at the foot of the portage. Sandy Bay portage is short, on the east side and past a very pretty fall. Three miles of good water bring us to Sharp Rock portage. This is a chain in length and over an island. Good water extends above Sharp Rock portage for two or three miles, when a portage is necessary on the west side. Above, poling is required for 20 chains, when we make the Beaver portage of 15 chains, also on the west side. Beyond the water is swift, rendering poling necessary for a short distance. Good water succeeds to the Albany rapids, a distance of nine miles from Sharp Rock. In these rapids the river is broad and shallow and there is a considerable fall. The rough water extends for 20 or 30 chains and can all be poled. The Albany river enters from the west a short distance above these rapids.

From the Albany river to the Devil's rapids is eight miles, the first part of which is good water to a sharp turn known as Wilson's Bend. Then succeeds swift water to the Devil's rapids. At this point and above are nine hard rapids ; I found it necessary to portage three times, the last by the Sugarloaf portage on the west side. Twenty chains above is the Achuter portage on the east side. Three miles of good water bring us to the Double portage on the east side. This portage is 25 chains in all, but is broken in the middle by a bay of the river, whence its name. The Brunswick river enters on the west side four miles above this portage. Four miles above the Brunswick river a hard rapid is caused by a spit of gneiss from the east side. Four miles more brings us to a small ripple followed by nine miles of good water to a heavy rapids requiring a lift-out. A small chute, with a drop of four feet, occurs three miles up. Six miles from here, after passing a river of some size, we arrive at St. Paul's portage on the east. A little rough water follows, and then good paddling to St. Peter's portage on the west side. In the next three miles are two long rapids to pole and then a half mile portage known as the Greenhill. It is on the south side and occurs where the river makes a bend to the north. It turns south again beyond the portage, and a mile brings us to the Wavy Rapid portage on the east side. Just beyond the river turns north again and we make another portage over an island. A short distance up is another rapid and a portage on the east side ; below it is a stretch of bad water and two small ripples above. Beyond the river resumes its southerly direction, and a mile brings us to a short portage on the east side known as the foot of Swampy Ground portage. This is followed by 14 miles of clear paddling through a level swampy district. A series of rapids follows. A portage on the east side of ten chains passes the first ; the next two must be poled, and the last may be run or may require a portage according to the size of the canoe. A little beyond a long rapid breaks the river for over a mile. It may in part be poled, but short portages are necessary. Another means of avoiding this obstruction is to make a half mile portage on the west side into the Nottawa river, which enters the Missanabie above this rapid. This stream is now so choked with driftwood that after descending 20 chains another half mile portage is required to regain the river. Three small rapids obstruct the navigation at intervals above the Nottawa. Clear water then continues for five miles, when two hard rapids occur. The first can be poled or tracked, while a well used portage of a few chains enables us to

pass the second. Three miles above this we enter Missanabie lake. The course is along the northerly shore, in a southwest direction, for 20 miles to a rocky point, where another arm from the north joins the lake. From this point we cross in a westerly direction to the opposite shore, follow it north for a mile and arrive at Missanabie portage. This portage of ten chains leads to a long thin lake ten miles in length. The Height of Land portage passes out of the extreme western end of this lake and enters Dog lake. It is short and somewhat swampy. Dog lake is very crooked and is crossed in three places by the Canadian Pacific Railway. From the portage to the station is eight or nine miles, but the route is so crooked that I am not in a position to describe it.

Crossing the Height of Land into Dog Lake.

Before closing this report I wish to express to Mr. Niven, to Mr E. Neelands and to Mr. W. S. Ritchie, members of his party, my sincere thanks for assistance afforded me during the summer. My gratitude is also due to Mr. Broughton of Moose Factory and to Mr. Jobson of New Post for valuable information and kindly treatment, and to the Very Rev. J. A. Newnham, Bishop of Moosonee. I am also indebted to Professor Coleman of the University of Toronto and Geologist to the Bureau of Mines for valuable advice and assistance in the preparation of this report.

Acknowledgements

GOULAIS RIVER TO DALTON.

By W. A. Charlton, Jr.

PURSUANT to instructions received from the Director of the Bureau of Mines to accompany the survey party of Mr. Speight, O.L.S., upon a Meridian Line to be run from the north end of the line between the townships of Hodgins and Whitman due north to the main line of the Canadian Pacific Railroad at or near Dalton, I left Toronto July 9, 1898, in company with Mr. Speight and his assistants, and arrived at Sault Ste. Marie the day following.

The starting point of the line between the townships of Hodgins and Whitman could be most easily reached by a walk of twenty miles inland from Garden river, but it was necessary that some of the party should come in with the canoes by way of the Goulais river. My instructions required me to accompany Mr. Kennedy, forest ranger, in side-trips from the line, and to undertake a geological exploration of the tract traversed. Subsequently I was detailed to accompany Mr. Kennedy into the country east of Batchawana bay, watered by the rivers Batchawana and Chippewa.

In and Around Garden River.

From Garden River to Starting point.

Garden River, situated upon the Indian Reserve ten miles east of Sault Ste. Marie, is a most picturesque spot and well merits its name. The soil there is sandy, but fine crops of potatoes, cabbage, etc. are raised and the pasturage is excellent. At Echo bay, five miles east, the land is a good clay loam and is the centre of an industrious farming community.

One mile north of Garden River station, on the road leading to Hodgins township, we passed extensive gravel beds, the property of the Canadian Pacific Railway Company. Beyond these the country on both sides of the road is well timbered with maple and birch. For ten miles the road is good and the slopes gradual, after which high rocky hills are encountered. Several swift running streams were passed, two with gray clay bottoms at the points of crossing. Along the roadway timothy was growing to a height of three to four feet, indicating that the country if cleared would make meadow and pasture lands of the first quality.

Rocks of the Cambrian System.

At about eight miles from Garden River a stretch of red sandstone crosses the road, and again near the eleventh and near the sixteenth mile similar stretches were passed. As we neared the Goulais river the country was seen to become very rough and mountainous, and from the hill-tops a good view of valleys well-timbered with spruce was obtained.

The Goulais River Valley.

Agricultural lands on the Goulais.

Where the road first reaches the Goulais river the Sault Ste. Marie Pulp Company have established headquarters for their winter camps. Here is a considerable clearing, and potatoes cabbages, turnips, carrots and onions were growing. The clerk informed me that this agricultural stretch extended, brokenly, one-half to one mile on each side far down the river. But above these camps the hills close in, leaving little level land between the river and the rough upland. The north bank of the river here is of sand and gravel, the south bank is a gray clay. A few miles from the headquarters of the Pulp Company's camps is a prospect owned by the Chicago Lumber Company. Samples of ore shown me were well mineralized with galena, copper and iron pyrites. I understand that a fifty-foot shaft was sunk in 1897, and that some drifting has been done.

Rock Formations of the Line.

Laurentian Gneiss.

For six miles above the camps the bed of the river is mostly gravel and sand, with stretches covered with large pebbles; a half mile west of the line and one and a half miles from its starting

point is a series of falls, 35 feet in all, with a portage on the east bank three-eighths of a mile long. These falls are over rock of the Laurentian gneiss, and below the river bed is well filled with boulders, mostly weathered gneiss and granite. East of the falls is a morainic deposit of gravel and sand, here 120 feet high and extending northeast, along the eastern side of which a stream 20 feet wide flows southwest, emptying into the river. About four miles above the falls several clay banks were noted on the west side of the river, one 70 feet wide and 25 feet high of gray strata. The water trickling down these banks was cold but soft. At this season of the year the river is quite shallow, and the current being swift, averaging over two and one-half miles per hour, it is necessary to pole in ascending by canoe.

At the second falls, near the 5th mile, a band of schistose rock 200 feet wide crosses the river, showing evidence of intense pressure and crushing. The rock is chiefly mica schist, but in places were sericite schists heavily charged with copper pyrites. A hard dark-gray rock with pitted surface walled the schists on the lower side. Up the bank, above the sweep of the water, this rock showed little circular masses of hornblende crystals upon the surface. Above the falls, on the east bank, rises a granite bluff nearly 700 feet high, and from the top of this a great number of similar risings were seen in the surrounding country.

Mica and other Schists

On a trip east of the 3rd mile a hornblende-granite gneiss was encountered, but the general country rock is the mica gneiss. At the 8th mile a contact of the granite-gneiss with an altered dark gray diorite occurs, the strike being west 10 degrees north. The diorite belt does not extend far, for two miles further on at the next exposure of rock (a wooded belt having been crossed) granite-gneiss is again met. One and one-half miles west of the 10th mile, crossing a tributary of the Goulais, is a large vein of quartz interbedded with much chlorite schist and carrying iron pyrites, chalcopyrite and bornite. The wall on either side was granite gneiss, the direction of the vein northeast and southwest and at this point was a perpendicular fall in the stream of 35 feet.

Contact of Diorite and Gneiss.

The bed of the creek below and above was full of boulders, weathered granite, gneiss, diorite, diabase and some fragments of schists.

Between the 15th and 16th mile there is a contact with the gneiss of a coarse-grained, hard gray granitoid rock, north 10 degrees west, and this gives place beyond the 16th mile to an area of slate and hornblende schist. Chlorite and sericite schists were met with on the shores of little lakes in this vicinity and up to the 21st mile. Beyond the 21st mile granite-gneiss again appears prominently and continues unbroken to the 26th mile, where slate and chlorite schist cross westerly. Some lean-looking quartz veins were passed in this locality. Two miles east of 26th mile slate was passed close to a little lake, but this seems to be included in the gneiss which appears at the 27th and continues to 30th mile, showing much mica. Between 30th and 32nd mile several areas of hornblende schists were noted, and two miles west of the 32nd mile a contact was crossed west 10 degrees north.

Slates and Schists.

To the east of the line between 36th and 38th mile several parallel dikes of diabase cut through the gneiss in a northwesterly direction and west of the 37th mile diabase dikes, green schists and phyllite parallel to the first named were passed. East and west of the 36th mile the country is a succession of high bare bluffs, and the river a series of chutes and falls for some distance below the line. But a little northwest of the 37th mile, the land is lower and more level, the hills presenting the appearance of having been worn or ground down, being low crowned and flat and covered with a mantle of gravel and white sand. Numerous little lakes were passed here. About three miles west of 38th mile diabase dikes and small areas of hornblende schists extending northerly were observed. Between the 38th and 39th mile two little lakes cross the line, around the shores of which is much green schist. From the 39th to the 40th the country is well covered with white sand and organic matter.

Diabase Dikes.

A Stretch of Montreal River.

A branch of the Montreal river crosses the line at the 40th mile, and beyond this the white sand extends three-quarters of a mile to a high

hill of Laurentian gneiss which rises abruptly 215 feet and slopes to the west, meeting the Montreal river a quarter of a mile west, the river here cutting through the rock and falling 35 feet or more. We crossed the Montreal river again at intervals up to the 51st mile, and during this distance I followed the banks on foot. On the western bank, at about the 42nd mile, an area of intrusive diabase 600 feet wide cuts through the gray granite and gneiss north 30 degrees west. Several dikes of the same rock were passed while crossing the hills east of the river between the 43rd and 45th mile, and a large area of saussurite-gabbro. These lay parallel or nearly parallel to each other, the strike varying from 20 to 30 degrees west of north.

Hills of Laurentian gneiss

Diabase Dikes.

From the 41st to the 47th mile the land is rocky and uneven, with many high hills and bluffs, and the country rock is well impregnated with iron. At the 47th mile begins a stretch of comparatively level lands well covered with sand, with areas of moss and muskeg. This stretch extends brokenly to the 59th mile, and rock exposures show a coarse-grained crumbly biotite-gneiss throughout this distance. A brulé extends from the 49th to the 54th mile.

At the 59th mile, on the north bank of the Mattawan river, a hard gray medium-grained granite-gneiss succeeds the poor variety of the last ten miles. Beyond the bank of this river there was little rock exposure up to the 73rd mile, the country generally presenting a rolling stretch of muskeg and ridges with some hills covered with sand and well wooded. East of the 70th mile and extending to the north for three miles and to the east for several miles, is an extensive sand plain with stretches of jackpine.

Ridges, Muskeg and Sand.

Mattawan River to Lake Windermere.

On September 19th Mr. Kennedy and I left Mr. Speight's camp to explore the shores of lake Windermere. We left at the 73rd and rejoined the camp at the the 83rd mile. Several bays of Windermere were entered and explored, rock exposures revealing a common whitish granite-gneiss. Several beaches of white and red sands were noted, particularly along the south shore of the main body of water. From lake Windermere we followed the outlet west and north towards Dalton. Gneiss predominated, but areas of true granite were passed at points west of the 84 to 85 and 86 to 87 miles. Talc schists were observed west of 84 to 85 miles. About west of 88 to 89 miles the river enters an area of sand and gravel with banks varying from 10 to 30 feet high. We made a portage somewhere in this region crossing to a little lake, and thence over the sand plains to the railroad track one mile and a quarter east of Dalton. The next day was spent upon the hills north of lake Windermere, which presented seemingly a high gneissic glacial-swept area. Some prospecting has been done there this summer, and I was shown white quartz with galena. I crossed a considerable area of rock country, finding nothing but gneiss of the Lower Laurentian. Several dark dikes were noted, fused into the light country rock.

Gneiss and Granite.

Natural Resources of the Country.

The Goulais river is a swift-flowing stream, rising in springtime six feet above the level at this season. Its valley is well timbered with spruce, tamarac, balsam and other woods, with numerous spruce and hardwood (birch and maple) bluffs on either side. The river crosses and recrosses the line several times up to the 8th mile, where it turns, coming almost directly from the east. Three falls were passed between the 1st and 8th mile, and on two of these some blasting would be required for log-driving. No large stream was crossed after leaving the Goulais until we reached the 26th mile, where a branch of the Chippewa rises one mile west of the line. Between the 27th and 28th mile the first branch of the Batchawana was crossed, and subsequently the second and third branches between the 32nd and 33rd and 36th and 37th miles respectively. The general slope of the country so far is to the southwest, and a majority of the little streams met were swift flowing. Few lakes were met on our side trips, the country being very rough and uneven and unfavorable to reservoirs. From

Timber and water falls on the Goulais

and Batchawana rivers.

the 6th to the 30th mile neither cutting nor trail indicated that hunter or trapper ever visited this region, and there were but few signs of game. Beyond the 30th mile game is more abundant, and the country is visited chiefly by Chapleau Indians.

At the 36th mile the Batchawana river presents a series of falls, which we followed for some distance down. No portages showed that this river had ever been travelled through here. Above and northeast of the line the river is broader and quite navigable, and is connected by a chain of lakes and portages with Montreal river, the route entering the latter at a point about six miles west of the 39th mile

Spruce, white Pine and Hard-wood

Some areas of white pine were passed or sighted on our side trips Up to the 20th mile the country traversed was timbered chiefly with black birch and maple, except in the valley of the Goulais and its tributaries, which contains much spruce ; but other woods—ash, elm, cedar and tamarac—were noted as well. Beyond the 20th and up to the 30th mile the timber is smaller,—white pine, spruce, tamarac, and cedar, with extensive areas of poplar and white birch. Between the 30th and 33rd mile the wood is small, and of no commercial value, with no pine on either side of our course, but east and west of the 33rd to the 35th mile are both spruce and pine, with hardwood hills of maple and black birch. Between the 35th and 36th mile the line passes through a brulé, and the bare bluffs extend at least seven or eight miles to the west, while to the northwest and northeast are spruce and hardwood hills, and in the valley of the Batchawana to the east and north small spruce and balsam. West of the 37th to the 40th mile the timber is small with much underbrush of hazelwood, but at the line and to the east there is better growth of spruce, tamarac, birch and small maple.

On the Montreal River.

Spruce and white Pine.

Along the Montreal river from the 40th to the 51st mile, small spruce, balsam and tamarac, and some ridges of good spruce and white pine were passed. Along the hills to the east of the river blueberries, pink cherries and high-bush cranberries were plentiful. Spignet was found on the banks of this and the Mattawan rivers.

The brulé which was crossed from the 49th to the 54th mile was well-covered in places along the east bank of the river with rich long grasses. Blueberries and raspberries grew in great patches. The burned area stretches from two to four miles on each side the line and extends in a west by northwest direction.

To the east of the 54th and 55th miles lies a spruce and balsam valley, succeeded at the 55th to 56th mile by a muskeg area. Between the 56th and 59th mile the land is generally more rolling and better timbered with small wood—tamarac, jackpine, spruce, poplar and birch.

Mattawan River to Height of Land.

Thrifty Tamarac and Jackpine.

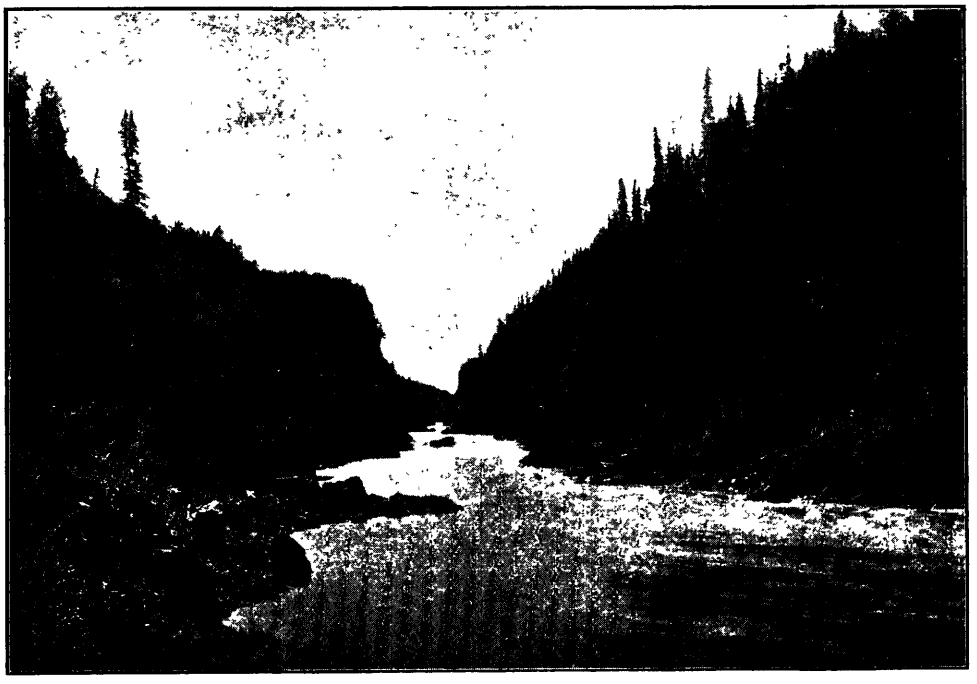
The Mattawan river, crossed between the 59th and 60th mile, is deep, crooked and somewhat difficult for canoe navigation It traverses a wide valley and expands at short intervals into small lakes. Large jackfish were caught in its waters. The river narrows, two miles above our crossing point, into a little unnavigable stream. Both banks are well timbered, chiefly with tamarac and jackpine. Considerable tamarac was noted in this section which would make five or six good ties per tree. The river empties into the Montreal three miles to the east.

Crossing the Water-shed.

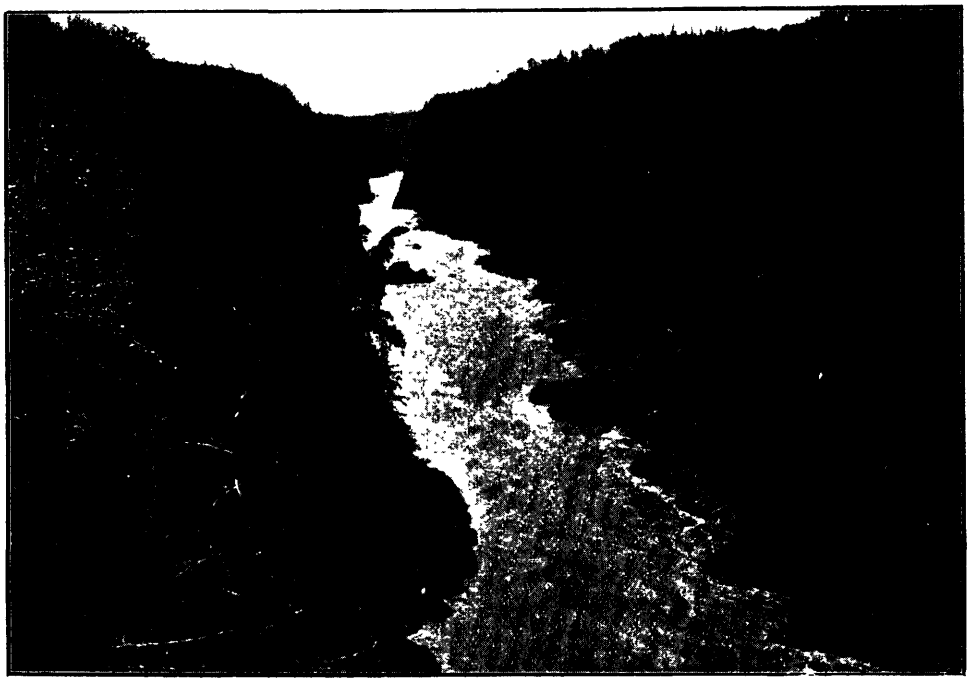
Between the 60th and 64th mile the land rises to a higher level, the hills sloping generally to the southeast. From 64th to the 67th mile comparatively level areas extend on both sides of the line, and it was evident that we were crossing the height of land. From the 67th to the 70th mile is a rolling stretch of muskegs and ridges, timbered chiefly with tamarac and spruce in the lowlands and with jackpine, birch and poplar on the ridges. Underneath the white sand the rock is a gray gneiss.

A little Reservoir.

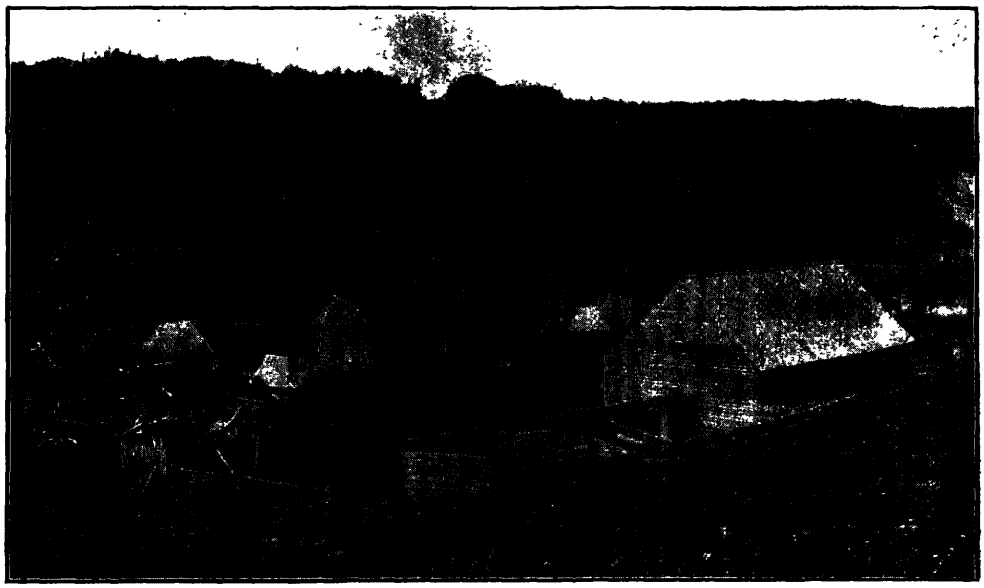
A small lake with much sand beach was crossed at the 70th mile. A navigable stream enters at the eastern end from the northeast, another from the south at the southwest, while the outlet flows northwest from the western end. Two miles beyond, at the 72nd mile, the line crosses between two large ranges of hills,



Abitibi Canon, looking south from level of River —Parks.



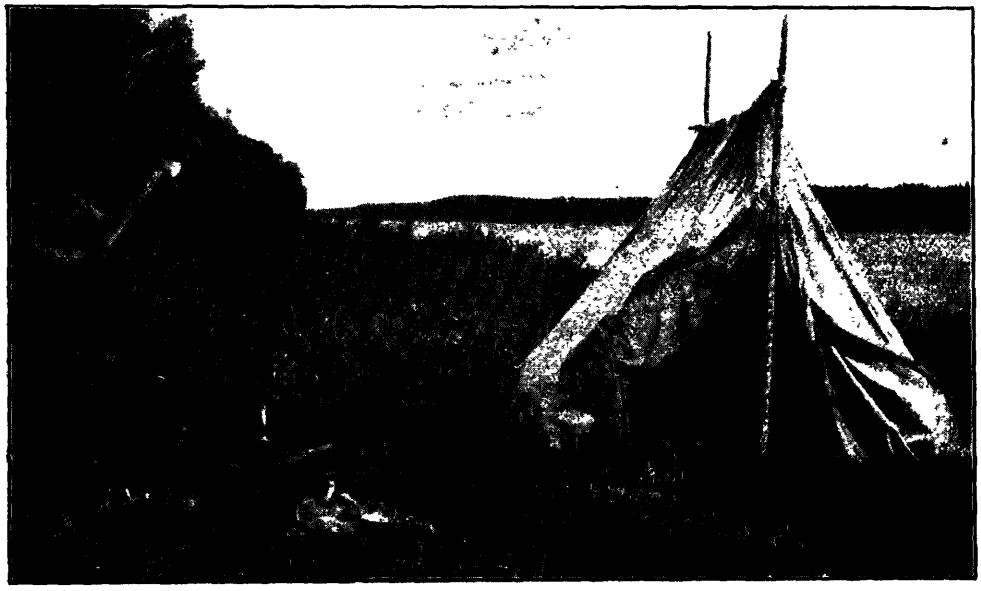
Abitibi Canon, looking south from bank of the River —Parks.



New Post (H B Co) on Abitibi River – Parks.



Indian Camp at New Post, Abitibi River – Parks.



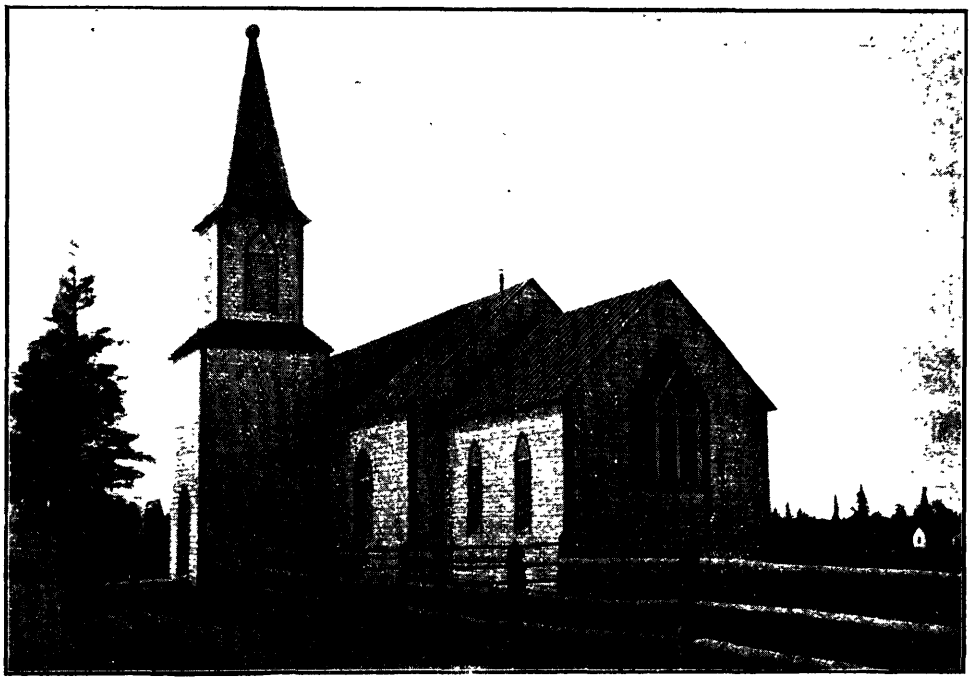
Camp on lower reach of Abitibi River --Parks.



Lignite deposit on Abitibi River —Parks



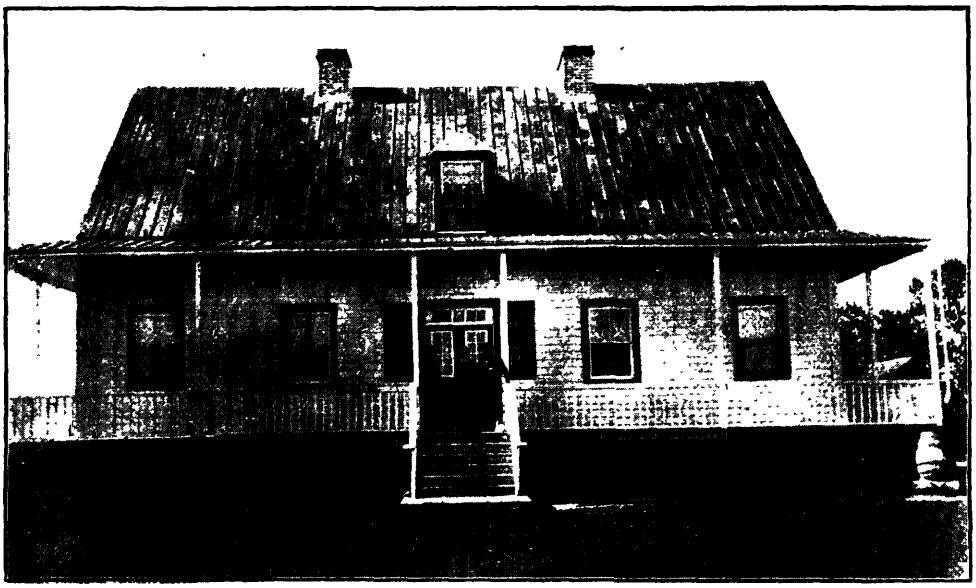
24 Limestone Cliff at Sextant Rapids, Abitibi River. —Parks



The Bishop of Moosonee's Cathedral at Moose Factory —Parks



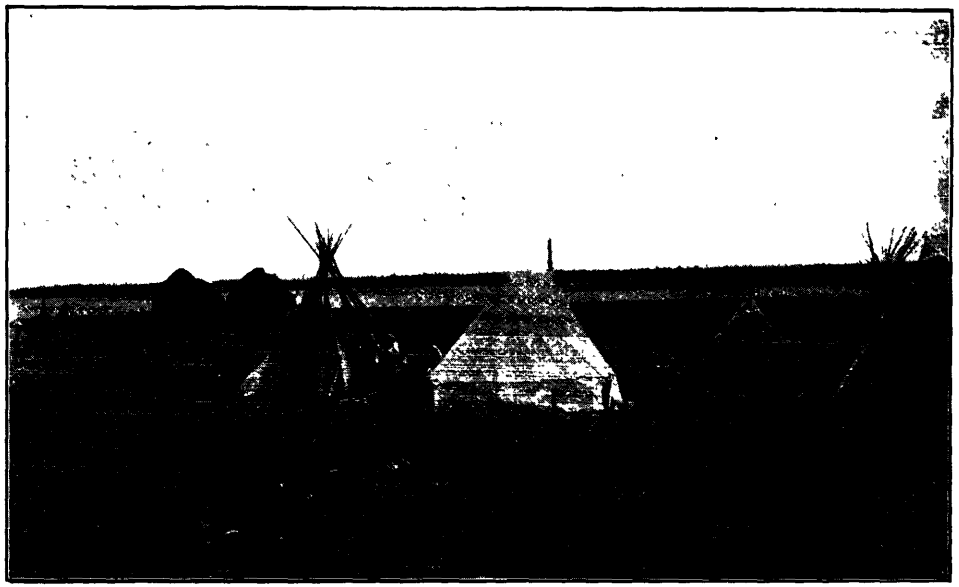
"Bishopscourt" at Moose Factory —Parks



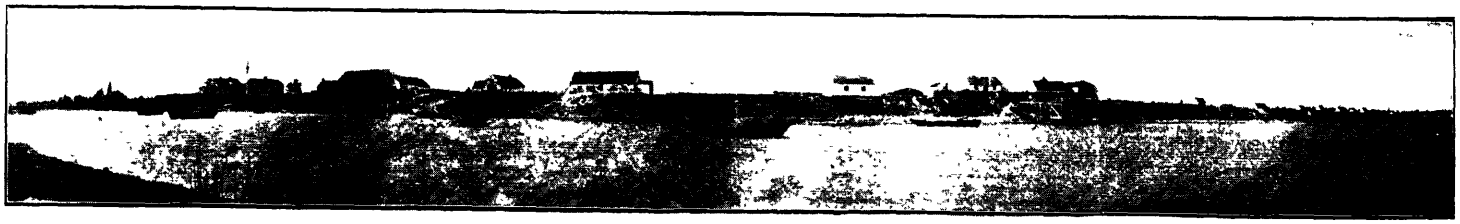
Chief Factor's Residence (H B Co) at Moose Factory. —Parks.



H. B. Co Employe's Family at Moose Factory. —Parks



Indian Camp on Moose Island —Parks



Moose Island, showing H B Co Buildings ot Moose Factory —Parks

those on the west sloping to the northwest and those on the east to the northeast. We followed the outlet of the lake at the 70th mile for some four or five miles of its course, passing through much marsh land with small tamarac and spruce on the sides. Several cuttings along the stream indicated that it was a travelled route. Five miles from its source it turns abruptly to the west and we concluded that it probably emptied into the Michipicoton waters. Rock exposures along the bank were all gray granite-gneiss, with some darker exposures fused into the former and well impregnated with iron. Returning to the lake, the feeder at the northeast was visited. This flows from a little lake about a mile and a half east of the 71st mile. Its course is entirely through low marshy lands with poor timber. To the east extends an area of muskeg and swamp. Two beaver dams were crossed. Beyond the lake to the east of the 71st mile the country north and east rises to a level sand plain crossed by a portage two and a half miles long to a tributary of Prairie Bee lake. Windermere Indians come in this way to hunt. The river end of the portage is just three miles east of the 73rd mile, and the country between is a rolling stretch of plain and muskeg. In the low marsh areas ground-cranberries were found, the first we had seen in quantity. Paddling down the river we passed through a low-lying region partly timbered with small spruce and jackpine.

Prairie Bee and Windermere lakes.

High, bare, rocky bluffs line the shores of Prairie Bee lake to the south, southeast and southwest. On the north the hills are covered with a mantle of sand and are well-wooded, chiefly with poplar and birch. Entering Windermere lake we traversed several of its bays, and climbed some of its highest bluffs, the whole country around its shores presenting a uniform appearance—birch and poplar timber, bare hills of gneiss and sand beaches.

An Indian settlement.

Several families of Indians live at the lake, fishing and cultivating little gardens. Whitefish, lake trout and jackfish are plentiful in Windermere waters. The outlet, called by the Indians "Bad river," is for miles a succession of falls and rapids. It is not a much travelled route and we had to cut our portages, which were numerous. It flows northwest until within two or three miles of Dalton, where it turns southwest, being joined at this point by the Missanabie and Dalton stream, and emptying into Michipicoton waters. Another water-way reaches from lake Windermere to Dalton, north of the C. P. R. track, but this is as bad as the first. A good canoe route extends south of the track from Windermere to Chapleau.

The Batchawana River Region.

Three days after leaving Mr. Speight's party at Sudbury we arrived at Batchawana bay and began our trip up the Chippewa river at once. Our camp for the night was at the foot of the lowest falls on the river, where the descent is about 75 feet, with a portage of half a mile on the left or north bank. At the upper end of the portage is a hard greenish rock of felsitic texture, which forms a natural damway where it crosses the river, so that the water of the stream could be backed here at very little expense and a strong power secured. Near the foot of the portage a trail was noticed rising from each bank of the river. This leads from Batchawana to the Government road which stretches from Sault Ste. Marie in this direction. The people of Batchawana hope that the road will soon be extended to their settlement and the rivers Chippewa and Batchawana bridged.

Waterfall on Chippewa River.

Up the Chippewa clay banks were frequently met with. High bluffs extend on the left side, but on the right is no mean stretch of river flats, well timbered with hardwood. These flats, if cleared, would make fine agricultural and pasture lands. Their cost and the labor expended in clearing might be more than repaid by the sale of hardwood, especially to winter camps.

Agricultural and Pasture lands.

North of the Chippewa.

Finding the Chippewa shallow and hard to ascend, we left it after a day and a half, on Thursday, October 6, and portaged inland north 5 degrees, east a mile and a quarter to Little lake. The country passed was a fine stretch of hardwood with scattered white pine, not large but solid and

Hardwood and Pine.

thrifty on the ridges and in the valleys. The slopes and ridges were well covered with a good sandy loam, intermixed with organic matter. Lake No. 1 lies about 200 feet higher than the Chippewa at the point where we left the river. We paddled three-quarters of a mile north and again portaged, going one mile north, 20 degrees east, to lake No. 2, travelling up a ravine between hills of gray granite gneiss. Considerable white pine was noted on the ridges passed and around lake No. 2. Crossing a little height of land we came to an old Indian camping ground and an extensive sugar bush. Years ago this country was well inhabited, but for some reason the game left or was driven out and is only now returning. From the old sugar bush we paddled across a little low-lying lake with pine upon its shores, and portaged into lake No. 4, a lake of legendary fame, whose tale our guide related as we paddled northwest a mile and a half on its waters. Large rocky bluffs line the shores, and a good deal of pine was observed.

An old Indian Sugar bush

North a mile and a half of lake No. 4 an area of green schistose rock was seen about half a mile in width, and striking west 20 degrees north we passed this in the low lying grounds of a former lake basin. Continuing half a mile north through good hardwood bush, maple and black birch, we came to another little lake, and having portaged from it 13 chains over a little height of land we entered the first lake, of the Batchawana system. The lakes of this system are easily distinguishable from those of the Chippewa by reason of the waters of the first named being dark and brownish colored, while those of the latter are clear as crystal. Speckled trout are found in nearly all the lakes. At lakes 6 and 7 we saw no pine. Going northeast up stream from lake No. 7 we came to a recently burned area which extended along our course for some miles. We now passed through a series of marshy lakes and streams of shallow water with much muck bottom. Many little portages were made and scattered areas of white pine noted. Small spruce, tamarac and balsam grew around the waterway. Turning to the southeast we again entered Chippewa waters. Numerous wolf trails were seen round one of the streams.

Green Schists.

A Region of Lakes and Marshes

To the east stretch a level plain, partly open and covered with dry mosses and a good growth of short coarse grass. Crossing a mile and a half of this open we came to a little stream and one-half mile farther to a heart-shape lake the shores of which were thickly wooded with small white pine.

Around Lake Chippewa.

After portaging we entered lake Chippewa, and here camped for three days, October 8 to 11, spending this time in exploring the country to the east and southeast of lake Chippewa. The whole of this district is well covered with hardwood, with scattered pine throughout and belts of pine around the lakes and in the valleys. An area of slate and diabase crosses lake Chippewa, striking north 40 degrees east. Three miles south of the same lake a diabase dike was crossed, and in the same vicinity quartz with magnetite and green schist walls. Samples from a quartz vein yielded traces of gold upon assaying. To the west of lake Chippewa hardwood ridges with little pine extend to the Batchawana river. North of the lake is a series of little lakes most of which are tributary to the Batchawana. To the east of these lakes is a pinery stretching to and beyond the Chippewa river.

Slates, Diabase and Veins of Quartz.

From a high bluff at the southwest end of Wart lake the country north, south and east could be seen for miles. To the southwest, south and southeast lay a country of hardwood hills and plains, ridges and valleys of pine, and extending, our guide said, through to the banks of the Goulais. But beyond Wart lake to the north and northeast a rough country was distinguishable, a great succession of bluffs, some timbered with spruce, but being for the most part bare rock,—the whole having the same appearance as the country crossed by our meridian line in this latitude. Gray granite bluffs surround the south and west shores of Wart lake, rising in places to an altitude of 350 or 400 feet.

Wart Lake.

The Batchawana Valley.

West of Chippewa lake the Batchawana river is wide and shallow. The bed is covered with large boulders and paddling in a birch canoe is slow work. Going down the

river Mr. Kennedy and I walked the banks while our guide brought down the canoe with the packs, he being in the water much of the time. After a day of this work we were able to do more paddling, the water being deeper and the stones in the bed smaller. Numerous stretches of gravel and sand were passed and along the sands of the river-side grew choke- and ground-cherries. Many wolf tracks were noticed.

This river must rise at least four feet above its autumn height in the spring-time, and then its waters come down with great force, as was evidenced by the presence of large stones which had been carried in among the bushes of banks three or four feet high.

Two series of falls were passed and portages made, going down the river. Logs would probably pass over the first fall easily enough in high water, but the rocks of the second would require some blasting for driving. A hornblende schist extending southwest was noted in contact with the granite-gneiss at the first falls.

Falls on the River.

We left the Batchawana river a few miles from its mouth and portaged two miles westerly into Pike lake, and from there two and one half miles to lake Superior. High bluffs of gray granitic rocks lay to the northwest of our portage into Pike lake. Iron and copper were found here, our guide said, more than thirty years ago. From Pike lake a trail of a quarter of a mile leads to an old road extending from lake Superior back four miles to a bed of iron ore. This road was graded and the ties laid more than twenty-five years ago, and much of it is now grass-covered. No ore was ever taken out over it, and at Batchawana I could not learn why operations had ceased at such a stage. The road passes through a country comparatively level,—sand loam and gravel, thickly timbered with hardwood and spruce. Much of this land would be suitable for agriculture.

Pike Lake.

An abandoned Iron Mine.

All the level front of Batchawana bay has been taken up for settlement. Some of the settlers are reaching back inland. Apple trees in the district bore and ripened fruit this year, but the crop is comparatively rare. Batchawana is one of the best fishing stations on lake Superior, and its front is well lined with a fleet of fishing boats. The steamer Telegram does a busy carrying trade throughout the season, its owners buying all the fish taken along the Canadian shore from Sault St. Marie to Otter Head. Three lumbering firms are operating in this district this season, two taking out pulpwood and one cedar. Altogether 500 men or more will be employed for the winter.

Farming, Fishing and Lumbering.

The large island in Batchawana bay is for the most part comparatively level land, is well wooded, and would make good farming or ranching land if cleared.

Eight miles below Batchawana, near the mouth of the Chippewa river, is a copper prospect upon which considerable blasting was done in 1897.

The business atmosphere of Batchawana is healthy and invigorating—lumbering, fishing, farming, with not unpromising prospects of development in iron and copper.

Economic Minerals of the Line.

At Garden River I was shown samples of nickel and iron ore said to have been taken from rocky bluffs in the country to the northeast. At Goulais river there is a gold and silver prospect, already mentioned in this report. Mineralized belts were crossed in this locality and up to the 12th mile. Of the country from the 16th to the 23rd mile the rock formation is very hard and in places flint-like, and not likely to prove good prospecting ground. Extensive slate areas of dull gray color were passed here. Quartz veins, carrying at the surface iron and copper pyrites, were passed in the country east and west of the 26th to the 30th mile.

Nickel and Iron, Gold and Silver.

A number of veins were crossed in the country along the 36th to the 43rd mile. Samples taken from a large quartz vein with schists assayed 7 oz. silver and traces of gold. The rocks to the east of the line were heavily impregnated with iron. Schists and diabase dikes cutting northwest through the granite were numerous here. This I believe is the most promising region for prospecting along the meridian line. It is four days' journey by water from Chapleau, and five or six from Batchawana.

In the Laurentian area north of the 45th mile little or nothing was found, if the talc and mica schists of Bad river be execpted.

In the region of the Batchawana and Chippewa rivers were numerous indications of both copper and iron. A dull lead-blue slate was found on the shores of lake Chippewa. A quartz vein south of the lake yielded traces of gold. Magnetite and quartz associated were found in this vicinity.

Copper and Magnetite.

CORUNDUM AND OTHER MINERALS.

By Willet G. Miller

Introduction.

FIELD WORK on the Economic Geology of Eastern Ontario was carried on during the summer of 1898 on lines similar to those followed in 1897.[1] It was at first proposed to complete the work in connection with the outlining of the area over which the corundum deposits occur, and after this was done to spend some time in studying the deposits of iron and other substances which have been attracting considerable attention in this part of the Province during the last few years. As the work progressed, however, the corundum-bearing rocks were found to cover such an extensive area that little time could be devoted to the deposits of other minerals.

My assistants, as in 1897, were Messrs. R. T. Hodgson and W. C. Rogers, whom I have to thank for the interest they showed in the work.

The Director of the Bureau of Mines spent the last week of September in the district, and I accompanied him in a visit to some of the chief corundum deposits.

During the past season, as in 1897, we received many favors at the hands of persons living in the district, and I desire to return thanks for the assistance which was so willingly given us during the progress of the work.

The Corundum Areas.

Our work in 1897 showed that corundum occurred at places over an area of about 50,000 acres, lying partly in the northern portion of Hastings and partly in the adjoining county of Renfrew. The length of the belt or strip of country in which we found the mineral in that year was about 30 miles. It was known, however, as stated in my last year's report and as shown on the index map which accompanied it, that rocks similar in character to those in which we found corundum in this belt outcrop to the south and southwest. I also stated that it was likely the mineral would be found to occur in place in this part of the district. These rocks, among which are the first outcrops of nepheline syenite discovered in the Province, had been studied pretty closely in some respects, but it seemed to me likely corundum would be found to occur in certain facies of them to which little attention had been paid by the geologists who examined the district. Our work during the past season has verified this prediction, as we found corundum in place at a number of points in Dungannon and other townships in which the remarkable masses of nepheline syenite have for some years been known to exist.

General observations of Occurrences.

In Nepheline Syenite and Anorthosite.

A very interesting occurrence of corundum was discovered in the townships of South Sherbrooke and Oso, where the mineral was found in a basic anorthosite. The similarity of this mode of occurrence of the mineral to some of those of Russia and India will be referred to again.

The past season's work has shown that corundum is to be found at intervals along a belt of rocks which runs for a distance of about 75 miles from the township of South Algona in the northeast to the township of Glamorgan in the southwest. In addition to this there are two bands of corundum-bearing rocks of lesser length which have not as yet been connected with the main belt. One of these belts, which has a length of about eight miles, runs from the township of Methuen in Peterborough county through a corner of the adjoining township of Burleigh to Stony lake. Another belt, which so far as examined is found to have a length of 10 to 12 miles, runs from the western part of the township of South Sherbrooke in Lanark county through the township of Oso southwestward into Olden and Hinchinbrooke in Frontenac county.

New Belts discovered and explored.

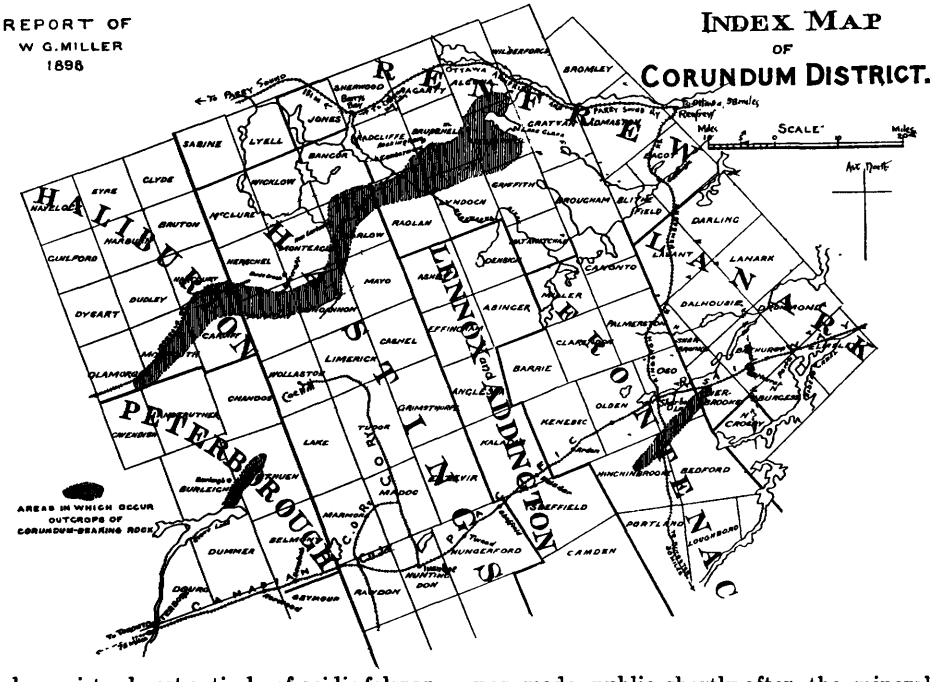
[1] Part III, Seventh Report of the Bureau of Mines.

The locations of these different areas of the corundum-bearing rocks are shown on the index map which accompanies this report (p. 198). It will be seen that the smaller belts are separated by a considerable distance from the larger belts, and that the three belts taken together partly surround a large district.

Index Map of Areas

As stated in last year's report, the corundum occurs as a primary constituent in a series of rocks which may be classed broadly as syenite. Numerous varieties of syenite are met with in this field, both as regards size of grain and constituent minerals. In some cases the rock consists almost entirely of acidic felspar, pink or white in color. In other cases nepheline, mica, hornblende or corundum is present. Corundum also occurs in a locality discovered in 1898 in a rock which may be classed as a basic anorthosite. The corundum-bearing rocks often occur as dikes which cut through the overlying gneisses. At other times these rocks have the form of large masses which in some cases appear to shade off into granite. In the following pages reference is made to the chief characteristics of the rock in different parts of the field.

A primary Constituent of Syenites.



Peterborough and Haliburton.

The past season's work was begun in July in the county of Peterborough. I had paid a hurried visit to this township at the end of the season of 1897, but time did not permit me to determine the area over which the corundum-bearing rocks occur.

Corundum associated with Mica.

Townships of Methuen and Burleigh.

The mineral was first found in the township of Methuen in some deposits which were being worked for mica, and its occurrence here was made public shortly after the mineral was reported to occur in Carlow, where it was found by Mr. W. F. Ferrier in October, 1896. In my hurried visit to the locality in 1897 I determined that the rocks in which the mineral here occurred were similar in character to those in which we had found it in Carlow and other townships, although the mineral itself was considerably different in color from other specimens of it which we had seen in the region.

The Region of the Blue Mountains.

On beginning our work in Methuen last summer we pitched our tents on the property known as the Bennett mine. It was on this property the corundum was first found in the township. The main buildings in connection with the property are located at the edge of a small lake, known as Mountain lake, and they are at the foot of a range of hills known locally as the Blue mountains. These hills, following the general direction of the strike of the rocks, run in a northeast and southwest direction and have a length of five or six miles. The Bennett property is situated near their western end. This part of Methuen is one of the most rocky and barren areas from the agricultural point of view which I have visited in the district. Rock is exposed at the surface over a large area, and many of the hollows are occupied by beaver meadows and small lakes. Five lakes can be seen from one point at the eastern end of the Blue mountains.

The Map of Methuen.

The map of Methuen, made from the survey of 1822-3, is one of the poorest and most inaccurate of any of the township maps which I have tried to use. The larger lakes are unrecognizable, and in most cases it is impossible to determine the boundaries of lots. In stating the locations of points in this township I wish it to be understood that in most cases I had no survey lines to go by, and could not make use of the inaccurate topographical features laid down on the map. The location of the lots and points referred to were determined as nearly as possible from information obtained from some of the older settlers, and from a few lines which have been run during late years by persons interested in mining claims.

Bennett and Miller Locations.

The Bennett mining location, on which considerable work has been done in mining mica, comprises lots 14 in concessions nine and ten. The main buildings are situated on the former lot and are on the north side of Mountain lake. The line between lots 13 and 14 runs across the southwest corner of the lake. Little Mountain lake, which is a short distance west of Mountain lake and in the same depression, lies wholly in lot 13 of the ninth concession. The Miller location, across Mountain lake opposite to Bennett's, embraces the southeast 50 acres of lot 13 in the same concession and the northeast 25 acres of lot 12 in the ninth.

Work has been done at Bennett's near the shore of Mountain lake on the narrow strip of land which lies between the edge of the lake and the base of the hill or mountain, and also near the top of the hill some distance farther west. Where the work has been done at the base of the hill the country rock is a dark gneiss, which is composed for the most part of plagioclase and hornblende, together with some mica. Through this gneiss there are several dikes which cut it in different directions, but have a general trend at right angles to the adjacent shore of the lake and the base of the mountain. These dikes are similar in appearance to ordinary acid pegmatites, but are composed essentially of pink or light colored felspar and mica, both light colored and dark. There appears to be no primary quartz present in them. It is these dikes which have been worked for light colored mica. The dikes may be classed as syenite-pegmatite. Between the foot of the hill and the dark gneiss there is a rather deep ditch-like depression along the contact. The rock on this face of the hill and for some distance over the top is for the most part rather fine grained and light in color, but in places it contains grains and stringers of nepheline which is usually in coarser grains than the mass of the rock. In places the rock also contains abundant and often well formed octahedrons of magnetite.[2] The

[2] A typical specimen of this rock of the Blue mountains, in which nepheline was not observed in hand specimens and which contained less magnetite than some parts of the mass, was analyzed by the writer and found to have the following chemical composition, which shows it to be a nepheline syenite:

SiO_2	58.27
Al_2O_3	23.75
$*Fe_2O_3$	1 86
MgO	trace
CaO	1.89
K_2O	5.17
Na_2O	6.90
Loss on ignition	2 30
Total	100.14

Sp. gravity=2.60.

*Fe O is estimated as Fe_2O_3.

coarse dikes cutting through the gneiss, which have been referred to, are somewhat similar in composition to the mass of the rock in the hill, with the exception that those at Bennett's apparently do not contain nepheline. Some of the coarse dikes and parts of the main mass of the hill carry corundum. The dikes cutting the dark gneiss near the lake shore run towards the mass, but cannot be seen to run into it. It is evident from the similarity in composition of the dikes and the mass of the rock in the hill that the material of which they are composed has been derived from the same source. Some of the dikes on the Miller property, which has already been referred to, and which are similar to those at Bennett's, have been worked for mica and contain corundum and nepheline; so that it would seem that these coarse dikes which cut the dark gneiss on both properties are composed of material of similar origin to that of the finer grained mass of syenite in the mountain.

Rocks of the Blue Mountains

As has already been stated, the greater part of the rock in the Blue mountains, which run across country here for five or six miles, is composed of a light colored rock which may be called in general syenite, and which contains in places more or less corundum and nepheline. On the northern side of the hill the syenite seems to merge off into granite. Between the part of the hill on which the Bennett property is situated and the buildings of the Miller property, situated about one mile to the south, there is a depression which for a distance across it is occupied by Mountain lake and nearer the Miller buildings by a swamp. This depression runs for some distance parallel with the hill and, as stated, both Mountain lake and Little Mountain lake with the outlet of the latter lie in it. For some distance to the east of Mountain lake the depression is occupied by swampy ground. The rock which outcrops in this depression, on the borders of which is situated the buildings of both the Bennett and Miller properties, is chiefly the dark gneiss to which reference has already been made. This gneiss is bounded to the north by the syenite of the ridge known as the Blue mountains, and to the south by a thin strip of pink micaceous syenite which passes over into a granite of similar general appearance. At the Miller mine however there is a narrow strip of lighter granite near the syenite before the pink granite comes in. Although the syenite and granite are so similar in appearance, and hence seem to be products of one magma, still along the line separating the typical granite from the typical syenite there is a narrow swampy depression. At the Miller mine the office is situated on one edge of this swampy ground.

The general geological structure of this part of the field can then be described as consisting of a basin-like depression lying between the foot of the Blue mountains, where the Bennett buildings are located, and the vicinity of the buildings at the Miller mine. This depression or trough is occupied chiefly by a dark gneiss with which is associated, further to the east, some crystalline limestone. Outcropping on either side of this trough of gneiss we have syenite which both to the north and south, across the strike, seems to pass into granite. The gneiss in this trough would then seem to be a part of a synclinal fold of a layer of material which before being denuded probably covered the Blue mountains to the north and the syenite and granite to the south of the lake. Since the syenite outcrops on both sides of the trough of gneiss it would seem that this rock is continuous under the gneiss, and the gneiss may thus be considered to occupy a depression in the mass of syenite. The dikes of syenite in the gneiss, which have been referred to as having been worked for mica, may be considered as representing material which was shot through the gneiss at the time the igneous mass represented by the syenite was in a state of fusion.

Grenville Series and Fundamental Gneiss

There are many areas of different sizes of the older gneisses and crystalline limestone isolated from one another overlying igneous rocks,—granites, syenites and basic members of the series—in this region. These areas represent for the most part what has been called the Grenville series, while the igneous rocks over which they lie or which have cut through them represent what is known as the Fundamental gneiss. The Grenville series in some parts

of the region covers large areas, while in other places it is represented by small patches here and there which occupy hollows or other protected areas over the surface of the Fundamental gneiss, showing that at one time this latter group has probably been entirely covered by the Grenville, which has now been removed with the exception of the patches here and there which have been protected from denudation. These areas of Grenville over the Fundamental gneiss possess a similar arrangement to the outliers of Potsdam and later formations of the Palæozoic which are found in places in the region overlying the different members of the crystalline series.

Rocks of three Ages

There are rocks of three ages usually associated with the outcrops of corundum. The oldest of these is a dark gneiss which is pretty uniform in character throughout the district This can be seen to be cut through by the different varieties of syenite in which occurs the corundum. Then both the gneiss and the corundum-bearing series are cut through at times by dikes of coarse quartziferous pegmatite. This structure is seen in the township of Methuen, which we now have under consideration.

Syenites of the Blue Mountains.

The most striking topographical feature of Methuen is the range of hills known as the Blue mountains, to which reference has already been made. This range runs from about lot 22 in the sixth concession to about lot 14 in the eleventh, which forms its western end. The southern face and greater part of the range is composed of syenite. This face rises abruptly from out the gneiss, the line of contact between the two rocks being occupied for a considerable distance along the range by a deep ditch-like depression. The top of the range for the most part is comparatively free from brush and fallen timber, which have been removed by fires at different times. From the north face of the range there stretches out a low lying tract of country which contains little timber and is occupied by rocky knolls and ridges, composed for the most part of pink granite, between which lie innumerable marshy hollows. At places over this granite area are small patches or outliers of gneiss and crystalline limestone. At the western termination of the range of hills there are a number of coarse quartziferous pegmatite dikes cutting through the gneiss. There is one particularly large dike of this character in the vicinity of Jack's creek, about a mile to the northwest of the end of the ridge.

Granite of the Range.

To the south of the edge of the syenite on the Miller property the country is also underlain by a granite somewhat similar in appearance to that to the north of the ridge. This area of granite occupies most of the shores and islands of Koshkabogamog lake. On some of the islands and adjacent parts of the shore the granite takes on a distinctly porphyritic structure.

Granite of similar character shows in the area at the eastern end of Stony lake. It outcrops along the southeast shore of Jack's lake and some miles farther east along the North river. In fact the granite may be said to be the most abundant rock in this part of the township. Through this runs the Blue mountains, which are composed for the most part of syenite. From the western end of the range the syenite runs at a lower altitude to the shores of Stony lake. Over this lie areas of the gneiss and crystalline limestone.

An Outlier of Potsdam.

In addition to the areas just referred to, we discovered an outlier of rock of Lower Palæozoic age. This outlier belongs to the Potsdam formation. It has a diameter of about one mile, and runs from a little south of the Miller property to near the end of the southwest arm, known as Stony Lake bay of Koshkabogamog lake. This area of Potsdam presents a level surface which at once attracts one's attention on going in on the road which runs from the eastern end of Stony lake to the Miller mine. Not a great distance from the mine the road passes over a corner of the area. The vegetation on this Potsdam is also somewhat different from that of the surrounding Laurentian, and has caused the settlers to give to it the name the Oak Ridge. The Potsdam here has no great thickness, standing up not much above the surface of the Archæan.

The reason for this area having been preserved is quite evident when we examine the topography of the surrounding country. To the north there is the ridge of the Blue mountains, while to the south of the outlier, in the vicinity of the southwestern arm of Koshkabogamog lake, there are hills of granite. The area of Potsdam thus occupies a part of the trough-like depression between two tracts of high ground. It has thus been protected to some extent from denudation and prevented from being worn away as have other areas of Palæozoic rocks which at one time no doubt covered a considerable part of the surface of the township.

Protection of the Potsdam

Lithologically the Potsdam rock which outcrops here in Methuen may be said to be made up of rather coarse pebbles of quartz and finer material of a similar composition.

Outliers of Potsdam occur at other points along the southern border of the Laurentian protaxis in the Province, but so far as the writer is aware this outlier in Methuen is many miles distant from any others of similar age which have been reported

In this Potsdam conglomerate some concretions were observed similar to those known to occur in areas much farther to the east.

Limestone of Black River age lies on both sides of Stony lake, some distance from its eastern end. It may be seen in place not far from Crow's landing on the south side of the lake and north of Julian's landing on the north shore.

It may also be added that an area of Potsdam appears to be in place along a part of the shore just south and east of Crow's landing. A number of boulders were found not far from the edge of the lake, but as much of the rock along the cliff is covered by loose material we did not succeed in finding an exposure. On the road about one mile south of Crow's the Silurian limestone rises into hills. The lower beds of this limestone in places contain pebbles of considerable size.

Corundum was first discovered in Methuen, as has been stated, in working a dike for mica. This was in one of the pits on the top of the Blue mountains on lot 14 in the tenth concession. At the surface of the ground no corundum was apparently observed, but on blasting into the rock the mineral appeared. On working down from the surface it became more abundant. In most of the dikes from which corundum has been blasted out the mineral is for the most part found as a core in the masses of mica. The corundum is often not observable in the mica until the latter is broken open, when it is found forming the centre or core of the mass. The rounded surface of the corundum and other characteristics leads to the belief that the masses of light colored mica are secondary products after the corundum. The relations of the two minerals are shown in Fig. 1. It might be added that the corundum shows a tendency to be segregated along the edge of the dike, and that as the mining proceeds to greater depths the mineral becomes more abundant at the expense of the mica.

Three Modes of Occurrence of Corundum in Methuen.

In addition to the light colored mica, most of the dikes contain a dark variety which has a green appearance in thin layers. No corundum is found in the dark mica. The two kinds of mica in these dikes seem to have different origins. The light colored is apparently derived from corundum by the alteration of this mineral, while the dark colored variety appears to be an original constituent of the rock. Some of the light colored varieties have a purplish tint in thin layers in transmitted light.

There is another mode of occurrence of the corundum in which the mineral is found as the centre of ball-or nodular-like forms in the mass of certain varieties of the fine grained rock. These nodular masses in the rock are quite striking in appearance. The inner parts of them, surrounding the corundum, are composed of rather fine grained white felspar, which is surrounded by a mixture of the same felspar and dark mica. An occurrence of this kind is seen a short distance off the road to the Bennett mine, on lot 15 in the ninth concession, known as the Madill property. Some blasting has been done here. A reproduction from a photograph of one of these nodules is shown in Fig. 2, which accompanies this report.

The nodules are tough and difficult to break with the hammer, and the photograph shows the corundum to have a somewhat radiated structure.

Different minerals of apparently secondary origin are found associated with the corundum, but a unique specimen was obtained from the outcrop to which reference has just been made. This specimen consisted of mica, felspar and corundum, together with a mass of galena an inch or so in diameter. This is the first specimen of galena that the writer has seen in connection with these rocks during the two seasons of field work. Pyrites however is frequently found in the corundum-bearing series in Carlow.

Corundum occurs in a third way in Methuen. In this case the mineral is found in grains, masses or crystals scattered through the mass of the syenite, and is not enclosed in masses of mica nor in the centres of nodular masses of differentiated rock. This third mode of occurrence is similar to that described in last season's report in connection with the deposits in North Hastings and South Renfrew. It may be stated however that well formed crystals are not nearly so common in Methuen as in the other districts, and moreover there is considerable variety in the occurrence of the mineral in the mass of the rock in this township. One of these is that in which the mineral occurs in small mica-like flakes with a bronze lustre on weathered surfaces. At first sight the mineral does not appear to be corundum. An outcrop of this character occurs on the Bennett property, on the top of the ridge north of the shore of Little Mountain lake and to the west of the main buildings. It is situated a little to the southwest of the blacksmith shop on the top of the ridge.

The Blue mountains, as has been stated, extend in a southwest direction from lot 22 in the sixth concession on their northeast end to a little west of the Bennett property, lots 14 in the ninth and tenth concessions. Near its northeast end the ridge has a breadth of about one mile, extending southward to within one-half mile of Koshkabogamog lake. Grassy lake occupies a hollow in the ridge near its eastern end. Throughout its whole length the ridge is composed for the most part of syenite, which seems to merge off into granite on the north. Corundum and nepheline appear at places in the syenite. The nepheline occurs at times in vein- or stringer-like forms through the rock. At other times it occurs in large masses in the comparatively fine grained syenite. Some of these masses, which generally have a rounded surface, have a diameter of a foot. Such masses of the mineral often occur isolated from one another. In addition to the dikes which have been opened up on the Bennett property, there are others near the southern face of the ridge at two or three points to the east of this. In several cases the rock has been blasted out in the search for mica.

The fine grained syenite which was referred to as outcropping near the buildings on the Miller property has a strike in the same general direction as that of the ridge of Blue mountains which lies about a mile to the north. This syenite of the Miller property consists of pink felspar and dark mica, and contains the characteristic small octahedrons of magnetite which have been spoken of as occurring in the syenite of the Blue mountains. From the buildings on the Miller property this band of syenite runs eastward and crosses the northwestern arm of Koshkabogamog lake, which here forms a narrow bay about 300 yards from its end. At the points where the syenite comes in contact with granite on the shores of this arm the contact is marked by two small bays on opposite sides of the larger bay or arm.

As has been already stated, there are coarse dikes of syenite which cut the dark gneiss in the vicinity of the buildings on the Miller property and which outcrop near the contact of the fine grained syenite and the granite. Two or three of these dikes contain corundum, in addition to the mica for which they have been worked. One of them lying the farthest east of those which have been worked carries in places a high percentage of nepheline. In one of the larger dikes there are a number of secondary minerals, among which were noticed quartz, occurring in geodes and stringers, tourmaline of a black or in some cases bluish color, calcite, pyrite, marcasite and chalcedony.

Syenite outcropping on Stony Lake.

From the end of the Blue mountains, near the western side of the Bennett property, the syenite rocks, carrying corundum in places, run southwestward at an altitude similar to that of the surrounding country to the north shore of Stony lake, and are continued on to a small island not far from the shore. This island belonged to the late Mr Craig, M.P.P., of Fergus, and there is erected on it a summer cottage. This cottage is nearer the east end of the lake than are any of the other numerous cottages which are situated on the shores and islands of this pleasant summer resort. The strike of the rocks changes near the shore of the lake, and runs in a more nearly east and west direction through the islands of the lake than does that of the rocks to the northeast.

The island, which is composed for the most part of syenite, lies two or three hundred yards to the southwest of a point on the shore which is also composed of syenite. The small islands along the shore a little to the east are composed of fine grained pink or grayish granite. On the point itself there are two or three dikes which carry a little corundum The island has a breadth of 75 or 100 yards, and on its northwest side there is a small band of dark gneiss about ten yards wide. There are also some narrow bands of this rock in places through the syenite. Some dikes of quartziferous pegmatite cut through the syenite on the island. The height and breadth of the island are greater on the east, and it narrows down towards the west.

Syenite of two colors, pink and white, occurs on the island, and these two varieties are quite sharply separated from each other. The white syenite runs through the centre of the island, and is bordered on both sides by the pink variety. The white variety has a width of about twenty-five feet. The white syenite can be seen as a white streak on the island for some distance from the northeast on the main shore, as it stands out so distinctly from the pink on its edges. About ten yards from the northwest corner of the cottage, down the face of the hill of the island, there is a segregation of bluish and grayish corundum in pink syenite. The largest of the pieces of corundum showing here has a diameter of between three and four inches. Corundum is also scattered in places on the island through the white fine grained syenite. Six or eight yards from the front door of the cottage nepheline shows in patches in the white rock. The individuals have a length of one or two inches. This island contains in small compass what may be called a synopsis of the geology of the corundum-bearing rocks and of the rocks which are commonly associated with these in the district. It lies in the tenth concession of the township of Burleigh.

On the main shore, a hundred yards or so to the west of the island, crystalline limestone is in place. The strike is about N 30° E., and the dip is about 60° to the southeastward. This limestone is rather fine grained and close in structure. It is somewhat impure and is dark gray in color.

About one mile west of the island, along the main shore, there is a quarry of biotite granite, and further west down the lake there is another granite quarry which was opened years ago on Eagle island. Granite from this quarry has been shipped to Toronto and other places as a road material.

Coming down the channel on the south side of the lake and near the east end the passage is seen to lie along the contact between two series of rocks. The islands on the north of the channel are composed for the most part of granite, while the shore of the mainland is composed of schistose rock, some of which appears to be impure crystalline dolomitic limestone. The strike is here N. 70° or 80° E. At the entrance of South bay, near the eastern end of the lake, the strike is N. 20° or 30° E. On the east side of this bay porphyritic granite is exposed, and this rock is also exposed at the extreme eastern end of the main part of the lake. Here at the head of the lake there is a small exposure of crystalline limestone which has a breadth of 10 or 15 yards and a strike of about N. 20° W., which is quite different from the general strike of the rocks of the area in the vicinity. The limestone has a dip of about 60° to the westward and is seen to be cut through by the granite, which thus accounts for the peculiarities in its dip and strike. The limestone band has been arched up by pressure from beneath at the time o

the eruption of the granite. At Hull's landing, near the mouth of Jack's creek, the rock is a gneissoid mica granite.

At Julian's landing, in the fifth concession of Burleigh, the lake is bordered by a band of Laurentian rocks which has a breadth of less than half a mile. To the north of this Silurian limestone comes in. This area of Silurian has a breadth here of about one and one-half miles and extends east and west some distance. Little Cedar lake, which occupies part of lot 8 in the fifth concession and parts of adjoining lots, lies in the contact between the Silurian and the Laurentian hills to the north. These hills are high around Loon and Big Cedar lakes, and in places are cut through by quartziferous pegmatites. Considerable quartz, which runs through the granite in vein-like forms, has segregated out of the rocks. This quartz has a very glassy appearance. Several samples of the mineral from the surrounding district were found to contain no gold. An outcrop of quartz in schistose rock near the boundary of lots 5 and 6 in the first concession of the township of Harvey however showed a value of $2.25 in gold per ton from samples collected by the writer and examined by the Provincial Assayer. This outcrop of quartz is at the shore of the lake and is situated a short distance from Burleigh Falls.

There is a good water power at Burleigh Falls, and a short distance to the northwest some work has been done in examining the Silurian rocks, to which reference has been made, for lithographic stone. The rock here is similar in character to that which has been worked for lithographic purposes in the township of Marmora to the east.

The road running from Burleigh Falls to Apsley village in the southeast corner of the township of Anstruther is known as the Burleigh road. A branch road runs from Julian's landing northward and joins the Burleigh road at lot 7 in the sixth concession of Burleigh township. From this point northward to Apsley the road keeps pretty close to the valley of Eel's creek, which it crosses at two or three places. Along this road to Apsley, with the exception of syenite, a similar assemblage of crystalline rocks is exposed to that which has been described as occurring farther to the south and east. After crossing the area of Silurian limestone, which has been described as lying a short distance north of Julian's landing, the road traverses a wide band of crystalline limestone, interspersed with black gneiss. The crystalline limestone is cut by numerous dikes of granite, which carry considerable tourmaline and some magnetite.

The district north of Stony Lake

From Apsley a trip was made down the Wellington road and a camp was established on lot 21 in the fourth concession of Methuen, at the edge of the stream known as North river. Work was carried on with this point as a centre for a few days, our object being to trace the corundum-bearing syenite belt farther to the northeast than we had succeeded in doing while camped on the Bennett property.

A considerable variety is shown in the rocks going from Apsley down to where the road crosses the North river. Most of these may be referred however to classes already spoken of in connection with other parts of the district. A short distance east of Apsley a quartziferous pegmatite dike was seen cutting through crystalline limestone. The dike attracted attention from the fact that it contained considerable graphite as a secondary constituent. This mineral was found to fill numerous cracks in the dike matter and was present in sufficient quantity to have caused someone to sink a shallow pit on the dike in search of a workable deposit of it. This graphite is evidently a deposit from liquid matter similar to deposits of anthraxolite, in which the mineral is found coating crystals of other substances, as in the deposit a few miles north of Kingston and in other localities in Ontario.

A vein of barite about an inch wide was found projecting above the surface of the dark rusty gneiss alongside of the road in the green bush about a mile and a half down the Oak Lake road from its junction with the Wellington road.

Some pits have been sunk in the rusty gneiss on lot 26 in the fourth concession of Methuen. The rock contains some copper pyrites and pyrite.

The country was examined for some distance on all sides of our camp on the North river. To the east of the camp, and extending down past the eastern end of Koshkabogamog lake, the surface is composed of hillocks and small depressions which are pretty free from soil and timber. The area in fact represents the surface of a large granite mass, and shows little variety in structure Some of the granite here, like that occurring around Koshkabogamog lake, previously described, possesses a well-marked porphyritic structure. A short distance west of the camp a band of dark gneiss comes in and has a considerable breadth. Over some parts of this gneissic area there is a thick hardwood bush. About a mile to the west of the camp a small band of coarse pyroxenite was observed. This rock is similar to that which has already been referred to as occurring north of the Blue mountains, some distance to the southwest. Associated with the dark gneiss here, in places, were small segregations, syenite-like in appearance and containing octahedrons of magnetite. No undoubted outcrops of syenite however were seen northeast of the end of the Blue mountains. At their northeast end these mountains, which should properly be called hills, show a face running northwest and southeast. The axis of the mountains themselves, as has been stated, runs northeast and southwest. At their northeast end along the face to which reference has just been made they have a breadth of about one mile. To the north of their northeast end the mountains are bounded by a green hardwood bush, which is underlain in its eastern part by dark gneiss and farther west by crystalline limestone. The gneiss lies along the foot of the syenite hill in a manner similar to that which it has been described as doing near the edge of Mountain lake on the Bennett property. The gneiss is here also cut by dikes of coarse syenite. It would seem that the syenite disappears here under the gneiss. There is a small lake on or near lot 19 in the fifth concession. It is known as Burritt's lake, and it lies about one half mile from the end of the ridge.

Township of Chandos.

Having completed the examination of the rocks within easy access of our camp on the North river, we went across country, following in a general way the strike of the gneiss, to lot 26 in the third concession of the township of Chandos, coming out on the Wellington road. This road runs between the second and third concessions. The branch road which we had taken going down to our camping place on the North river turns off from the Wellington road near lot 21 in the second concession.

Deposit of Magnetite.

There is a deposit ot magnetite on lot 27 in the second concession of Chandos on which some work was done some years ago. This deposit lies in a valley a little north of a small lake with swampy shores, known as Devil's lake. The valley appears to owe its origin to the weathering out of a narrow band of crystalline limestone, some of this rock outcropping along the valley. The deposit, judging from a hurried examination of its surroundings, is situated near the contact between granite which lies to the west and schistose rocks to the east. The magnetite is fine grained and the ore body appeared to have a width in places of five or six yards. A pot hole with a diameter of three or four feet has been excavated in the surface of the ore body. probably during the glacial period. There is also a deposit of magnetite on lot 30 in the second concession of Chandos, but we did not visit it.

Mica Syenite at Coe Hill

Along the road a little west of lot 26 in the third concession there is a pink colored rock which has the appearance of syenite and is similar to the material in an outcrop between the station and the iron ore body at Coe Hill, specimens of which were collected by the writer some years ago. The rock at Coe Hill proved on examination to be a mica syenite. The outcrop on the road west of lot 26 in the third concession of Chandos shows at the surface for about one mile past the school house and side line. The mass cuts a crystalline conglomerate-like rock.

Country around Apsley Village

The country was examined for some distance around Apsley. Numerous dikes of light colored quartziferous pegmatite were observed. These dikes in many cases carried black tourmaline and they were examined with a view to the discovery of some of the rarer minerals which frequently occur in this association, but with-

out success. On lot 27 of the third concession a so-called mica deposit was examined by my assistants, who obtained specimens of rock from it which were composed essentially of white mica and quartz and were similar in appearance to greisen. The rocks also carried some tourmaline and hematite.

On lots 10 and 11 in the tenth concession of Chandos within a short distance of the shore of Loon lake there is an outcrop of rusty gneiss which has attracted some attention from prospectors, as have similar outcrops in which test pits have been sunk in the search for gold in different parts of the district. The rusty appearance is given to the gneiss through the decomposition of iron pyrites, with which mineral the rock is often highly impregnated. The mica schist associated with the gneiss carries garnets. A little zincblende was found in some of the crystalline limestone alongside of the road near school-house No. 1. The strike of the rocks east and northeast of Apsley is more nearly north than that of the rocks near Stony lake.

Crab lake, which lies west of Apsley, is surrounded by hills of gneiss whose strike is about east. The gneiss is cut by numerous quartziferous pegmatite dikes.

Township of Cardiff.

My assistant Mr. Hodgson examined the country around Pandash lake. Some gneiss, syenitic in appearance, was found by him near the east end of the lake. Fairly well rounded boulders of nepheline syenite were found near the school-house, lot 30 in the tenth concession of Cardiff. A large angular boulder of nepheline syenite four by five by nine feet in size was found on lot 23 in the seventh concession. Other boulders were found on lots 27 and 29 in the ninth concession. On the latter lot a syenite-like gneiss was observed in place. The boulders were followed north through lot 29 in the eleventh concession, and a ridge of what Mr. Hodgson called syenite running N. 20° E. was found on lot 30 or 31 in the fourteenth concession. A ridge of very fine grained crystalline limestone occurs on lot 29 in the same concession. On the top of the ridge a large boulder of pink syenite carrying magnetite and weighing about two tons, was found. Working west from Cardiff and following the road leading to Gooderham station of the Irondale railroad, boulders of syenite were found at one or two places along the new road north of Cheddar post office.

Traces of Nepheline Syenite.

Monmouth and Glamorgan.

Pink syenite was found in place on lots 16 and 18 in the eighth concession of Monmouth. On lot 15 of the same concession an extensive development of nepheline biotite-syenite was observed. A sample of dark corundum was obtained in the syenite here. The variety of syenite referred to passes into a white variety free from dark mica. Pink syenite occurs bordering the nepheline variety. The syenite is cut in places by granite dikes. At lot 29 in the seventh concession of the township of Glamorgan nepheline syenite outcrops alongside of the railroad track. Syenite containing nepheline outcrops near the road on lot 32 of the same concession.

Nepheline Syenite and the indications of Corundum.

An outcrop of nepheline syenite was mentioned in my last year's report as occurring on lot 30 in the third concession of Glamorgan. Some blasting has been done in the rock here, it being thought by those who did the work that the blue color of the sodalite which accompanies the syenite indicated copper. This year other outcrops of coarse nepheline syenite were found about a mile east of this one, on either side of the concession line.

There is a very good waterpower at the High falls near the line between lots 5 and 6 in the sixth concession of Monmouth.

Along the road at lot 9 on the seventh concession of Monmouth there is an exposure of crystalline limestone which is cut by light colored dikes of pegmatite. Just east of this nepheline syenite appears. The rock here contains hornblende, and is coarse and gabbro-like in appearance. There is a rather narrow strip of the rock here and then comes in a band of somewhat similar rock, and then going eastward there is an exposure of crystalline limestone carrying apatite and graphite. A little west of Hotspur P. O.

where the road branches off towards Wilberforce, there is a prominent exposure of nepheline syenite alongside of the road. The dark mineral in the rock is here chiefly black mica. The rock also contains a little corundum. On the road going towards Wilberforce, about one-half mile from the turn just referred to, there is a hill to the right of the road and a valley to the left. This hill is composed of syenite. Much of the syenite contains considerable magnetite. A belt of syenite lying about parallel with the railroad track and to the southwest of it was traced from this point to the vicinity of Wilberforce station and has a length of eight or ten miles. Going east from Tory Hill station by the wagon road, the rock outcrops along the road at a number of points after passing the summit of the hill. Just beyond Alfred Reid's farm buildings the road runs through a rather striking pass in the syenite ridge. Nepheline syenite containing a little corundum was found near where the ridge approaches the railroad track on Mr. Graham's farm, lot 28 in the thirteenth concession, a little south of Wilberforce station. Outcrops of the rock were also examined on lots 21 and 23 in the eleventh concession, and lots 27 in the twelfth and thirteenth concessions. In working eastward from Wilberforce a ridge of nepheline syenite was observed near the point where the wagon road first crosses the railroad, lot 7 in the twenty-second concession of Cardiff.

A Syenite Ridge near Wilberforce Station

Proceeding along the wagon road towards Deer lake station, boulders of white syenite carrying brown corundum were found a short distance to the northwest of Leafield post office, lot 24 in the twenty-second concession. The boulders were quite large and angular. One of these lay at the roadside just over the brow of the hill before coming to the post office, and several others were noticed in the field to the right. From the post office a prominent hill of white rock can be seen lying across a ravine about half a mile to the eastward. It was thought that these boulders had likely come from this hill, and on making an examination of it corundum was found in place. Some of the syenite in the hill has a quite strongly marked porphyritic structure. Syenite shows at the road-side about half a mile to the southeast of the post-office.

Corundum near Leafield P O

Herschel and Faraday.

There is an extensive development of syenite with, in places, coarse nepheline in stringers around the northeast end of a small lake and along the wagon road for half a mile just after passing the summit of a high hill which lies near the point where the townships of Cardiff, Herschel and Faraday come together. The syenite has a strike of about N. 30° W., and can be traced in that direction for a considerable distance from the road. This brings this area into the same belt of rocks as the areas to which reference has just been made, and which may be said to follow in a general way the line of the Irondale Railway from a little to the south of Gooderham station to the vicinity of Deer Lake station. The area lying near the junction of the three townships referred to will be shown later to be connected with the outcrops of syenite lying farther to the southeast in Faraday, and also with those of Dungannon.

Connecting Corundum Areas in Cardiff, Herschel and Faraday

The outcrop occurring near the junction of the three townships is bordered on the northeast by crystalline limestone and on the southwest by gneiss. Many of the outcrops of this rock in the district are associated with crystalline limestone. In fact the two rocks are so commonly found together that some explanation seems to be required for their frequent association. This point will be referred to again.

The village of Bancroft, the location of which is wrongly marked on some maps, is situated on lots 60 and 61, Hastings road, which runs along the eastern boundary of Faraday. The village is underlain by syenite, and outcrops of the rock occur along the York Branch river which runs through the village, and at other places in the vicinity. The southern edge of the syenite, where it comes in contact with crystalline limestone, is at the rapids alongside the mill at the edge of the village. The strike of the rock here is about N. 80° W. and the angle of dip of the limestone is about 60° to the

In the Eastern part of Faraday.



Fig 1. Corundum, c, forming core of mass of Mica, m (p 210). The figure shows the parts produced by breaking the mass in two. The Mica is evidently an alteration product of the Corundum. Bennett Mine, Blue Mountains, Township of Methuen. Natural size. From a drawing by William Revell.



Fig 2. Corundum in centre of nodular mass of differentiated Syenite, (p 210) Lot 15, tenth con Methuen ⅔ natural size —Miller



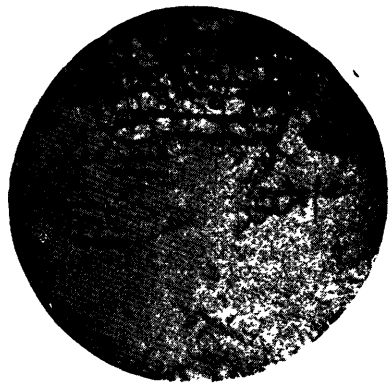
Fig 3.—Photomicograph of thin section of Norite, Parham (p 228). The Plagioclase shows twinning according to the Albite and Pericline laws, and is partly surrounded by its alteration product, Scapolite (s) —Miller



Fig 4 —Photomicograph of thin section of Scapolite-hornblende rock (p. 229) Glendower iron mine. —Miller.



Crystal of Corundum, Raglan Township Size 4 by 1¾ inches —Miller



Photomicograph of thin section showing Corundum in Nepheline Syenite. The figure brings out the parting planes in the Corundum. —Miller



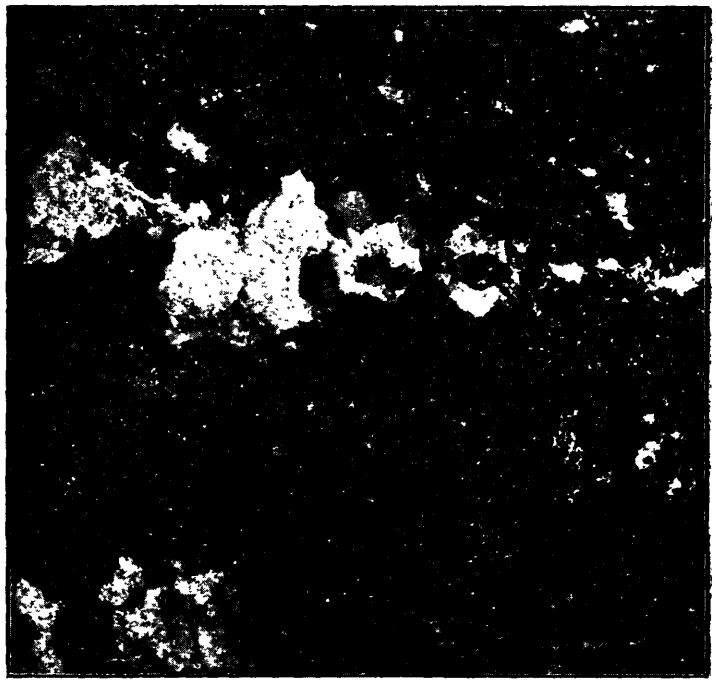
Photomicograph of thin section of Anorthosite from South Sherbrooke (polarized light) —Miller.



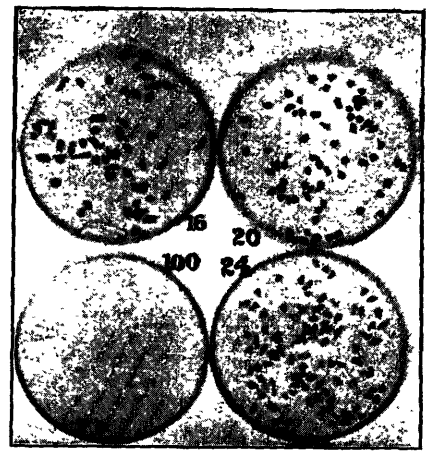
30 Corundum in Anorthosite, in sixth concession of South Sherbrooke —Miller.



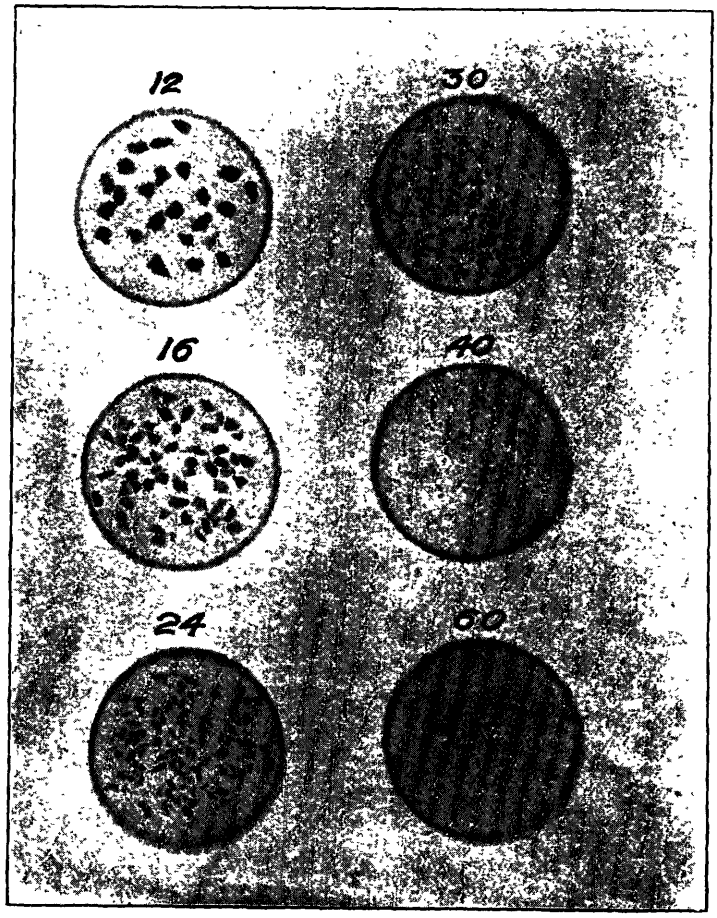
Weathered surface of rock composed of Nepheline and Felspar, the latter mineral being discolored by Oxide of Iron Natural size. —Miller



31 Weathered surface of rock showing Nepheline associated with Hornblende, Garnets, and Felspar. Township of Lyndoch —Miller.



X-ray Photograph of corundum grains —No. 16, 24 and 100 represent grains of Ontario corundum of the numbers indicated by these figures No 20 represents grains of so called ruby corundum from the southern U. S The photograph shows that these grains are not corundum, as they are scarcely permeable to the X-rays. X-ray photographs offer a means of determining the purity of commercial samples of grain corundum. —Miller



X-ray Photograph of Grain Corundum. Natural size. —Miller

southward. The syenite shows in places for about half a mile along the Hastings road north of the village, and is associated with a little crystalline limestone. The rock bordering the syenite belt to the northward is a gneissoid granite, which rises into quite prominent hills.

Along the western edge of the river, at the rapids in the village, the syenite was found to contain nepheline, and on tracing the syenite band to a point about half a mile west of the village a little corundum was found in place. The mineral appears to occur very sparingly in the syenite in this vicinity.

Going west from Bancroft the band of syenite can be traced practically continuously for some distance. Drift deposits however interfere to some extent. The belt was followed to lots 10 and 11 in A concession of Faraday, and westward in the general direction followed by the Monk road. The syenite band appears to cross the road near a little lake on 16 A. A prominent exposure of syenite shows on lot 19 A. About lot 23 A., just before coming to a bend in the road to the west, nepheline syenite is exposed on the north of the road. Syenite carrying nepheline crosses the road at 26 A and B. The strike here is N. 70° W. Crystalline limestone comes in along the border of the white variety of the syenite. The whole band of syenite here has a breadth of only 8 or 10 yards. The band of crystalline limestone which flanks it on the west has a breadth of two or three miles. Pink syenite was found on or near lot 32 in the fourteenth concession. This outcrop carries a quantity of magnetite in places and has a considerable breadth. About lot 29 in the same concessi n there is a well developed band of nepheline syenite which is about 200 yards wide. It carries magnetite and coarse nepheline, and has a strike of N. 30° W. It runs up into a high hill and is well exposed. Following along the strike S. 30° E. from here for about one mile outcrops of nepheline syenite were seen in three or four places in a hardwood bush.

From a hill on part of the belt of nepheline syenite on lot 30 or 31 of the fourteenth concession a clearing can be seen on the Deer Lake road to the northwest. The belt of white syenite could be seen in the distance keeping a direction of about N. 30° W. to within a very short distance of Deer Lake road, near the point where the outcrop which has already been referred to was observed in the vicinity of the junction of the three townships of Faraday, Cardiff and Herschel. This shows that the belt of syenite traced west from Bancroft through Faraday is continued, as has been stated by the writer, through the southwestern corner of Herschel, thence through Cardiff and around through Monmouth, keeping here pretty well the direction followed by the Irondale railroad, and into Glamorgan.

In the part of the band last referred to in Faraday the nepheline syenite is bordered by a band of pink syenite which carries magnetite, and is about one-quarter of a mile wide. The white syenite on lot 29, concession fourteen, carries considerable magnetite with a little pyrite, but nepheline is not strongly developed in it. It also contains some dark colored mica. The hills of syenite here are fully as high as the hills of other rock surrounding them. West of the syenite is a broad band of crystalline limestone.

County of Hastings.

Tracing the belt of Syenite Rocks eastward.

Having now traced the belt of syenite rocks from the township of Glamorgan in a general eastward direction through Monmouth, Cardiff, Herschel, and Faraday to the village of Bancroft on the Hastings road, which runs along the eastern side of Faraday and forms the boundary between this township and the township of Dungannon to the east, it is proposed to trace the belt eastward through this township and into adjoining townships, and to show the connection of this part of the belt with the belt of corundum bearing rocks which lies some distance to the northeast. This latter belt has a length of over 30 miles. A description of it was given in my report for 1897, and the map which accompanied the report showed the location of the belt.

Township of Dungannon.

Explorations along the York Branch.

It will be seen that corundum occurs much more frequently in the part of the belt which lies to the east and northeast of Bancroft than it does in the part lying to the west of this village. Moreover deposits of corundum will be de-

scribed in the part of the belt now to be considered which are much richer in the mineral than are any of those lying to the west of the village. It may be stated that the whole belt of syenite and corundum-bearing rocks has a length of approximately 75 or 80 miles. About one-third of the belt lies to the west of Bancroft and the remaining two-thirds to the east and northeast of this village.

From Bancroft the syenite belt can be traced practically continuously through the township of Dungannon to the bridge across the York Branch river in the eleventh concession of the township. Some of the outcrops consist of very coarse grained rocks which contain a high percentage of nepheline. The syenite runs across the river above the bridge near the mouth of Egan's creek. On the east side of the river, near the bridge, the strike of the syenite is about north. Just north of the road, to the west of the bridge, there is an outcrop of coarse syenite carrying much nepheline and some sodalite. This outcrop was among the first of those discovered in the district by Dr. F. D. Adams, who collected specimens from the vicinity, and some of the material was subjected to examination by himself and Dr. B. J. Harrington.[3] No corundum was found in the vicinity however till 1898, when we found the mineral in syenite at points along the river's bank on both sides of this outcrop.

The part of the belt on the west side of the river crosses to the east at Egan's chute, which lies a short distance below the bridge to which reference has been made. Near the chute the belt, which is quite narrow here, is broken through by a hill composed of a rather dark igneous rock. On the other side of this hill nepheline syenite of similar character was again found in places and the belt was traced with various slight breaks up the eastern side of the York Branch river to a short distance below where Papineau creek enters this river in the tenth concession of the township of Carlow. Much of the syenite exposed along this part of the belt is rich in nepheline, and corundum was found in the rock at numerous places.

[3] Am. Journal of Science, July, 1894.

Syenite also runs up the west side of the York river and outcrops show at intervals between the eleventh concession of Dungannon and the mouth of Papineau creek.

Features along the York Branch.

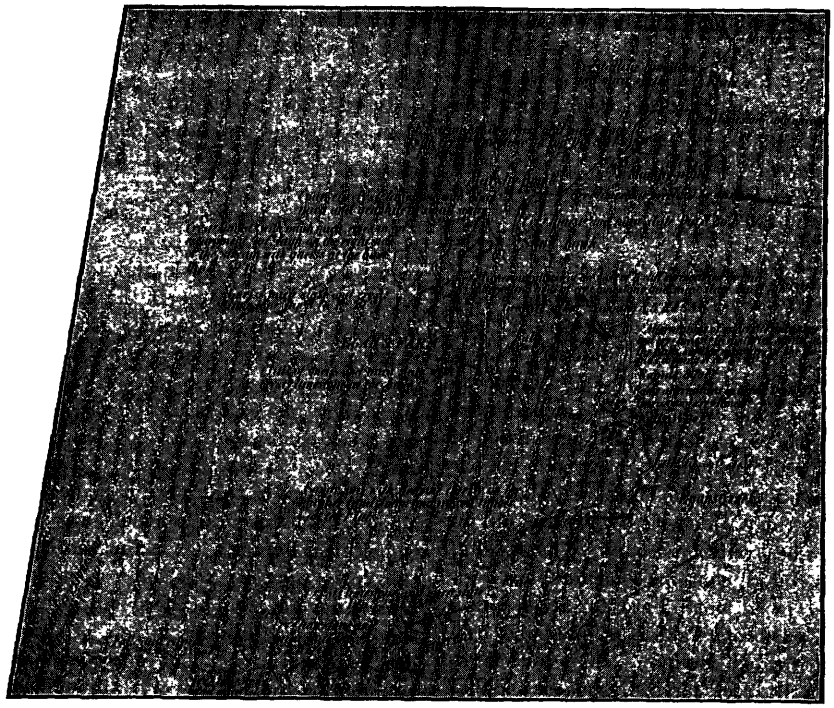
In Dungannon corundum was found near the centre of lot 18, in the eleventh concession. Some of the mineral is here light bluish gray, almost white, and it occurs in large sized pieces. The percentage of the mineral over the small surface examined here compares favourably with that seen in deposits in other parts of the district. Time did not permit of a careful examination of the lots immediately to the west, but from this lot to lot 13 in the same concession the rocks are covered to a considerable extent by drift and alluvial deposits and it is difficult to get exposures. On the north part of lot 13 there is a high hill composed essentially of granite which runs down into lower ground about half way across the lot towards the south.

On examining a map of the township of Dungannon it will be seen from the outcrops of syenite which have been referred to that the belt of this rock follows pretty closely the general direction in which the York Branch river runs.[4] Near Bancroft the strike of the rock in the belt is pretty well east and west. From this point the direction of strike swings around gradually conforming to the general direction of the course of the river, although not swerving at the smaller bends, till near the mouth of Egan's creek, and at the bridge on the eleventh concession the strike of the syenite belt and the direction of the course of the river are approximately north. The general course of the river from this point on for 12 or 15 miles to the mouth of Papineau creek is north, and the strike of the syenite band conforms to it. Near the mouth of Papineau creek the river

[4] The late Alexander Murray of the Canadian Geological Survey mapped the York river in 1853. A photographic reproduction of a part of his map with accompanying notes on the rocks along its banks accompanies this report (p. 211). The rock he calls mica slate is nepheline syenite, which in some cases possesses a well defined laminated structure and frequently carries corundum. What he calls hornblende rock is nepheline syenite with hornblende, and in some cases corundum and garnet. His quartzite is granite. Egan's farm is now known as Bronson's or Lancaster's.

makes its first great bend after leaving the bridge on the eleventh concession of Dungannon 12 or 15 miles below. This bend of the river is to the eastward, and the strike of the syenite changes again and conforms, as will be later described, to the course followed by the river.

As has been stated, the part of the syenite band on the west side of the river crosses to the east side at the first of the chutes which lies a short distance north or down the river from the bridge. Here on the east side of the chute the syenite is associated with some crystalline limestone, and a little north of the chute the narrow syenite belt is broken through by a hill of igneous rock which in the field was taken to be a diorite or gabbro. The syenite here is much more schistose in structure than the rock in the hill, and from this it was inferred to be the older of the two rocks. A little north of the hill considerable corundum was found in the rock. At the second chute, which lies a half mile or so down the river from the one to which reference has just been made, and below the sharp turn which the river makes after leaving the latter, syenite and crystalline limestone are seen at the edge of the rapids on the east side of the river. The limestone underlies the syenite and occurs at the water's edge. It has a strike somewhat east of north and dips eastward at an angle of about 40°. The channel of the river follows pretty well the direction of the limestone, apparently having been formed through this rock wearing away more readily than the other rocks with which it is associated. The limestone at the chute is graphite-holding. The bends in the river appear to be due to the fact that the limestone band has been disturbed or broken across by igneous masses. The river has not been able to cut its way through these so readily as through the limestone, and has hence been caused to swerve out of its course in places.



Part of York Branch (Shawashkong) River, after Murray, 1853

Following down the east bank of the river, we found the syenite belt to be practically continuous. The rock is frequently very

coarse in grain and contains a high percentage of nepheline. The belt keeps a pretty direct course and is thus at some points some distance from the river, as the latter has numerous bends. Towards the northeast corner of Dungannon we came to a large beaver meadow which breaks through the syenite belt and has its outlet in low land towards the river. The syenite runs up to the south edge of the meadow and outcrops again directly opposite, on the north edge. The syenite occurs in distinct ridges, which are frequently broken through by small ravines.

South of the beaver meadow referred to we found corundum of different colors. Some of this was of a deep blue and had a rather striking effect, some of the crystals standing well above the general surface of the rock, on account of the different rates of weathering of the two, and presenting a great contrast in color to the white of the rock.

Crystals of Blue Corundum.

Monteagle and Carlow.

At the river bank and near the point where the corners of the three townships of Dungannon, Monteagle and Carlow come together we found an outcrop of nepheline syenite which showed on its weathered surface a high percentage of light colored corundum[5]. An old timber road comes down to the river just above the end of the ridge which rises into the hill on which the best outcrop occurs. The syenite, which, as stated, contains considerable corundum, was traced north here for about half a mile and was broken across at one point by a swampy wooded ravine. In addition to corundum the rock carries in places sodalite and white mica in flakes of considerable size. The rock here possesses a well defined schistose character, as does the syenite in many parts of the district. The corundum is light in color and the individuals of the mineral are of comparatively small size. Over a distance of some yards across the strike corundum is thickly scattered through the rock. Considering the situation of this deposit, its nearness to the water power at the Egan chutes, and the percentage of mineral carried by the rock, it appears to be one of the most promising in the district from the economic point of view.

A promising Deposit in Monteagle.

The occurrence in this deposit of high percentages of both corundum and nepheline is somewhat exceptional, as usually where the percentage of one of these minerals is above the normal the other is either absent or only sparingly present.

Near the boundary between the townships of Monteagle and Carlow, and on the east side of the river to the northeast of Norway bay, there is an outcrop of pink syenite at the river's edge Farther down the river and a little above the mouth of Papineau creek, rock of similar character outcrops again at the river's edge.

Just below the mouth of Papineau creek syenite is found on both banks of the York Branch river. The river near the mouth of Papineau creek, as has been previously stated, changes its course from northward to eastward. At the mouth of Papineau creek and for some distance to the east and north there is a tract of low, level, somewhat swampy ground, which is partly flooded at some seasons of the year. The outcrop of syenite at the edge of the York river just east of the mouth of Papineau creek comes up in this low land and is of small size. It can however be traced back from the edge of the river for some distance along a low, rocky ridge which rises through the alluvial deposits. On the south side of the York, opposite this outcrop, a more extensive development of the syenite is exposed, the belt here forming higher ground. It has a breadth of about 400 yards and is bounded on the west by crystalline limestone and on the east by crystalline limestone and gneiss. On both sides of the York here the rock has in places a high percentage of nepheline.

Below Papineau Creek in Carlow.

From the higher parts of the hills a tract of country of considerable size can be seen which is composed of the low land which has been referred to as lying north and east of the mouth of Papineau creek. This tract has the appearance of being surrounded by a range of high hills which seem to be arranged in a somewhat circular form. Some of these hills lie immediately to the west of Papineau

[5] This outcrop is on lot 2 in the second concession of Monteagle.

creek. Others lie to the south and northeast of the York Branch, and one of the highest ranges of hills is that which runs from the northeast to lot 14 in the fourteenth concession of Carlow. It was on this lot that corundum was first found in the district. An account of the outcrop of rock which carries the mineral on this lot was given in my last years's report.

From the mouth of Papineau creek eastward, along the north parts of the lots in the tenth concession of Carlow, outcrops of syenite were found at a number of points. Foster's rapids on the York Branch are situated on the southern half of lot 19 in the tenth concession. On the northern half of this lot and the adjoining lot 18 there is a hill which stands at a considerable height above the surrounding area. The southern face of part of this hill comes down to the edge of Foster's clearing, and in the clearing near the foot of the hill several fairly large angular boulders of nepheline syenite were found. These boulders lie near the west side of the road which runs from the main road into Foster s buildings. Corundum was found in place on the north face of the hill. This part of the hill lies about one-half mile to the southeast of the east end of Foster's lake, and near the boundary between the tenth and eleventh concessions. The rock here is basic in character, some of it having the appearance of pyroxenite. Nepheline occurs through some of the darkest of it.

At Foster's Rapids.

From the hill referred to a ridge more or less continuous can be traced eastward along the northern part of the tenth concession to the point where the York Branch crosses the line between the tenth and eleventh concessions at lot 28. The road which crosses the river west of the rapid at Campbell's farm, lot 26, near the line between the ninth and tenth concessions, and runs northwestward towards New Carlow, follows the low land to the north of this ridge for some distance. On the north face of the ridge and near its foot, south of a point on the road which is distant about one-half mile from Campbell's bridge, nepheline syenite was found in place. It here dips under crystalline limestone, which lies farther up the face of the ridge. The limestone is itself overlain by gneiss. Other outcrops of syenite would no doubt be exposed between this point and the outcrop on the hill north of Foster's, were it not for the covering of soil which overlies a great part of the surface. On part of the ridge a coarse gabbro-like rock is exposed. This may, as in other cases examined, be only a facies of the syenite rock.

Near Campbell's Rapids.

Eastward across the road the ridge runs out into a point which lies between two somewhat marshy bays of the York Branch. The bay on the north is known as Robinson lake. Syenite was found in place on this point on the northern face of the ridge.

The ridge is continued on the east side of the York Branch and was followed through marshy ground to near the edge of the Mississippi river. In this part of the ridge no syenite was found in place, but crystalline limestone was observed under conditions somewhat similar to those under which it is associated with syenite farther west on the ridge. The syenite occurs here in all probability in the low ground to the north of the foot of the ridge. Time did not permit us to attempt to follow the ridge east of the Mississippi in the tract of country lying between this river and the Madawaska, but it seems likely that outcrops of syenite do occur here and that this part of the belt runs eastward till it joins the main part of the belt of the corundum-bearing rocks in the northern part of the township of Lyndoch to the east. An examination of the map of the corundum belt which accompanied my report for 1897 will show that the part of the belt which runs down into Lyndoch is much wider and extends farther south than does that part of the belt which lies farther west in Raglan and Carlow. The narrow belt of syenite rocks which we traced in 1898 from near the mouth of Papineau creek, if continued eastward of the Mississippi and across the Madawaska, will strike the southern edge of the belt mapped in 1897 in Lyndoch.

Extension of the Syenite band Eastward.

The association of crystalline limestone with the nepheline syenite at points in the

tenth concession of Carlow has been referred to, as well as the frequent association of these rocks at various points along the York Branch between the mouth of Papineau creek and the bridge on the eleventh concession of Dungannon. Crystalline limestone also occurs at the eastern end of Foster's lake, lot 19 in the eleventh concession of Carlow, and at other places in the twelfth and thirteenth concessions of this township, as at Armstrong's mill site on Papineau creek, lot 6 in the thirteenth concession. This rock lies in a trough-like depression between the band of syenite in the tenth concession with the hills immediately south of the York Branch and the hills in the thirteenth, fourteenth and fifteenth concessions of the township. These last three concessions form part of the belt of corundum-bearing rocks which was mapped in the report of 1897. A great part of this trough has a covering of sand, and in addition to the crystalline limestone there are outcrops of granite, much of which is pegmatitic in character and which gradually rises into the hills in the thirteenth and fourteenth concessions. The outcrops of corundum-bearing syenite in the northern concessions of Carlow, as stated in last season's report, occur isolated. They cut through a dark gneiss and both the gneiss and the syenite are cut through by quartziferous pegmatites. Along the York Branch, as has been stated, the outcrops of syenite form a band which is practically continuous. It would thus seem that the outcrops of corundum-bearing syenite in the northern concessions of Carlow occur isolated owing to the fact that the gneiss through which they cut has not been worn down sufficiently to allow the band of syenite to be exposed continuously. That the isolated outcrops are parts of one continuous band is evident from the fact that they occur in line over so many miles, and from the fact that the outcrops of these rocks in Dungannon and some other townships do form one continuous though often narrow band over considerable distances. The lack of continuity of the syenite in some parts of the belt is also due to eruptions of coarse granite through it, as well as to difference in degree of denudation of the overlying dark gneiss and crystalline limestone. That some of the syenite has been subjected to strong metamorphic action is evident from the well developed schistose structure which it presents. The occurrence of two belts of syenite, one of which runs parallel with the tenth concession of Carlow and the other to the more northern concession of this township, is due to two causes, viz. : the overlying gneiss and limestone and the intrusion of granite of later age than the syenite. A structure of a similar kind was referred to on a preceding page in the description of the syenite rocks in the township of Methuen. In Methuen the syenite belt of the Blue mountains is separated from and runs parallel to a narrower belt which lies to the south of a trough which is filled with dark gneiss, together with some crystalline limestone and a little granite.

Relations of Crystalline Limestone, Syenite and Granite.

County of Renfrew.

Leaving Carlow behind, we enter the county of Renfrew. With the exception of revisiting lots 1 to 4 in the eighteenth and nineteenth concessions of Raglan and examining the lots in the vicinity of Palmer's rapids we did not in 1898 re-examine other parts of the belt of corundum-bearing rocks which were traced through this township in 1897.

Township of Raglan.

In the report for 1897 reference was made to the occurrence of corundum on lot 19 in the eighteenth concession, and on two or three lots immediately northeast of the Madawaska along the line between the eighteenth and nineteenth concessions of Raglan. The high hill, known as Indian Hill, on lot 19 was re-examined last season, and in addition to the outcrops of corundum-bearing rocks which occur near the summit of the hill and towards its west face other outcrops of the rocks were found near the base of the hill on the opposite face. The outcrops near the summit of the hill contain garnet in places in association with the corundum, which is a somewhat rare association, having been found

Tracing the Corundum belt to Madawaska River

in but few of the numerous outcrops examined in the district.

From the Indian hill on lot 19 the rock can be traced through lot 20, there being an outcrop of rock on this lot similar to some of that which usually carries corundum. This rock is a light colored syenite and contains considerable white mica. The side hill on which the outcrop occurs (in which it may be said no corundum was found) is pretty well covered by soil and trees. The outcrop of syenite being exposed by a recent fire which has destroyed the surrounding bushes can be seen for a considerable distance to the northeast. From the foot of the hill on which this outcrop occurs a sand plain stretches out to the Madawaska, at the edge of which, and in a line which runs in the direction of the concessions from the last mentioned outcrop, there is another small exposure of syenite. This exposure is situated on the south side of the river, at the head of the little rapid known as the Horserace. This outcrop carries corundum and is situated on the west side of lot 24 in the eighteenth concession, very close to the line between lots 23 and 24.

Across the river from this outcrop and a short distance from the bank corundum again shows in the rock on lot 24 of the eighteenth concession. From this lot on to and including lot 28 corundum was found in a number of outcrops. These outcrops are situated on the north end of the lots in the eighteenth concession and on the south end of the lots in the nineteenth. An outcrop occurs at the edge of a small swamp at the post where the corners of the four lots 24 and 25 in the eighteenth concession and 24 and 25 in the nineteenth come together. The posts in the centre and on the edges of the concession were here found in place. Being situated in low ground they had escaped destruction by the fires which have burned over the district during the years which have elapsed since the surveys were made. Very few of the original posts have escaped these fires.

To the east of lot 25 the chief outcrops of corundum are on the south parts of lots 26, 27 and 28 in the nineteenth concession. The rock in which the mineral occurs is for the most part pink in color and coarse grained. Much of the corundum is coarse grained, agreeing in this with the rock in which it occurs.

A little east of the post which has been referred to as being situated at the point of contact of the four lots, and north of the concession line, there is an outcrop of nepheline syenite. This outcrop is at the edge of the small swamp mentioned. These occurrences of this variety of syenite are met with at intervals, as stated in last year's report, throughout the whole length of the belt running from Carlow on the west to Sebastopol on the east. The outcrop just referred to was not observed till last season. The nearest outcrop of similar character observed to the west is on lot 1 in the nineteenth concession of Raglan, and the nearest to the eastward is in the western part of Brudenell.

It will be noticed from the description given that the outcrops of corundum-bearing rocks across Raglan follow very closely the direction of the line between the eighteenth and nineteenth concessions, being sometimes just over the line on one side and sometimes on the other. Thus corundum occurs on the concession itself in the most western part of the township, as well as on the south parts of lots 1 to 4 in the nineteenth and on the north parts of 3 and 4 in the eighteenth. Then near where the concession line crosses the Madawaska the outcrops occur in the same relation to it, and others occur in the same situation as regards the line between these lots and the lots along the extreme western end of the line. Moreover, it was stated in last year's report that corundum-bearing rocks occurred sparingly on the north part of lot 35 in the eighteenth concession, this lot being the one the farthest east. The outcrops thus, from one side of the township to the other, have a rather remarkable arrangement in that they all follow so closely the direction of the concession line.

Radcliffe and Brudenell.

A small outcrop of corundum-bearing rock was also found near the edge of an old lumber road on lot 21 in the first concession of the township of Radcliffe. Other small outcrops also occur on one or two other lots immediately to the

A small Area parallel to the Main Belt.

northeast of this one. These may be said to form a small belt which has a direction roughly parallel to that of the main belt. It was stated in last year's report that the strike of the rocks changes near the western edge of the township of Brudenell and runs towards the northwest. This small isolated belt in Radcliffe serves to connect the outcrops near Palmer's rapids with those in the fifth, sixth and seventh concessions of Brudenell. These latter outcrops as shown on last year's map appeared to be somewhat disconnected from the part of the belt lying to the southwest It may be stated that the corundum on lot 21 in the first concession of Radcliffe is associated with garnet similar to the outcrop referred to on lot 19 in the eighteenth concession of Raglan.

A number of large boulders rich in corundum were found on lot 19 in the sixteenth concession and on lots 18 and 19 of the fourteenth concession in Raglan. These boulders were no doubt carried southward by ice during the glacial period.

Sebastopol and South Algona.

In last year's report it was stated that nepheline syenite boulders had been found in places thickly strewn along a line running east of north from the northeast corner of Lyndoch into the adjoining township of Sebastopol and across that part of the Opeongo road which lies to the west of lake Clear. A few were also found to the north of the lake. The position of these boulders was shown on the map, and it was stated that the outcrop from which they had been transported lay to the north. During last summer the outcrop was found in the first concession of the township of South Algona, which bounds Sebastopol on the north.

Extension of the Belt into South Algona

On lot 14 in the first concession of South Algona a number of nepheline syenite boulders were found and the rock was found in place on lot 11 of this concession. The syenite is here very coarse in grain, and the nepheline occurs in it in large sized pieces. The rock was also found in place across lots 8, 9 and 10 to the eastward and across 14, 15, 16 and 17 to the westward. The strike of the syenite here is about N. 75° E., magnetic. The band assumes the character of a series of dikes which cut a pinkish colored rock. They vary from one or two feet to 30 or 40 yards in width. The rock carries magnetite, some pieces of this mineral being a foot in diameter. The syenite is for the most part coarse in grain and somewhat porous. No corundum was found in place here, but some boulders carrying the mineral were found a short distance south of the outcrop.

The direction followed by the glacial striæ in this part of the field is N. 15 E. magnetic. Had time permitted no doubt other outcrops of syenite could have been found farther eastward.

In the southernmost part of Sebastopol a number of outcrops of nepheline syenite were found. In the first concession a band of this rock was traced through lots 13 to 5 inclusive. On lot 6 the band is at least 300 yards wide, but tapers towards the east and west. Closely associated with the syenite are more basic rocks. The band is flanked on both sides by crystalline limestone. The band was traced from the west end of Highland lake, lot 12 in the first concession, to the south end of lot 5 and appears to run into Griffith on the south. It crosses Highland creek at Lambert's mill. The strike of the rock is northeast.

Nepheline Syenite in Sebastopol

Nepheline syenite boulders were found alongside of the road on lot 4 in the fifteenth concession of Denbigh.

Along the Snow Road.

The road from lot 3 in the thirteenth concession of Denbigh follows Hyde's creek to the vicinity of Denbigh village. The creek is quite rapid in places. From the village to the Snow road crossing is a distance of about three miles. The rock here exposed is gneiss, associated with which there is a narrow band of crystalline limestone which outcrops about one-quarter of a mile from the crossing.

Westward on the Snow Road.

Following the Snow road westward from the crossing an area of gray or white granite with a width along the road of 12 or 15 miles comes in. The eastern boundary of this area is near the line between Denbigh and Ashby,

and the western boundary in the latter township is not far from the edge of Mayo. The rock is very uniform in character. That the area occupied by it is unsuited for cultivation is evident from the fact that for about 12 miles along the road, through what is known as the "long bush," there are no settlers. Rock of similar character is exposed some miles to the northeast of Griffith's, north of the Madawaska river.

The road in Ashby runs between Otter and Weslemkoon lakes, where the granite is well exposed.

Proceeding westward through Mayo, from the edge of the granite area, the rocks exposed are gneiss and crystalline limestone.

From Mayo the road proceeds westward through Dungannon, and crosses the York river at the bridge in the eleventh concession to which reference has been made.

Lanark and Frontenac.

Corundum discovered in South Sherbrooke.

Corundum was found in place in the township of South Sherbrooke, Lanark county, by Mr. L. J. Gemmell of Perth, in September, 1898. Mr. Gemmell had been in attendance on the prospectors' course at the Kingston School of Mining during January and February, 1898, and while there had had his attention directed to corundum, which was being experimented on at the time at the School. He had learned something of the character of the mineral and of its mode of occurrence, and on going into the field in the following season had decided to look for it. On meeting Mr. Morrow, a resident of the township referred to, a gentleman who has paid considerable attention to the minerals of his district, Mr. Gemmell described to him how corundum occurs in the rocks, laying special stress on the fact that the mineral usually stands well above the weathered surface of the mass in which it is found. Mr. Morrow at once stated that some years before he had observed crystals of mineral attached to the surface of a rock in the sixth concession of South Sherbrooke. Tho two gentlemen visited the locality together and found a mineral occurring as Mr. Morrow had described it. They were in doubt however as to whether it was corundum, on account of its being almost white in color and thus differing from the specimens Mr. Gemmell had seen in Kingston. However, to make sure of the point, they sent specimens to Prof. Nicol of the School of Mining, who assured them that it was corundum without a doubt.

Immediately after the "find" had been verified Mr. Gemmell invited the writer to visit the locality, in order that a comparison might be drawn as regards the richness of these deposits in Lanark with those situated in North Hastings and adjoining areas fifty miles or so to the northwest. A visit was accordingly made to South Sherbrooke in October, after the completion of the field work which has been described in preceding pages. It was found that the corundum occurs in a belt of igneous rocks which has a strike about parallel to that of the concession lines of the township. This is N. 45° E., astronomical. This belt, so far as examined in the township, lies wholly in the sixth concession and has been traced from lot 12 to lot 1, the latter lot lying at the boundary between this township and Oso to the west. The breadth of the belt is about three-quarters of a mile. The belt also extends into Oso, keeping the same direction.

Size and color of the Crystals.

The largest crystals of corundum observed in the rock had a length of about $1\frac{1}{4}$ inches, but are thick and more tabular in form than most of those found in North Hastings and adjacent country. The majority of the crystals have a diameter of about half an inch and show a rather striking uniformity in size, there being scarcely any of the mineral in small grains. The color of the mineral is also pretty uniform, being light gray or almost white, and sometimes light pink or flesh colored. It may also be stated that the corundum is distributed across the whole breadth of the band of rocks but in no place examined was the percentage high, the richest parts of the rocks averaging probably about five per cent. The crystals stand well out on the weathered surface of the rock and are often attached to it by a very small part of their under surface.

Corundum-bearing Anorthosite.

Thin sections were made of specimens of the rock, and on examining these under the microscope they were found to consist largely of a basic plagioclase felspar together with some green hornblende. Mr. William Lawson, B.A.Sc., kindly made a chemical examination of the rock for me. He also analyzed the plagioclase and hornblende after they had been separated from the powdered rock mass by means of a heavy solution. On analysis the rock proved to be anorthosite, but of a more basic character than the typical varieties of this rock on which much work has been done by officers of the Canadian Geological Survey and others. The felspar in the South Sherbrooke rock was found to be bytownite with the formula Ab_1An_4, while the felspar in the normal anorthosites is more acid in character, being typically labradorite.

Characteristics of the rock

The only anorthosite or plagioclase felspar rock the writer has seen described which agrees in composition with this South Sherbrooke rock is one from Seine river in northwestern Ontario. This rock was described by Dr. A. P. Coleman some years ago.[6] Dr. Coleman says of this rock: "The results of the analysis show that the anorthosite from the mouth of the Seine is one of the most basic of the massive rocks, and it is possible that the low silica contents and the fact that it consists essentially of anorthite instead of labradorite would justify a separation under a distinctive name; but there seems little doubt that numerous intermediate rocks, such as that from Bad Vermillion, link it to the typical anorthosite of the Province of Quebec. On the whole it will be wiser not to add another name to the rapidly growing burden of the lithologist; for it is clear that these rocks are not definite species, but shade into each other just as the plagioclase felspars do. Possibly a binomial nomenclature like that tacitly admitted in the classification of other rocks, such as the granites, might be adopted, the typical anorthosite being called labradorite anorthosite, that from Bad Vermillion bytownite anorthosite, and the rock from the mouth of the Seine anorthite anorthosite."

Classification of Anorthosites.

The following analyses will show the close resemblance there is in chemical composition between the South Sherbrooke anorthosite and that described by Dr. Coleman from the mouth of the Seine (p. 227).

Anorthosites of Ontario and Quebec.

Judging from the general appearance of some varieties of the rock from Eastern

[6] **Fifth Report Bureau of Mines, pp. 99 and 100, and Journal of Geology, Chicago, November-December, 1896. Reprinted in Canadian Record of Science, vol. VII., No. 4, 1897.**

NOTE.—Since the above was in type the writer has met with other analyses, made years ago. These taken together with those of the rocks from Seine river and South Sherbrooke show that basic anorthosite is not so rare as has been thought. The two Ontario localities to which reference has just been made are about 800 miles distant from each other.

	Russia. IV.	Ottawa, Ont. V.
SiO_2	46.54	47.40
Al_2O_3	30.73	30 45
Fe_2O_3	3.23	0 50
FeO	1.18	
MnO	...	
CaO	15.45	14.24
MgO	1.35	0.87
Na_2O	1.36	2.82
K_2O	0.52	0.38
CO_2	....	2.00
H_2O	0.04	Volatile
	100.40	98.96
Sp. Gravity	2 73	

IV. Analysis quoted by F. Zirkel, Tschermak's Min. Mitt., 1871, page 62. The rock is described as being composed of anorthite and hornblende in the proportion of 90 of the former to 10 of the latter.

V. The analysis is by T. Sterry Hunt, who thus describes the specimen examined: "A greenish-white granular variety of anorthosite rock, from a boulder near Ottawa, having a density of 2 73. This is a portion of the specimen upon which Dr. Thompson founded the species named by him bytownite . . The rock is coarsely crystalline and made up of black hornblende, with a little sphene, and a white triclinic felspar, the cleavage surfaces of which are sometimes half an inch broad, and beautifully striated." Geology of Canada, 1863, page 79.

Most writers state that labradorite is the essential constituent of what they call the typical anorthosites. It would seem that this is owing to the fact that few analyses have been made of these rocks Moreover, it may be said that only comparatively restricted areas have been examined. The most of Hunt's analyses and those of other workers on this continent were on samples from the district in Quebec which lies adjacent to the St. Lawrence river, and from the adjoining region in the United States to the south The assumption that labradorite is the typical felspar of those rocks may moreover be due to the fact that most of the areas of anorthosite to which attention has been directed are of large size, and thus, for various reasons, would on the whole be more acidic in character than smaller outcrops From the analyses which have been quoted by the present writer from Ontario and Russia, it would seem that no one plagioclase should be considered the typical constituent of these rocks.

Rosenbusch (Elemente der Gesteinslehre, pages 151 and 153) quotes four analyses of anorthosites; Kemp (Handbook of Rocks, page 49) three, and Adams' (N. J. Fur. Min. 1893, page 494) two. These range in percentage of silica from 53.42 to 59.

Ontario albite anorthosites also occur associated with the corundum-bearing group.

	I. Seine River.	II. South Sherbrooke.	III. Rawdon, Que.
SiO_2	46.24	47.32	54.45
Al_2O_3	29.85	30.36	28.05
Fe_2O_3	1.30	1.35	0.45
FeO	2.12	1.55	...
MnO	trace	...	...
CaO	16.24	15.45	9.68
MgO	2.41	2.44	...
Na_2O	1.98	1.88	6.25
K_2O	0.18	0 66	1.06
C_2O_2	1.03	0.58	....
H_2O	.....	0.10	0.55
Total	101.35	101.69	100.49
Sp. Gravity	2.85	2.73	2.69

The following analyses, made by Mr. Lawson, show the composition of the two constituents of the South Sherbrooke anorthosite. For comparison the theoretical composition of a plagioclase, $Ab_1 An_4$, quoted by Zirkel[7], is given, as well as the composition of a hornblende from hornblende gabbro quoted by Rosenbush[8].

	Bytownite.		Hornblende.	
	I.	II.	III.	IV.
SiO_2	48.12	48.03	41.40	39.58
TiO_2	...	..	...	trace
Al_2O_3	34.54	33.43	15.39	14.91
Fe_2O_3	0.36	...	7.01	4.01
FeO	....	....	7.17	10.67
MnO	....	...	trace	trace
CaO	16.30	16.28	12.53	11.76
MgO	trace	....	10.31	13.06
K_2O	0.15	...	1.56	0.62
Na_2O	1.91	2.26	3.58	2.87
H_2O (ignition)	none	.. .	0.81	2.79
	101.38	100.00	99.76	100.27
Spa. Gravity	2.731	2.735	3.188 at 15° C	3217—3222

I. Bytownite from the Anorthosite of South Sherbrooke, Ont.

II. Bytownite, Ab_1An_4, given by Zirkel.

III. Hornblende from the Anorthosite of South Sherbrooke.

IV. Hornblende from a Hornblende Gabbro, quoted by Rosenbusch.

It will be seen that there is a remarkably close agreement between the theoretical composition of bytownite, $Ab_1 An_4$, as regards the percentages of the silica, lime and alkalies and that of the felspar from the South Sherbrooke rock. The proportion of alumina in the latter is however over one per cent. higher than that of the theoretical percentage. This may be due to the presence of a small amount of corundum embedded in the felspar in a very fine state of division, as this mineral occurs, as has been stated, in parts of the rock. None of it was identified however, either by megascopic or microscopic examination, in the specimen analyzed. In thin sections under the microscope the felspar is seen to contain numerous crystallite-like inclusions It is possible that some of these are corundum.

The hornblendic constituent of the anorthosite is seen by the analysis to have the composition of the typical variety, or what is called common hornblende.

[7] Petrographie, 2nd edition, page 221.

[8] Elemente der Gesteinslehre, page 148.

Oso in Frontenac County.

Westward Extension of the Belt.

From the boundary of the township of South Sherbrooke the belt of corundum-bearing anorthosite runs westward into the adjoining township of Oso in Frontenac county. During the little time I spent in this township however I did not succeed in finding the belt so well defined as in South Sherbrooke, although corundum was found in the rock in situ at two or three places and anorthosite boulders carrying corundum were found lying south of a line which runs several miles to the west, thus showing that the belt continues for a considerable distance across country.

As only a hurried walk was made through this part of the township the location of the outcrops of rock and the distribution of the corundum-bearing glacial boulders can be only approximately stated. This is owing also in some measure to the fact that some of the streams and small lakes were found to be incorrectly laid down on the township map. In a general way it may be said that the belt of corundum-bearing anorthosite enters Oso near the northern edge of Rock lake, which lies at the boundary of the townships of South Sherbrooke and Oso. This is near lots nine or ten in the seventh and eighth concessions. From this point the belt, judging from the position occupied by the glacial boulders, runs southwestward about midway between the southern edge of Sharbot lake and the northern extremity of Crow bay, which is an extension of Bobb's lake. No clearly defined belt was found here, but considerable rock in place resembled that farther east, and this rock crosses the Kingston and Pembroke railway a short distance south of Olden station. Just east of the railway

track the rock was found to be associated with crystalline limestone. At the side of a spring which has been fitted up with a curb, and which is situated just over the fence on the east side of the track near some farm buildings, there is a boulder which carries the characteristic light colored corundum of the district. A little to the southeast of these buildings and along the wagon road to the east numerous similar boulders occur, scattered over the surface of the ground. Down the track a mile or more south of Olden station other boulders which carry corundum occur. All the boulders referred to are rather dark in color on weathered surfaces, but have a somewhat characteristic appearance, due to a bluish or purplish shade of color, which can be made out when some distance from them, and thus serves to distinguish them from the boulders of "trap" and other dark colored varieties of rock which are associated with them.

West of the railway track the belt runs towards the north end of Eagle lake, of which the greater part lies in the north-east corner of the township of Hinchinbrooke. A boulder carrying corundum was found at the roadside about one mile north of the village of Parham, which is situated to the southwest of the lake. As none of the rock was found in place around the north shore of the lake, it would appear that the belt runs through the lake or along its southern edge. The rock may be in place on some of the islands of the lake, which time did not permit us to examine. This belt is likely continued to the southwestward of Eagle lake, and other outcrops of the corundum-bearing variety will likely be found in place here if a careful examination be made of the territory.[9]

Around Eagle Lake.

The Parham Gabbro Area.

The track of the Kingston and Pembroke railway runs through some "cuts" just north of Parham station. The rock in these is very coarse grained and dark in color, and on microscopic examination is seen to belong to the gabbro family. The chief constituents of the rock are basic plagioclase and pyroxene. The pyroxene consists in some specimens of both diallage and hypersthene, so that it would be as proper to call the rock a norite as a gabbro. Both the diallage and the hypersthene contain the inclusions characteristic of these minerals. The inclusions here are however striking on account of their comparatively large size, and have been referred to in a paper published some three years ago.[10]

Other minerals occurring in subordinate amounts in this gabbro are biotite, apatite, magnetite and pyrite, besides other accessory constituents of less prominence. Stringers of quartz of secondary origin are also sometimes present. An interesting fact in connection with part of the gabbro is that some of the basic plagioclase on microscopic examination is found to be altering into scapolite, as shown in Fig. 3. This mass then represents a stage in the alteration of gabbro into the scapolite rocks which are so characteristic of some parts of the region under consideration. In the typical scapolite rocks the essential constituents are scapolite and secondary hornblende. The former mineral as stated is believed to come from plagioclase, and the latter appears to be derived from pyroxene by alteration. In some varieties of the scapolite rocks, which will be hereafter referred to in speaking of some of the iron ore deposits, none of the plagioclase or pyroxene remains unaltered.

Other minerals in the Gabbro

Part of the gabbro mass just north of Parham station lies to the east of the railway track and part of it extends westward to near the shore of Eagle lake.

The phosphate deposit known as the Boyd Smith or Eagle lake property lies at the edge of the mass and near the shore of Eagle lake. This deposit has been described in the Report of the Royal Commission on the Mineral Resources of Ontario, 1890. While most of the phosphate has been mined at the edge of the igneous mass, still some outcrops of the mineral are surrounded by the gabbro

[9] Since the above was written outcrops of pink syenite-pegmatite carrying corundum have been found some miles to the southwest, in the township of Hinchinbrooke.

[10] W. G. Miller and R. W. Brock, Canadian Record of Science, Oct., 1895.

with no other rocks intervening. A considerable amount of titaniferous magnetite also occurs on this property in the gabbro, and some of the ore has been blasted out. This magnetite, like other titaniferous varieties, carries a small amount of nickel and cobalt.[11]

One specimen was found to contain 0.1974 per cent. of the metals. A fine grained variety from the same deposit was found to contain 0.5648 per cent. of nickel and 0.2622 per cent of cobalt. Samples of pyrite in association with the gabbro on the same property gave 1.6785 per cent. of nickel and 0.9847 per cent. of cobalt. All these analyses were made by Mr. F. J. Pope, M. A., late demonstrator in the Kingston School of Mining.

Scapolite Rocks.

As has been stated, some of the basic plagioclase in the Parham gabbro mass can be seen, when the rock is examined in thin sections under the microscope, to be more or less altered into scapolite. There are other large masses of the rock in the district in which the plagioclase appears to have been completely altered into scapolite and the pyroxene into hornblende. Again there are masses of gabbro-like rocks intermediate in mineralogical composition between the Parham mass and these masses in which the felspar is represented entirely by scapolite. Many of these scapolite-bearing rocks are found in association with iron ore deposits. Very often the scapolite rock forms one wall of the ore body while the other wall consists of usually somewhat impure crystalline limestone. A deposit of this character is that known as the Glendower mine, near Bedford station on the K. & P. railway. Here the foot wall of the deposit is a scapolite rock which in the field has the general appearance of a somewhat coarse gabbro, but when examined in thin sections under the microscope the light colored constituent is seen to consist almost entirely of scapolite, with some calcite, while the dark constituent is hornblende. See Fig. 4.

Scapoilte associated with Iron Ores.

The scapolite rock is much freer from oxides of iron than is ordinary gabbro, and it would seem as if in the process of alteration of the gabbro, now represented by the scapolite rock, the iron oxides had been leached out and deposited from solution, thus giving rise to the iron ore body.

In his description of the corundum district of Burma Prof. J. W. Judd[12] states: "The study of the Burma limestones leads to the conclusion that the basic gneisses may undergo a corresponding metamorphosis, the breaking up of the lime-felspar leading to the formation of an unstable scapolite, from which and from other unstable minerals originate, as a consequence of further change, the calcite and dolomite." It may be added that in Eastern Ontario it is possible that some of the crystalline limestones which are so intimately associated with scapolite rocks, which latter are alteration products of igneous rocks, may represent the extreme forms of the alteration of these igneous rocks.

The scapolite rock from the Robertsville mine, which forms one of the walls of the magnetite deposit, in mineralogical composition stands between the Parham gabbro and the scapolite rock of the Glendower mine. I consists essentially of scapolite, plagioclase, both of which occur in large amounts, and hornblende. The microscopical characters of this rock were described some years ago by Dr. F. D. Adams and Dr. A. C. Lawson.[13]

Corundum in other Countries.

In last year's report, p. 213, a brief account was given of the modes of occurrence of corundum and emery in different countries. Since the publication of that report two important monographs have appeared on the subject. For a copy of one of these I am indebted to Dr. T. L. Walker of Calcutta. This valuable report on the corundum deposits of India, consisting of 79 pages, is by Mr. T. H. Holland.[13] The other publication referred to is by Josef Morozewicz, and deals with the artificial pro-

Recent Reports by Foreign Authors.

[11] Seventh Report Bureau of Mines, pp. 230 to 232.

[12] The Rubies of Burma and Associated Minerals. Phil. Trans. Roy Soc. London, vol. 187, p. 205.

[13] Can. Rec. Science, 1889, page 198.

[13] A Manual of the Geology of India, Economic Geology part I, Corundum by T. H. Holland, A.R.C.S., F.G.S., Deputy Superintendent Geological Survey of India, 1898.

duction of corundum and other minerals in magmas.[14] A brief account is also given of the modes of occurrence of corundum in Russia. The volume consists of reprints of articles from an Austrian periodical, and I am indebted to the kindness of the author for a copy of it.

In India.

As corundum occurs under many forms in India, and some of its modes of occurrence there are similar to those under which the mineral occurs in Ontario, it seems advisable to give a brief review of Mr. Holland's paper in this report.

In the introduction to his report Mr. Holland states that "The Indian Empire can with very good reason be claimed as the home of corundum. The name corundum—under which the dull-colored and non-transparent forms of natural alumina have generally been known since the introduction into Europe of a large number of Indian specimens towards the end of the last century—is only a modified form of the Sanskrit word korund. Not only are there large deposits in India of the common form of this mineral, . . . but the most highly prized specimens of its transparent red variety, the ruby, have been obtained from the famous mines of Burma, whilst the mines of Kashmir are noted for the size and transparency of the blue variety, sapphire."

The home of Corundum

Mr. Holland does not deal with corundum as an ore of aluminium, as he states that the high price of the mineral for abrasive purposes at the present time, in addition to there being no processes as yet devised for the extraction of the metal from the mineral, prevent corundum from entering into competition with other ores which contain a lower percentage of the metal but can be sold at a lower price.

An interesting account is given of the views which have been held concerning the character and relations of corundum in the mineral kingdom. Reference is made to the supposed magical and medicinal properties of the gem varieties. It is stated that the ruby and sapphire, known as "perfect corundum," were prized by the ancients "for their beauty and supposed efficacy in medicine or magic." A quotation is given from an ancient author by whom the mineral is called hyacinthus. "This is the gem that feels the influence of the air and sympathizes with the heavens, and does not shine equally if the sky be cloudy or bright. Besides, when put in the mouth it is colder than other stones. For engraving upon indeed it is by no means adapted, inasmuch as it defies all grinding; it is not however altogether invincible, since it is engraved upon and cut into shape by means of the diamond." Even at the present time, Mr. Holland states, the mineral is thought by the natives to have a medicinal value. "Like many minerals common corundum is used in India for medicinal purposes. The hakims (native doctors) of the Punjab use calcined corundum as a cooling medicine in fevers (dose about 16 grains). They also apply it to wounds to stop bleeding." In fact mythical properties innumerable seem to have been attributed to the common and gem varieties of the mineral. Rubies of certain quality were believed to concern the life, death, wealth, poverty, success, failure, humiliation, exaltation of their owners. Stones of certain character were believed to subject their possessors to lightning strokes, to blows from a weapon, or to loss of domestic animals. To the sapphire among other properties was attributed the power of extinguishing fire, and of curing fever, inflammation and evil passions. It may be added that this belief in the supernatural powers of gems and other inanimate objects is not confined to eastern nations. Even among ourselves at the end of the nineteenth century there are some who consider it ill luck to possess or wear certain gem stones, and everyone has heard of men who carry horse chestnuts in their pockets or wear lead rings as a preventative of rheumatism!

Supposed Medicinal and Magical Properties of the Gem Varieties.

Mr. Holland states, p. 10, that "There seems to be no à priori reason why corundum, when occurring as a rock constituent, should require any different explanation than that generally applied to

Theory of Mr Holland on Origin.

[14] Experimentelle Untersuchungen uber die Bildung der Minerale im Magma von Josef Morozewicz in Warschau. Saparat-Abdruck aus Tschermak's Min. und Pet. Mitt., Band XVIII, Heft 1 und 2. Wien.

the other simple oxides occurring in a precisely similar manner." This agrees with the opinion expressed by the present writer in last ysar's report. Mr. Holland further states that until recently the known occurrences of corundum in situ were few, and this may account for the tendency there has been to regard the origin of corundum as due to unusual or secondary circumstances, its production having been thought to be due to the action of mineralizing agents or other causes affecting the aluminous rocks in which it occurs. "The principal Indian occurrences of corundum in situ can be divided into two classes: (1) Those in which corundum is associated with basic rocks, and (2) those in which its associates are distinctly siliceous (acid). Both classes are well represented in India, but in most cases where corundum has been found associated with basic rocks intrusions of pegmatite have also been found in the neighbourhood." The basic rocks have pyroxene as a predominant constituent. With it are associated hercynite, ruby, spinel, pleonaste, magnetite, ilmenite, corundum and other minerals. Corundum also occurs in crystalline limestones, and it has been shown that these limestones are intimately associated with pegmatite, this association of the rocks being a constant feature of the Madras corundum deposits. In view of Prof. Judd's conclusions these limestones are regarded as extreme forms of the alteration of rocks which are now generally regarded as igneous in origin. "It seems appropriate to link with them (the limestones) the anorthite rock containing corundum in the Salem district of Madras. Although the anorthite matrix was the first described amongst the occurrences of corundum, this association appears to be rare, possibly because the anorthite has in many cases been changed to carbonate of lime."

Prof Judd's Conclusions

In connection with the Ontario occurrences of corundum the fact has been mentioned that corundum has been found in a basic anorthosite, a rock very similar in character to the corundum-bearing anorthite of India No occurrences in this Province are however known which resemble those of India in which corundum is found in highly pyroxenic rocks, or in their altered representative the crystalline limestone. Attention has been drawn however, both in the present report and that of last year, to the frequent association of quartziferous pegmatite with the corundum-bearing rocks of the Province. It has also been stated that the corundum-bearing rocks of Ontario are, in the majority of cases examined, closely associated with crystalline limestones.

Comparison with Ontario Occurrences.

"The sapphires of Kashmir occurring in a granite, form a good example of the occurrence of corundum in rocks of acid composition."

In Ontario corundum has not been observed in granite, but the more acidic varieties of syenite which contain the mineral appear, as has been stated, to pass into granite in some cases.

Burma.

In Burma, which is celebrated for its rubies, the principal mines are those in which the stones are found in crystalline limestone, hill-wash, or in alluvium. In one small area in Upper Burma there are ten distinct bands of crystalline limestone in a distance at right angles to their strike of 2½ miles. Their collective thickness across their outcrops is about 2,670 feet. The gem stones are obtained by washing the detrital matter produced by the weathering down of the limestone. "The limestone itself has also been quarried for the rubies occurring in situ, but the shocks produced by blasting and subsequent hammering of the rocks invariably injure numbers of the gem-stones." At one point in the Coimbatore district "two rocks of different composition and structure are connected with the appearance of corundum . . . The one is the pale gray elæolite syenite of the Sivamalai Hill, and the other a coarse felspar-rock intruded as veins into the former rock." The latter rock is composed of red or deep flesh-colored plagioclase and biotite in large nests of small plates. It is in this rock that the corundum occurs, and it appears to be an original constituent of the rock. Although

Rubies in Crystalline Limestone.

corundum occurs in a rock here which is associated with elæolite or nepheline syenite, the mineral has apparently not been found occurring in the latter rock in India. The same appears to be true of all other countries, including particularly the Ural mountain district of Russia and other districts in which both corundum and elæolite syenite occur. Judging from the descriptions of the occurrences of corundum in these countries which have so far been published, Ontario is the only country in which corundum has been observed to occur in elæolite (nepheline syenite). In this Province numerous occurences have been observed by the present writer in which the mineral is embedded in syenite of this character.

Unique occurrence of Corundum in nepheline syenite in Ontario.

In the Salem district corundum occurs under conditions very similar to those which have been stated by the present writer to prevail in the deposits of this mineral in the township of South Sherbrooke. Mr. Holland describes the rock as "consisting of anorthite (indianite) and hornblende chiefly." The specific gravity of a specimen with but little hornblende was found to be 2.824. The corundum is of a "pale, greenish-gray, rarely flesh colour, and occurs sparsely distributed" among the parts of the rock which has a gneissoid structure, which are richer in anorthite. "It takes the form of irregular lumps averaging from one-quarter to one inch in diameter. The crystals do not, as a rule, show the prismatic and pyramidal faces . . ."

This description of the mineralogical composition of the rock and the form and color of the contained corundum applies very well to the occurrence in South Sherbrooke.

In the Salem district, as in the other corundum areas of India, one of the characteristic features is the occurrence of dikes of coarse granite or pegmatite, and reference is also made to the occurrence in this district of dikes of a dark compact trap, both of which rocks are frequently found in the neighbourhood of the Ontario corundum deposits.

Paparapatti Area.

In the Paparapatti area corundum occurs in the solid rock, and since this is one of the few localities in India in which attempts have been made to work such deposits in order to extract the mineral for abrasive purposes it may be well to give Mr. Holland's description of the occurrence, with his conclusions as to the economic value of the deposits. This will be of some assistance in estimating the relative importance of the Ontario deposits

Working rock Corundum for Abrasive purposes.

"The actual matrix of the corundum in this area occurs as bands of lenticular masses, of principally deep flesh-colored orthoclase (finely crystalline, and showing under the microscope a fine microperthitic or cryptoperthitic inter-growth of possibly plagioclase) in which there is often a considerable proportion of sillimanite (fibrolite), rutile, opaque black and green spinel, with biotite, which last is especially developed at the periphery of each lenticle. The size of these lenticles is sometimes as much as fifteen feet long and eight feet across where actually seen in the rock. The corundum here differs entirely in appearance from that of Sittampundi. It is of a deep purplish brown or sometimes dark greenish-gray colour, and is always regularly crystallized into hexagonal prisms with a great number of variously inclined pyramidal faces imperfectly developed, and so giving the prism an elongated barrel or even spindle shape.

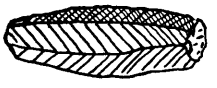
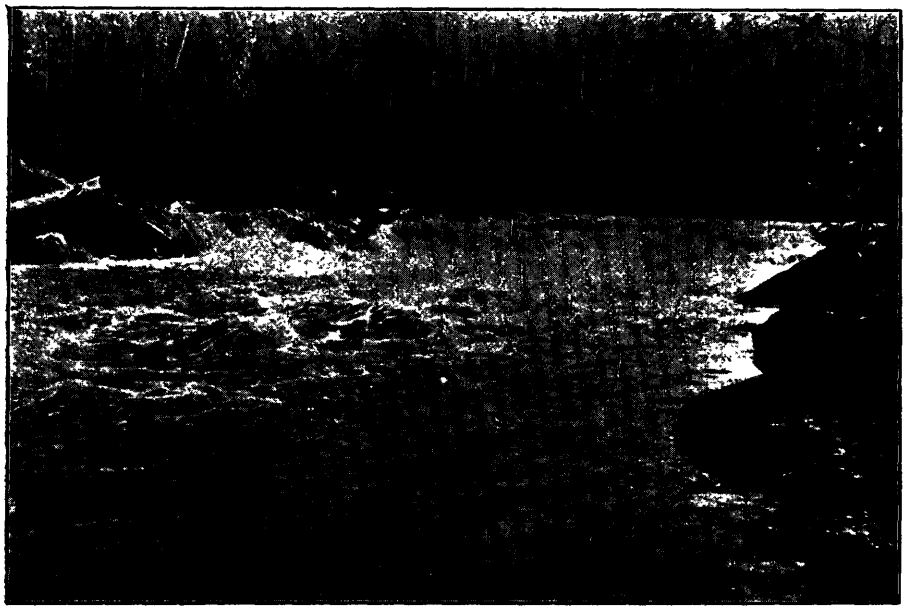


Fig 5. Crystal of Corundum showing the curved faces due to alteration of the prism and pyramid, as well as traces of the rhombohedral parting planes Paparapatti area, Salem district Natural size (after Holland)

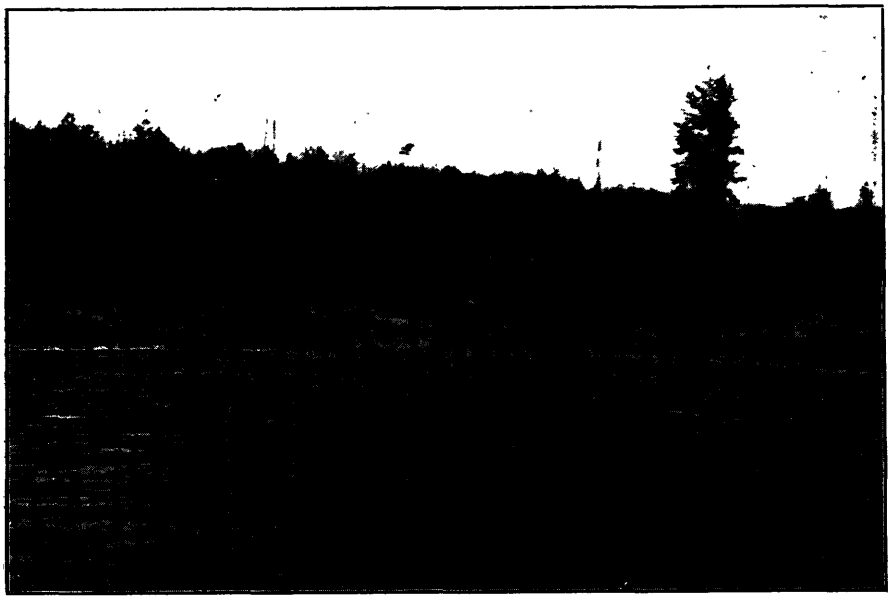
"In size they vary from extremely minute grains and crystals, only visible in a microscopic section, to large crystals several inches long and from one-fourth to one inch in diameter. The characteristic parting planes parallel to the rhombohedron are easily made manifest by breaking the crystals, and sometimes traces of these planes are visible on the prism faces (Fig 5). Occasionally also a combination of the rhombohedron and prism may be seen in a single crystal. Each crystal is surrounded by a shell of purer orthoclose,



Rapids above High Falls, York Branch River —W. K. George.



 High Falls on York Branch River, from a point above the Falls – W K George



At the foot of High Falls on York Branch River —W K George.



34 Second Falls on York Branch River at Bronson or Lancaster Farm (18 ft.) —Harris



View on the York Branch River —Harris.



 Foster's Rapids on the York Branch River —Harris.



Corundum-bearing rock on Robillard's farm, lot 3, con. 18, Township of Raglan —Harris



 Corundum-bearing rock on Robillard s farm, lot 4 con. 18, Township of Raglan. —Harris.

generally flesh-coloured, but sometimes white, having a thickness of from one-fourth to one-eighth inch. When a corundum crystal has been broken out or has dropped out from the rock, the place where it lay can always be distinctly recognized by this shell which remains behind. Microscopic examination shows that this shell differs from the remainder of the matrix in the absence of minute corundums, sillimanite and most of the accessory minerals.

"It is clear from the map that the outcrops of the rock in which corundum occurs lie in successive lines, roughly parallel to the strike of the gneiss, namely, N.N.E. —S.S.W.

"This conclusion has since been confirmed by the discovery of corundum occurring under precisely similar conditions in the Hosur taluk to the north, and also in the same line to the south, making the corundum-bearing band over 24 miles long. This fact, and the circumstance that the mineral occurs in two and probably more parallel bands of slightly different rocks, make the Paparapatti area a decidedly promising one. Experiments to test the prospect of mining for corundum along this band have been conducted by Mr. C. S. Middlemiss, on a lenticle 13 x 8 x 9 feet, near the village of Erranhalli, 2½ miles S.W. by S. of Palakod. It was found that 722 cwt. of matrix-rock yielded 2,845 lb. or nearly 3.5 per cent. of pure corundum, at a cost of ₹ 385-2-0, that is at 8 annas per cwt. of rock broken up and 3.9 lb. of corundum cleaned.[15] As the chief expense was incurred by the mere labor of crushing the rock, which was done entirely by hand, it is certain that the cost of extracting the corundum would be greatly reduced if stone crushing and washing machinery had been employed, as of course would be the case in actual mining operations on a large scale."

Relative Richness of Ontario and India Deposits.

Since Mr. Holland—who is in a good position to judge on account of the fact that more work has been done on corundum in India than in any other country —considers the area just described a decidedly promising one, I have thought it well to quote his description fully, both as to the characteristics of the mineral itself and as to its mode of occurrence, so that comparison might be instituted between these deposits and those of Ontario.

Advantages of the Ontario Corundum.

Since in order to work either the India or Ontario deposits on a large scale would require the use of machinery, the cost of mining and crushing the rock in the two countries may be taken as being practically the same. In so far as climatic influences, transportation facilities, water for washing the crushed material and for use in generating power, electric or otherwise, are concerned, the Ontario deposits are certainly as well situated as any in the world.

The chief constituent in the India rock, as in that of Ontario, is felspar. But in addition to the felspar the India rock contains often a considerable proportion of fibrolite, rutile and spinel. These minerals are heavier than felspar and have specific gravities of, respectively, 3.23 to 3.24, 4.18 to 5.2. 3.5 to 4.1, that of the felspar being 2.57. On washing away the felspar these minerals would tend to come down with the corundum, which has a specific gravity of 3.95 to 4.10, and would thus give an impure product. Mica occurs in the rock from both districts, and hence this mineral may be left out of consideration in making a comparison of the treatment of the two. The heavy mineral which comes down with the Ontario corundum on washing is magnetite, but this mineral is easily and cheaply isolated by passing the mixture over a magnetic separator. Moreover the magnetite, which averages about four per cent. of the rock treated and is of good quality, is in itself a by-product of value for use as an iron ore.

In the mill tests of the Hastings rock made last year by Prof. DeKalb, the corundum obtained from one sample of 550 lb. represented 12.74 per cent., and in another sample of 1250 lb. the corundum separated was 15.50 per cent. of the rock treated.[16] Since the India rocks yielded only 3.5 per cent. of pure corundum, the Ontario deposits would seem to have a considerable advantage over

[15] 8 annas=about 11 cents. The cleaned corundum therefore cost 2.82 cents per pound.

[16] Seventh Report Bureau of Mines, p. 246.

those of India as regards the percentage of mineral in the rock from the two districts.

As stated in last year's report, p. 225, it is difficult to get much information from Government reports concerning the percentage of corundum carried by the rock in deposits which have been worked. The United States reports state that the producers of the mineral are averse to giving information concerning the corundum industry. The percentage quoted from the India report and two others given in a United States report are the only ones the writer has met with In the latter report one vein from two to six feet wide is said to average 15 per cent. corundum. The material of another deposit in which the vein is from four to 15 feet wide is said to average probably 10 to 15 per cent. corundum.[17] It would thus seem that the Ontario rock contains at least as high a percentage of the mineral as do the deposits with which it will have to compete if worked.

Judging from the characteristics of the India corundum given in the description which has been quoted, the quality of the Ontario mineral is not inferior for abrasive purposes. In fact much of the mineral in the deposits of this Province appear to be of a superior quality to that of the Paparapatti district. The parting planes in the India corundum seem to be more perfectly developed than they are in much of the Ontario mineral, and for abrasive purposes it is desirable that they be not well developed.

With regard to the extent of territory over which deposits are found in the two districts under consideration, there does not seem to be much difference. Mr. Holland states that the mineral has been found along one band which is about 24 miles in length, and that there are two and probably more parallel bands of somewhat similar character. In Ontario corundum has been found, as has been stated in this report, in three different bands or belts of rock. These belts taken together have a length of about 100 miles.

The lenticles or deposits in which the Indian corundum occurs are stated by Mr. Holland to be "sometimes as much as 15 feet long by eight feet across where actually seen in the rock." From the descriptions which have been given of the surface measurements of some of the Ontario deposits, such as the York river deposits and others, it will be seen that those of this Province are, to say the least, not smaller than those of the India district which is under consideration.

[17] Mineral Resources, U.S., 1893.

Corundum Rocks of India.

Geological Characteristics of India Corundum

In summing up the geological characteristics of the India corundum region, Professor Judd says:[18] "In all these districts (in Southern Asia) the rocks containing corundum appear to be highly crystalline gneisses, sometimes passing into schists, and frequently including masses of limestone and dolomite, the latter rocks being as a rule highly crystalline, and containing many silicates and other minerals. Intrusive masses of granite or pegmatite also occur. There is no evidence, so far as I am aware, opposed to the view that the whole of these rocks must be regarded as of Archæan age." From the descriptions which have been given in this report and in that of last year of the Ontario corundum region it will be seen that there is a strong resemblance between the rocks of the two regions. The similarity is not less strong when we consider the occurrence of certain special rocks of the two regions, such as the nepheline syenite and the scapolite gneisses.

In the Ontario region however the corundum occurs as an original constituent of igneous rocks, while in India most of the corundum, including the gem varieties, occurs in crystalline limestones and is a product of metamorphism.

In Russia.

Occurrences of the Mineral in parts of Russia

Reference was made in last year's report to the occurrence of corundum in Russia, and a little was said of the characters of the rocks with which the mineral is associated in that empire.

Morozewicz, in the excellent monograph to which reference has been made, and which

[18] The Rubies of Burma and associated Minerals by C. Barrington Brown and J. W. Judd. Trans. Roy. Soc. London, 1896, p. 191.

was published during the winter of 1898-9, in addition to describing the interesting results of his experiments on the artificial production of corundum, gives an account of the modes of occurrence of the mineral in some of the Russian localities visited by him. As in these localities the mineral occurs under conditions similar to those under which it is found in Ontario, it will be well to mention in this report some of the characteristics of the corundum-bearing rocks of Russia described by this author.

Corundum-Anorthite Rock.

Associated with Anorthite.

The variety of corundum-bearing rock of Russia which has attracted most attention is that in which the mineral occurs associated with anorthite. This rock occurs in stocks or very large dikes. It is associated with granite and serpentine, which lie on either side of it at the locality on the river Borsowka. The rock at this locality is medium to fine grained in texture, and is made up of crystals of corundum scattered through a gray ground mass in which occur plates of biotite. The finer grained varieties of the rock have at times a gneissoid structure. In some cases the corundum occurs in long hexagonal crystals, and in others it occurs in small pyramidal forms. Fresh specimens show no trace of alteration products, such as calcite or chlorite. Varieties of rocks, differing in the size of the grain, are seen in thin sections, when examined under the microscope, to possess the same constituents but in varying proportions. The gneissoid variety contains the most biotite, while the finest grained contains more secondary material. The chief constituents of the rock are corundum and anorthite, together with spinel and biotite. Apatite and zircon occur as accessory constituents. The secondary minerals present are muscovite, chlorite, kaolin and chrome iron ore. The following is the order in which the primary constituents have crystallized out of the magma, viz.: zircon, spinel, corundum, anorthite, biotite. It is claimed by Morozewicz that the corundum-anorthite rock forms a new type of an alumino-silicate magma and is called "kyschtymit" by him.

The Ontario corundum-plagioclase rock which has been described in this report is similar in character to this Russian rock, the chief difference between them being that the felspar in the specimen of Ontario rock analyzed was somewhat more acid than that of the Russian variety, and in place of the biotite of the Russian rock the corundum-anorthosite of this Province contains hornblende.

It would seem that instead of introducing the name "kyschtymit" for the corundum-anorthite rock of Russia, it would be better to use the name anorthosite, which has long been used by Canadian geologists and others for igneous rocks whose characteristic constituent is a plagioclase.

Corundum-Orthoclase Rocks of the Urals.

In addition to the basic or anorthite corundum-holding rocks just described, other rocks of a more acidic character occur in the Urals. The varieties of these latter rocks which carry corundum contain as their chief constituent, in addition to this mineral, acidic felspar or orthoclase.

Morozewicz makes two divisions of these orthoclase rocks, the coarse grained being called corundum-pegmatite and the finer grained corundum-syenite. The rocks occur as dikes or masses in gneiss. The corundum occurs in them in large as well as in very small microscopic crystals.

Corundum-Pegmatite

In hand specimens the pegmatite is seen to consist of coarse grains of yellowish orthoclase through which penetrate long hexagonal crystals of blue corundum. The crystals of orthoclase often show Carlsbad twinning. Secondary white mica often shows on the surface of the corundum crystals. The length of the corundum crystals reaches 10 centimeters (about 4 inches) and their diameter is about one centimeter. The small crystals seen in thin sections under the microscope have a length of 1 to 1.5 mm., and a thickness of 0.5 mm. The small crystals are characterized by the possession of pyramidal terminations, a feature which was not observed in the large ones. Again the small crystals are perfectly colorless, while the large ones possess a clear

blue color. The small crystals are completely enclosed in orthoclase.

Micro-Perthite

The orthoclase is almost exclusively developed into micro-perthite. Numerous stripes of albite are mixed through the mass of the orthoclase. In addition to corundum, the orthoclase encloses in its mass hairs of rutile and short needles of apatite and zircon. Products of weathering are represented by kaolin, and limonite is also present. A mineral which occurs in small, black, opaque, glistening prisms in both the orthoclase and corundum is present, but its true character was not made out by Morozewicz.

Corundum-Syenite.

In describing the corundum-syenite the author states that a rock made up of a granular mixture of corundum, orthoclase and biotite is not seldom met with in the Urals. The rock occurs in granite in the form of stock-like segregations (Anhaufungen). Some of these occurrences are poor in biotite, while others are pretty rich in the mineral. The corundum in rock of the former kind is in short prismatic blue crystals, while in the latter kind the mineral occurs in broad dark gray plates. In both cases the corundum may be looked on as playing the part of quartz in granite. If the corundum in the syenite were changed to quartz the rock would become a typical granite.

Similarity to the Ontario Mineral in Occurrence.

Judging from Morozewicz' description of the corundum-bearing rocks of Russia it would seem that corundum has not yet been found occurring in that country in nepheline syenite. With this exception the occurrence of the mineral in the igneous rocks of the two countries, Russia and Ontario, shows a close parallel. It is altogether likely that further search will prove that the mineral does occur in nepheline syenite in Russia, since this rock is known to be associated in places with the corundum-bearing varieties. As has been shown by an analysis quoted in this report, some of the rocks of this Province which in hand specimens would not be considered to contain nepheline do contain this mineral. There is a very gradual passage from one variety of syenite to another.

Since the greater part of known igneous rocks belongs to alumino-silicate magmas, and since the principal and least varying components of such rocks are silica and alumina, these compounds are taken by Morozewicz as a basis for classification of alumino-silicate magmas. The following divisions are made :

Alumino-Silicate Magmas

GROUP A.

1 Magmas supersaturated with alumina, e.g., corundum syenite.
2 Magmas saturated with alumina, e.g , syenite.
3 Magmas not saturated with alumina, e g , gabbro

GROUP B

1. Magmas supersaturated with silica, e.g , granite
2. Magmas saturated with silica, e g., syenite.
3 Magmas not saturated with silica, e.g., nepheline syenite.

In connection with 3A and B it may be stated that nepheline syenite is saturated with alumina, but not fully saturated with silica.

Probable wide extent of Corundum-bearing Rocks

Morozewicz claims that rocks of the type of 1A, although at present so far as known are of rare occurrence, will be found to occur more widely when search is made for them. The discoveries of corundum-bearing rocks, over such a wide tract of territory which have been made in this Province in old settled districts within the last three years confirm the author's view. Rocks of similar character to those of Eastern Ontario are known to occur not only in other parts of the Province, but also in the Province of Quebec, and it seems not unlikely that if searched for corundum will be found over a wide extent of territory along the southern edge of the Canadian Archæan protaxis. Nepheline has been found in boulders in the central part of the Province, the Pic island in lake Superior, and in rock in place in the Rainy River district towards its western boundary, as well as in the eastern part and in the Province of Quebec.

Magnetite and Spinel

Ontario rocks have considerable magnetite, about four per cent., associated with the corundum, while those of the districts of Russia under consideration carry spinel. But as these are isomorphous compounds the two occurrences may be considered as being closely identical. The percentage of magnesia in most of the Ontario corundum rocks is very low—analysis showing

merely a trace. Zinc spinel however occurs at one or two places in the township of Raglan.

General Conclusions.

As has been stated in the preceding pages, the igneous rocks in which corundum has so far been found to occur in Ontario are of four kinds, viz.: (1) Syenite (mica, etc.), (2) Syenite-pegmatite, (3) Nepheline syenite, (4) Anorthosite. The following table shows which of these corundum bearing varieties are found in India and Russia according to the descriptions given by Holland and Morozewicz ·

Classes of Igneous Rocks

1. Syenite—Ontario, India and Russia.
2. Syenite-pegmatite—Ontario, India and Russia.
3. Nephelne syenite—Ontario only.
4. Anorthosite—Ontario, India and Russia.

It may be added that corundum occurs in another igneous rock in India, viz., granite. This mode of occurrence of the mineral has up to the present not been observed in Ontario, although, as has been stated, the corundum-bearing varieties are sometimes cut through by quartziferous pegmatites, and the corundum-bearing syenite appears to merge off into granite in some cases.

Locations of Ontario Deposits.

The index map which accompanies this report (p 206) shows the locations of the corundum deposits. The distances of the deposits by rail from some of the chief cities of the Province are stated on the map. The extension of the Pembroke Southern Railway from Golden Lake station to Bancroft, for which a Government bonus has been granted, will cross the main corundum belt and will greatly increase the shipping facilities. The Central Ontario Railway is also being extended to Bancroft.

Situation favorable for Industrial Development

Reference was made in last year's report to the favorable situation of the deposits as regards waterpower, labor and supplies. Excellent waterpowers occur on both the Madawaska and York Branch rivers in the vicinity of some of the main deposits. The district is well able to supply labor and agricultural products, and there is abundance of wood for fuel.

Water-power, Labor and Supplies

Statistics of Corundum.

As has been previously stated, it is difficult to get reliable statistics concerning the production of corundum. Some Government reports state that the producers are averse to giving information. The Engineering and Mining Journal of New York gives the following as being the amounts of corundum and emery produced in the United States in 1897 and 1898:

Exact information has not been available.

	1897.	1898.
Corundum, tons .	293	786
Emery, "	1,900	2,956

The value of the two materials taken together in 1897 was approximately $112,000 and in 1898 it was $210,000. The value of emery grains and rock imported into the United States in 1897 was about $130,000 while in 1898 it was $133,399. The U. S. Government reports give the total production of corundum and emery in the country in 1898 as being 4,064 tons, valued at $275,064.

Of other abrasive materials produced the Government reports state that the garnet had a value of $86,850, and pumice stone $13,200. Some other materials, such as crushed steel and carborundum, are used quite extensively. The value of the crushed steel produced in 1898 is said to be $46,200, and of carborundum $151,444.

Other abrasive Materials

The writer was informed by a gentleman who visited the corundum district of North Carolina recently that prospecting for the mineral is being actively carried on in that State, but without much success in the discovery of new deposits. Users of the material have also informed the writer that they have great difficulty in obtaining sufficient supplies of the material. One firm in Great Britain asserts that it has given up trying to secure corundum, and prefers to use high grade emery on account of the difficulty experienced in securing a constant supply of corundum and on account of much of the material supplied under that name being adulterated, or being only imperfectly separated from associated minerals.

Difficulty of procuring Corundum Supplies.

Prices of Abrasive Materials.

The following list of prices of corundum and other materials used for abrasive pur-

poses is taken from the Engineering and Mining Journal of New York :

Abrasives.	Measure.	Price.
Carborundum grains, f.o.b. Niagara Falls.	lb.	$0 10
Corundum, N.C.,	lb.	.07 @ 10
do Chester	lb.	04½@ 05
Emery grains, Turkish	lb.	05
Pumice stone, Am. powdered.	lb	01 3-5@ 02
Rouge. . .	lb.	17 @ 30
Tripoli, prepared .	short ton.	20 00

The average value of garnet produced in 1898 was $28.78 per 2,000 lb.

It seems likely that if corundum of good quality were put on the market at a somewhat lower price than at present quoted the result would be that it would displace to a large extent inferior abrasive materials and thus its consumption would be largely increased.

Abrasive Quality of Ontario Corundum.

A quantity of grain corundum produced from rock quarried in the township of Carlow, Hastings county, and milled in the laboratory of the School of Mining, Kingston, was submitted to the Hart Emery Wheel Co. of Hamilton, Ontario, for a test of its abrasive qualities. In a letter to the Director of the Bureau of Mines, dated March 2, 1899, they state in part as follows in reference to the test :

Comparative Tests at Hamilton

" The tests were made with disks 12″ in diameter and from ¾″ to 1″ in thickness, the small quantity of Hastings corundum procurable preventing the use of larger disks. The wheels were placed on opposite ends of the same arbor ; one made of Hastings corundum being placed on one end, the other end being either supplied with North Carolina corundum or carborundum. The speed at which the arbor ran was 1,700 revolutions per minute. The pieces of metal ground in the series of tests were of (1) Brass, (2) Cast Iron, (3) Wrought Iron and (4) Cast Steel, and the trial bars were about 1″ by ½″ in size."

The company report having made 23 comparative tests. Four of these were with what they describe as the Hastings "special," but as they do not state what is meant by this term the results of these four tests are not included in the following tabular summary, which shows the results of the other seventeen tests.

1. Comparative Test of Hastings (Ontario) Corundum and North Carolina Corundum on Brass :

Material.	Time of test.	Net ground.	Excess ground.
Hastings	3 hours.	1 lb. 13½oz.	½oz.
N. Carolina	3 hours.	1 lb. 13 oz.	

1A. Comparative Test of Hastings Corundum and Carborundum on Brass :

Material	Time of test	Net ground.	Excess ground.	Excess lost on weight of wheel
Hastings C .	2 hours.	8 oz.		
Carborundum	2 hours.	15 oz.	7 oz.	
Hastings C ...	1 hour.	11½oz.		½ oz.
Carborundum	1 hour.	1 lb. 5½oz.	10½oz.	

These two comparative tests of Hastings corundum and carborundum on brass cannot be relied on, as will be seen from the figures, both materials being said to grind away more brass in one hour than in two. Moreover the total amount of brass said to have been ground away by Hastings corundum in these two tests, which lasted for a total time of three hours, two hours and one hour respectively, is 1 lb. 3¼ oz. while in the three hours' test already referred to in which Hastings and North Carolina corundums were compared, Hastings is stated to have ground away 1 lb. 13½ oz.

2. Comparative Tests of Hastings Corundum and North Carolina Corundum on Cast Iron.

Material.	Time of test	Net ground.	Excess ground.	Excess lost on weight of wheel.
Hastings C .	2 hours.	2½oz.		
N. Carolina C...	2 hours	4½oz.	2	
Hastings C	1 hour.	2 oz.	.	½ oz
N. Carolina C...	1 hour.	3½oz.	1½	
Hastings C .	1 hour.	1½oz.		
N. Carolina C. .	1 hour.	3 oz.	1½	
Hastings C . .	3 hours.	8¾	5¼	
N. Carolina C.	3 hours.	3½	..	1¼

In these four tests lasting for a period of 7 hours the Hastings corundum ground away 14½ oz. of cast iron, while the N. Carolina ground away 14¼ oz. Judging from the fourth test lasting 3 hours the Hastings wears much better on this material than the North Carolina. This may be owing to the grains of the former material breaking away as the wheel wears down, so as to present constantly a good cutting surface. Some wheels as they wear down show a tendency to become more or less "greasy" on their cutting surface.

2A. Comparative Test of Hastings Corundum and Carborundum on Cast Iron :

Material	Time of test.	Net ground
Hastings	1 hour.	2¾ oz.
Carborundum	1 hour.	2¾ oz.

3. Comparative Test of Hastings Corundum and North Carolina Corundum on Wrought Iron :

Material.	Time of test.	Net ground.	Excess ground.	Excess lost on weight of wheel.
Hastings C .	3 hours.	3½oz.		
N. Carolina C	3 hours.	4½oz	1	½ oz.
Hastings C	1 hour.	1 oz		
N Carolina C	1 hour.	2½oz.	1½	

3A. Comparative Test of Hastings Corundum and Carborundum on Wrought Iron :

Material	Time of test	Net ground.	Excess ground.
Hastings C	1 hour.	2¾oz.	
Carborundum	1 hour	4 oz.	1¼
Hastings C	2 hours.	4½oz.	
Carborundum	2 hours	9 oz	4½

Some of the figures given in tests 3 and 3A are difficult to understand. Working on the same material, wrought iron, and under the same conditions, Hastings corundum in one case is said to grind away 3¼ oz. in 3 hours, while in another case it is said to grind away 4½ oz in 2 hours. In another case Hastings is said to grind away 1 oz. in 1 hour, while in another experiment it is found to grind away 2¾ oz. in the same length of time It will be noted that this latter amount is greater than the amount ground away by N. Carolina in the same length of time.

4. Comparative Test of Hastings Corundum and North Carolina Corundum on Cast Steel

Material.	Time of test	Net ground.	Excess ground.	Excess lost on weight of wheel.
Hastings C	1 hour.	3 oz	..	¼
N. Carolina C	1 hour	3 oz		
Hastings C	2 hours	4½oz	1	
N. Carolina C	2 hours	3½oz		

4A. Comparative Test of Hastings Corundum and Carborundum on Cast Steel :

Material.	Time of test	Net ground.	Excess ground	Excess lost on weight of wheel.
Hastings C	1 hour	2¼oz	1¼	
Carborundum	1 hour	1¼oz		1¼oz
Hastings C	2 hours	4¾oz	4¼	¼
Carborundum	2 hours	½oz.		
Hastings C	2 hours.	4½oz.	4	
Carborundum	2 hours.	½oz		
Hastings C	2 hours.	5 oz.	2½	
Carborundum	2 hours.	2½oz.		
Hastings C	1 hour.	2 oz.	1¾	
Carborundum	1 hour.	¼oz.	..	¼

Test 4 between wheels of Ontario and North Carolina corundum, made on cast steel and maintained for three hours, shows that the former ground off one ounce more than the latter, or an excess of 15½ per cent. Test 4A between wheels of Ontario corundum and carborundum, made also on cast steel and maintained for eight hours, shows that the former ground off 19 oz. and the latter 5¼ oz., being an excess of 13¾ oz. or 262 per cent. in favor of Ontario corundum. In steel plow works abrasive wheels are largely used, and it is probably the case now that as much of steel as of iron undergoes abrasive treatment in foundries and machine shops.

Testimony from Other Sources.

Dealers and Manufacturers

Smaller samples of grain corundum than that furnished the Hart Emery Co. have been supplied different companies both in the United States and Europe. In no case has the material been condemned. The following quotation from a letter recently received by the Director of the Bureau of Mines from a London, England, firm to whom some pounds of the grain had been sent voices the opinion of others who have examined the material : "We consider the mineral to be good, and hope some company will be formed for the exploitaton of these corundum deposits ; in which case we shall be glad to hear from you again."[19]

[19] Since the above was written an additional quantity of corundum-bearing rock has been treated under the direction of Mr. R Instant in the mill of the Kingston School of Mining. This rock was obtained at the Robillard property in the township of Raglan and weighed 8 tons 650 lb. The method followed in its treatment was the same as that used by Prof. De Kalb and described by him in the Report of the Bureau for 1897. The rock was first broken in a Blake crusher to such a size that the larger fragments had a diameter of about one inch. It was then passed through rolls, after which treatment the larger pieces of rock had a maximum diameter of one-quarter inch. After coming from the rolls the rock matter was sized by means of sieves. It was then treated by the Hartz jig, which through the agency of water separated the minerals of low specific gravity (chiefly felspar and mica) from those of higher specific gravity. These latter were corundum and magnetic iron ore. After coming from the jig the mixture of these two minerals was dried and then the magnetite was freed from the corundum by means of the magnetic separator.

The 8 tons 650 lb. of rock gave by this treatment, after recrushing some of the No. 10 and 12

mesh, the following amounts of the different numbers of cleaned corundum.

No. 10	259 lb.
" 12	467 "
" 16	506 "
" 20	203 "
" 24	221 "
" 30	282 "
" 40	180 "
" 50	155 "
" 60	60 "
" 70	17 "
" 90	10 "
" 100	9 "
Total	2369 "

This equals 14.22 per cent. of the rock treated. In addition there were various small amounts of corundum abstracted as samples at different times, which would aggregate probably 50 lb. Moreover the dust or finest material coming from the crushers was not jigged. This material it was estimated contained about 100 lb. of corundum in a fine state of division. In addition to this some corundum was lost in the tailings from the jigs.

The result of this test agrees with that obtained by Prof. De Kalb on rock from the township of Carlow, which adjoins Raglan on the west. In that test the amount of corundum extracted in the mill was equal to 14.67 per cent. of the rock treated. The rock from both townships was similar in appearance, being coarse grained and for the most part pink in color, forming what is known as syenite-pegmatite

The specific gravities of the various numbers of the grain corundum extracted in the mill test from the Raglan rock were determined. Those of No. 16, 30, 40 and 50 were found to be 3.952, 3.953, 3.976 and 3.945 respectively. Since the specific gravity of pure corundum ranges from 3.95 to 4.10 it will be seen that the product from the mill run of the Raglan rock is practically free from foreign matter.

The X-ray photographs which accompany this report show the form and actual size of the grain of corundum of the different numbers. They moreover show that it is possible by photographing samples of commercial corundum in this way to determine their degree of purity, since corundum grains themselves are not so impervious to the rays as are silicates such as felspar, garnet, chlorite and mica, which are frequently associated with this mineral or are used to adulterate it in commerce.

A dozen or more samples of the grain corundum, each weighing upwards of 100 pounds, produced from the Raglan rocks, were submitted to leading manufacturers of abrasive goods in America and Europe, by whom they were tested and pronounced suitable for use both in vitrified wheels and in those which are cemented together according to the ordinary binding formulas. The Prescott Emery Wheel Co., of Prescott, Ont, report: "For light work for tools the corundum presents a fine cutting surface. If these wheels are too soft or too hard we can easily remedy that by a variance in our formula." The Sterling Emery Wheel Mfg. Co. of Tiffin, Ohio, say: "The samples look very nice and the corundum works well. Please advise us in what quantities you expect to get it out." The Chicago Wheel and Mfg. Co. say that the corundum in the wheels manufactured by them looks well and they are sure the wheels will do good work. The Norton Emery Wheel Co. of Worcester, Mass., state that the result of their tests on the grain corundum to see whether it would work up satisfactorily according to their process was all that could be desired. The manager of the Northampton Emery Wheel Co. of Leeds, Mass., says his company finds it to be a very good quality of corundum so far as their wheel is concerned. The president of the American Emery Wheel Works, Providence, R. I., writes: "We have found this material well suited for certain kinds of grinding, especially for saw sharpening, roll grinding, spindle grinding, and surface grinding on hardened steel. For these purposes and perhaps for some others we believe it will come into extensive use, provided it can be furnished at a reasonable price and that the quality runs uniform. Our experiments indicate that on the above classes of grinding it heats the work less than emery."

A number of wheels, together with bricks, rounds and triangles, made from Ontario corundum by different manufacturers according to different processes, have been shipped to Paris, where they are to exhibited in 1900, along with numerous samples of corundum in the raw and partially manufactured state.

CORUNDUM IN ONTARIO[1]

By Archibald Blue

JUST one hundred years ago, in a paper read before the Royal Society of London and published in its Transactions, Rt. Hon Charles Greville established and named the mineral species Corundum, the crystalline oxide of aluminium ; and we have it on the authority of Professor Judd that in an appendix to Greville's paper the Count de Bournon correctly defined the crystallographic characters of the species. The names of its gem-varieties, sapphire and ruby, had been in use from a much earlier time[2] ; and the name corivindum, or corrivendum, had been given to it by Woodward, in a vaguer way, as early as 1714.

Where Corundum is Found.

Occurrences of the Mineral

In the western part of Asia Minor, and in some islands of the Grecian archipelago, the crystalline limestone which is interbedded with the schists and gneisses carries a blue corundum mixed with magnetite, which is the emery of commerce. The corundum occurs in smaller quantities as a constituent of granite and gneiss in Silesia, Auvergne and elsewhere in Europe ; in a compact felspar rock in Piedmont ; in dolomite with tourmaline at St. Gothard ; in crystalline limestone, along with numerous other minerals, in Orange and Westchester counties, New York, and Sussex county, New Jersey, and at various localities in Connecticut, Massachusetts and Pennsylvania. It is said by Dana to be common at many points along a belt extending from Virginia across western North Carolina and Georgia to Dudleyville, Alabama.

Oriental Ruby in Burma.

In Burma, which became a British Province in 1886, ruby mines have been worked for a very long period. There the country rock is chiefly gneiss, with bands of crystalline limestone of varying thickness and many miles in length. Most of the mining has been carried on in the hill-wash and alluvium carried down from the decomposed summits of hills and mountain ranges ; and it has been observed that where the sands and gravels are mixed with a dark brownish earthy clay, which is a product of the decomposed crystalline limestone, they are richer in such gems as ruby and spinel. The explorations of Barrington Brown appear, indeed, to have satisfactorily established that in Burma the only rock in which rubies are found in place is crystalline limestone. "It is of the usual composition and character of ordinary crystalline limestones," says Mr. Brown, "being made up of finely crystalline or granular limestone in layers, together with irregularly shaped bands of very coarsely crystalline limestone of white and bluish colors, which are interfoliated with the gneissic rocks." Where a quarry has been worked near Mogok, the matrix of the ruby is a coarsely crystalline, semi-opaque limestone of about twenty feet in width. The rubies are found over a space of six feet in width, extending almost vertically from the bottom of the quarry to the surface of the ground, and along the centre-line, where the rubies are most numerous, are small developments of a grayish diaspore enclosing small crystals of iron pyrites. As to the limestone itself, whether occuring as disseminated crystals through the gneiss or as great interfoliated masses, it is the opinion of Professor Judd that it has been neither organic nor due to direct chemical precipitation in its origin, but has resulted from a metamorphism of the lime-bearing felspars ; while during the process of change from basic felspar to scapolite,

[1] A paper read before the Canadian Institute 10 December, 1898.

[2] In the Burma corundum every shade of color, from white to the highly prized deep crimson or pigeon's blood, is found, and they are named according to colors instead of composition or system of crystallization—the red variety as oriental ruby, the blue as oriental sapphire, the yellow as oriental topaz, the purple as oriental amethyst, and the green as oriental emerald.

and from scapolite to hydrated alluminium silicates, and from these to alluminium oxide, "the slowly liberated oxide may assume the crystalline form, and thus give rise to corundum." Among other minerals found in the corundiferous limestone are pyrrhotite, hematite, apatite, graphite and spinel.

Corundum in Ceylon, India and China

In Ceylon, in the peninsula of India, and in China there are numerous occurences of corundum in crystalline schists; and in almost every case the mineral is of the gem variety. As far as known to the writer, there are no deposits in Asia now exploited for use in the arts, saving the emery of Asia Minor.

Corundum and Emery in the U S

In the United States corundum is confined almost wholly to the region of the Appalachian mountains, along a belt that extends from New Jersey to Alabama. In the form of emery it is found at Chester, Massachusetts, in a chlorite belt about twenty feet wide, that lies between formations of hornblende-schist and talc. and traverses the mountains for about four miles. There is also a productive emery mine in Westchester county, New York, which ships from 500 to 700 tons of abrasive emery per annum.

Along the Appalachian mountain chain corundum is found in felspar veins and associated with chlorite in peridotite and serpentine rocks, in amphibolite, dunite and gneiss, as well as in gravel-beds. The principal deposits are found in association with magnesian rocks, chiefly peridotites, which occur as small lenticular masses in gneiss. As a rule however the corundum is neither in the peridotite nor in the gneiss, but in a narrow zone of chloritic minerals between the two. The largest known areas are in the southwestern counties of North Carolina, where corundum was first discovered in 1870. This state has furnished nearly all the corundum of commerce for the United States, but the statistics of the mines and works have never been published. There has been much waste of effort in mining for the gem varieties, encouraged by occasional discoveries, but chiefly by the attractive colors in which the corundum is found. The whole process of mining and milling has had to be learned by experience; and the task has been made difficult not only by the character of the formations, which is not favorable to sinking or drifting, but also by the closeness with which the corundum crystals adhere to the matrix.[3] For abrasive use it is very important that the corundum should be free from particles of rock or mineral softer than itself; and for use as an ore of aluminium it should be free from all impurities, to make extraction practicable by present methods.

Discoveries in Ontario.

By Dr Sterry Hunt in Burgess

The first discovery of corundum in Ontario was made by the late Sterry Hunt fifty-one years ago, in the second year of his connection with the Geological Survey of Canada. Dr. Hunt explored part of the county of Lanark in 1847. He was joined in some of his excursions by Dr. Wilson of Perth, who at that time enjoyed local reputation as a geologist (the mineral wilsonite is named after him), and who is still remembered as a man who paid considerable attention to the natural history of his district. The first place visited by them was the fourth lot on the eighth range of the township of Burgess, upon which Dr. Wilson a short time before had discovered a body of apatite. Near by, on the second lot of the ninth range, was a deposit of copper pyrites in crystalline limestone, and this was also visited. The only exploration work consisted of two or three blasts, and among the masses of rock thrown out were some composed of silvery mica, with quartz, felspar or albite, and calcspar, holding a delicate emerald-green and almost transparent pyroxene of rare beauty, as well as crystals of a dark honey-yellow sphene. The mica was often aggregated in masses of small crystals, having

[3] Mr. Alexander Rickard of New York, who is owner of a corundum property at Energy, in York county, South Carolina, says in a letter to me of recent date: "All our corundums are very difficult to clean. While the gangue is soft, it is tough, and adheres to the grains of corundum when it is broken up. This reduces the cutting value, and also creates trouble by fluxing when making into wheels."

a columnar arrangement,[4] imbedded in which, and disseminated throughout the rock, were a great number of crystalline grains of a transparent mineral, varying in color from a light rose-red to a deep sapphire blue. Dr. Hunt, in his report to Sir William Logan, said :

"Their hardness, which is so great as to enable them to scratch readily the face of a crystal of topaz, showed them to be nothing else than the very rare mineral corundum, which from its colors is referable to the varieties known as oriental ruby and sapphire. The grains obtained were small, none indeed larger than a pepper-corn ; but at the time I was on the spot they were not noticed, and the specimens were collected for the pyroxene, in only two or three of which I have since detected the corundum. It is probable that further examinations may develop larger and more available specimens of these rare and costly gems. It is in this crystalline limestone that they generally occur, and the corundum found in the State of New Jersey is in the same rock and with similar mica."[5]

Yet it does not appear that this discovery in Burgess received further attention from Hunt or other members of the Geological Survey, and the mineral was practically rediscovered there a year ago by Professor Miller of the Kingston School of Mining. It will be seen from Hunt's account that the specimens were collected only for their pyroxene, and that the crystals of corundum were not noticed or identified until a later time.

[4] It is not improbable that these were decomposed or altered crystals of corundum. On the metamorphosis of the mineral Professor Judd says: "At the earth's surface, as is well-known, corundum or the crystallized oxide of aluminium is one of the most unalterable substances. Fragments found in river gravels and sands, though perfectly water-worn, show no trace of chemical alteration in their surfaces. On the other hand, there can be no doubt that conditions must exist in the earth's crust under which chemical change of this mineral does take place ; this is abundantly proved by the frequency with which undoubted pseudomorphs of corundum occur. Among the minerals found replacing corundum as pseudomorphs are muscovite (damourite), various forms of spinel, andalusite, fibrolite, cyanite, margarite, chloritoid, zoisite, ripidolite and other chlorites, various vermiculites, kaolin, and other substances."

[5] Geol. Sur. Can. 1847-8, p. 134.

By Henry Robillard in Raglan.

The largest known deposit of corundum in the Province was discovered twenty-two years ago on the farm of Henry Robillard, in the township of Raglan, Renfrew county ; but in this case twenty years elapsed before the mineral was correctly identified. According to Robillard's story, he was returning with his little daughter from a cranberry marsh on the wide flats of York river, and in climbing a hill which rises about 500 feet above the river, he sat down upon a large boulder to rest. In telling me the story Robillard said : "Annie was kneeling behind me, and picked up a queer-shaped stone, and, showing it to me, said it looked like the stopper of a cruet-bottle. It was just like that ; and I wondered what fool of a man had gone to work and whittled it out. Then I looked at the stone where I was sitting ; and, bless you, sir, it was paved with cruet-stoppers. And here is the very boulder now," he added, as we reached the spot, about half-way down the hill.

Specimens gathered by Mr. Robillard were shown to several persons in Combermere, and one who professed to be a miner of phosphate of lime in Lanark county pronounced them to be crystals of that mineral. In 1884 one John Fitzgerald joined with Robillard in an application to the Crown for the mineral rights on the property, including several lots on the 18th and 19th concessions of Raglan ; and for a number of years they sought in vain for a customer to buy an apatite mine. The sturdy pioneers would brook no contradiction of their claim that the mineral was veritable apatite ; and when a doubt was raised by two young mineralogists who visited the region about ten years ago in the interest of a capitalist, and a suggestion was meekly made that it might be emery, one of the pioneers cut negotiations short by threatening to "punch their heads." Last year, however, these pioneers were overjoyed to learn on the authority of an expert that the mineral was not apatite, but corundum.

Twelve years ago, in 1886, Nesbitt T. Armstrong, a farmer and mill-owner in Carlow, discovered corundum on lot 14, in the 14th concession of that township, but he did

not know its name, and did not suspect that it possessed any value. A sample was shown to a student of Toronto University, who thought it might be emery, and inquiry stopped there. But in 1893 Mr. W. F. Ferrier, lithologist to the Geological Survey, acquired by purchase a number of specimens collected by Mr. John Stewart, formerly of Ottawa, among which was a package labelled "Pyroxene crystals, south part of Carlow." On examining these specimens some time afterwards, presumably in 1896, Mr. Ferrier recognized them as corundum, and immediately took steps to ascertain the precise locality from which they came. In October, 1896, he was sent upon this mission by Dr. Dawson, the head of the Geological Survey, and, guided by Mr. Armstrong, he found the corundum in place upon the lot on which Armstrong's discovery had been made ten years before. Then for the first time the fact was established, on the best authority, that this mineral had been found to exist in Canada in commercial quantity, and that it was valuable as an abrasive material on account of its great hardness. But as it was too late in the season for field-work, Mr. Ferrier did not extend his explorations beyond that one locality.

By N T. Armstrong in Carlow

Eleven years ago Professor Coleman, now of the School of Practical Science at Toronto, picked up some boulders of nepheline-syenite in the vicinity of Cobourg, on the shore of lake Ontario, which held crystals of corundum. A fortnight ago I showed Dr. Coleman several specimens of nepheline, rich in cornudum, which I had taken from a large deposit recently discovered in the township of Dungannon, and he at once pronounced them to be identical with his own. "I feel sure now," he said, "that I know where my float-boulders came from."

By Dr Coleman in float Boulders

Geological Reconnaissances.

The first geological reconnaissance of the district in which corundum has been found was made by the late Alexander Murray, of the Geological Survey, in 1853; but his notes of it are very meagre. Mr. Murray made two traverses of the country lying between Georgian bay and Ottawa river—the first from west to east, by way of the Muskoka and Petewawa rivers, and the second by way of the Bonnechere and Madawaska, to the headwaters of the Trent. The source of the Bonnechere is within a mile of Kaminiskeg lake, on the Madawaska, near to where Barry's Bay station now stands, on the Ottawa and Parry Sound Railway. Mr. Murray descended the Madawaska to the mouth of its principal tributary, the York branch, or York river; known also at that time by its significant Indian name of Shawashkong, or Mishawashkong, the river of the marshes. The course of the stream, which Mr. Murray ascended, lies for more than forty miles within the corundum belt; and along its banks are numerous exposures of syenite, with occurrences of nepheline syenite. But no reference is made in the report to the rock formations [6]; and the record of levels for the first ten miles is of very doubtful accuracy.

By Alexander Murray

Forty years elapsed before another attempt was made to work out the geology of this interesting area, and the task was then entrusted to the very capable hands of Dr. Frank D. Adams. The area under examination is comprised in sheet 118 of the Ontario series of geological maps, and the four corners of it lie in the townships of Digby, Finlayson, Hagarty and Grimsthorpe respectively, embracing an area of about 3,500 square miles. In his first report, made for the season of 1893, Dr. Adams sketched briefly the geological features of the district, the northern portion of which he found to be occupied exclusively with the ancient crystalline rocks of the Laurentian system, and the southern and eastern portions with the limestones and gneisses of the Grenville series. "The discovery of so large an area of the Grenville series in this district," Dr. Adams says in his report, "is most encouraging, as indicating the probable occurrence in it of large and valuable mineral deposits." An extensive and remarkable mass of nepheline syenite was discovered in

By Dr Frank D. Adams

[6] The rock formations along the York river however are carefully noted on the maps which accompanied the report, as are also the waterfalls and rapids of the river from its mouth to its source.

the townships of Faraday and Dungannon, which was traced for a distance of over seven miles in an east and west direction. Dr. Adams says :

"This is a rare rock, found in but few places in the world, and never before discovered in our Laurentian system. The nepheline is very abundant, forming in many places an almost pure nepheline rock. The mass is flanked on the south, along a considerable part of its course, by crystalline limestone, and it is also intimately associated with a fine-grained reddish rock, resembling aplite. It is of a prevailing gray color, and often has a distinct foliation, coinciding with that of the associated rocks."

The beautiful blue mineral sodalite was also found in a number of places, associated with the nepheline syenite, in the form of veins and irregular masses ; but no occurence of corundum was observed

By Barlow and Ells

During the past three seasons Mr. Barlow has been associated with Dr. Adams on the work of this field, and a very interesting and valuable report may be confidently looked for upon some of the most intricate questions of Archæan geology. Dr. R. W. Ells has also been engaged at intervals in surveying portions of the Ottawa valley east of the area on which Messrs. Adams and Barlow have been working, into which the corundum belt is known to extend as far at least as the Ottawa and Opeongo road. The two map-sheets however, as well as the accompanying reports, will deal with the general geology of the districts, and notwithstanding the importance of the corundum discovery it is not likely that prominence will be given to that subject, if the usual practice of the Survey is followed.

Recent Exploration Work.

Prof. W. G Miller's Reports.

During the last two seasons Professor W. G. Miller of the Kingston School of Mining has been employed by the Ontario Government to make a special report on the field. Beginning last year with the study of the occurrence of the mineral at the place of first discovery in Carlow, he has been able to trace the corundum-bearing rocks eastward across that township, through Raglan and Lyndoch, to the shores of Clear lake, near the eastern line of Sebastopol, a length of about 30 miles. The breadth of the band varies from half a mile to three or four miles, and its total area embraces about 60,000 acres. The prevailing country-rock of the district is gneiss, composed chiefly of hornblende, biotite and felspar, and it is probably an altered gabbro. Numerous dikes or masses, consisting largely of felspar, cut through the older rocks, which sometimes have the character of coarse syenite, passing in places into nepheline syenite. In both of these rocks corundum was found, as well as magnetite, pyrite, garnets, zircon and sodalite. In continuing his work this year Professor Miller has succeeded in tracing the syenite band continuously for about 75 miles, from the township of Glamorgan in Haliburton to the township of South Algona in Renfrew, besides tracing it to a considerably greater width over the region explored last year.

An extensive Area traced out.

Corundum was found at a number of places in the western part of the belt, and a large and apparently rich deposit in a ridge of nepheline syenite near the middle of it in the township of Monteagle. But as the rocks over nearly the whole of their extent are covered with sand, it is probable that many valuable deposits remain to be discovered. The total area of this band is about 300 square miles ; and, as it lies in a Free Grant district, the mineral rights are reserved by the Crown in almost all the lots that have been taken up for settlement. In a few cases, where lands were sold more than thirty years ago, the mineral rights went with the surface rights, and since that time some lands have no doubt been sold or leased as mining lands. But it is safe to say that the Crown holds for disposal the minerals in at least 90 per cent. of the whole tract.

Two years ago corundum was found in a property that was being worked as a mica mine in the township of Methuen, in Peterborough county, about 45 miles southwest from the original discovery in Carlow. This locality has also been explored by Professor Miller this year, and the corundiferous band

of syenite has been traced in a northeast and southwest direction about six miles, with a width of two miles. The range of hills over which it extends is known locally as the Blue mountains, and at its southwest end it reaches the shore of Stony lake.

A Tour of the Corondum Belt.

I spent the last week of September with Professor Miller in going over the more northerly band, from the easterly end of it on Clear lake, in Sebastopol, to the village of Bancroft on the Hastings road, on the line between Dungannon and Faraday. Only a few of the principal properties were visited, including the Block location in Brudenell, the Robillard location in Raglan, the Armstrong location in Carlow, and a recent discovery in Monteagle, not far from the York river. All these are large deposits, easy of access, and favorably situated for mining operations.

From Sebastopol to Bancroft

Where the exposure occurs on the Block farm the crystals are in syenite, and are thickly studded in the face of the rock. Outcroppings of nepheline syenite occur near by; and, owing to its resemblance to limestone, an attempt was made by the owner to burn it for lime. The crystals of corundum have a bronze lustre, and vary in size from half an inch to an inch in diameter. Numerous boulders are strewn over the face of the ground which carry a high precentage of the mineral, and in some cases the crystals are nearly pure white in color.

On the Block Farm.

On the Robillard hill corundum may be traced for a mile or more along its southern face, wherever the syenite is exposed. The corundum crystals are frequently observed to run in strings several inches wide along the surface of the rock, and are of all sizes from half an inch to two or three inches in diameter, usually barrel-shaped, and ranging from an inch to four or five inches in length. On the western shoulder of the hill there is an outcrop of nepheline syenite; and in this rock the crystals are finely shaped, but of small size—about a third of an inch in diameter and an inch or an inch and a half in length.

On the Robillard Hill

An expert who has examined this hill estimates the corundum in sight at several millions of tons. There is certainly a large quantity, and in some places it amounts to from 30 to 40 per cent. of the rock mass. Along the foot of the hill are numerous large boulders of syenite, speckled over with crystals like plums in a pudding.

The Robillard hill is cut off by a stream upon its west side from a range of high hills that extends westward five miles into Carlow. Professor Miller has carefully examined this range, and has discovered corundum in it at a number of points. The largest showing however is on the Armstrong lot, where another stream cuts through on its way to join York river. The rock has scaled off so as to show a perpendicular face about 300 feet in length and 30 feet in height, exposing a mass of syenite which has been thrust up through the gneiss, and which in its turn has been cut by a dike of pegmatite. The gneiss has been thrown up to form an anticlinal arch over the syenite, but is cut through along the north side, where the syenite dike is well exposed with a thickness of ten or twelve feet. According to Mr. Ferrier it has been traced along the strike about 700 feet. Crystals of corundum are numerous on the exposed face of the syenite, and are also found in the pegmatite nearest the syenite, which is composed chiefly of felspar. But where quartz comes in with the felspar the corundum disappears. A lot of several tons, taken without selection from this location last year and treated at the Kingston School of Mining, yielded from 12.75 to 15.5 per cent. of corundum.

On the Armstrong Lot

The last location I examined is in the township of Monteagle. It is in a ridge of nepheline syenite, having a width of 90 to 100 feet, and rising upon one side to a height of about 60 feet. My time only permitted me to follow it for a length of about 150 yards, but Professor Miller informed me that he had traced it for half a mile. The whole surface, as far as I examined it, was thickly strewn with small crystals of corundum, ranging in color from pearl to blue; but here and there parts of it were altered into white mica. A sample of

In the Township of Monteagle

it, assayed for me under the direction of Dr. Coleman, carried nearly 10 per cent. of corundum, and was remarkably free from iron. An ore of this character ought to be well suited for the production of aluminium, especially as the nepheline itself, the gangue rock contains about 30 per cent. of alumina.

Economic Uses of Corundum.

A possible source of Aluminium

Here it may be remarked that, owing to the presence of iron and other impurities, makers of aluminium assert that corundum is unsuited for the production of that metal. But it is safer to keep an open mind on subjects of this nature. When one reflects that by the adoption of new and improved processes the cost of producing aluminium has been reduced within forty years from its weight in gold to 30 cents per pound or less, one ought not to assume that it is impossible to find a process for producing pure corundum at low cost, if not a process to make aluminium out of an impure ore. Professor DeKalb of the Kingston School of Mining was able last winter, with a small experimental plant, to extract corundum (99.61 per cent. pure) from rock that carried five per cent. of magnetic iron ore. What then might be expected from a large and well-equipped plant, capable of treating 50 to 100 tons per day, supplied with every device that the wit of man can invent, and especially with a good quality of rock to work upon? In one particular the Ontario mineral appears to differ from the mineral of the Appalachian belt; the gangue is brittle, and is easily broken up and separated from the corundum.

It will certainly add greatly to the value of the corundum deposits of Ontario if they can be used in producing aluminium as well as the material for abrasives, if the history of that metal during the last ten years is a fair index of its future. In the ten years ending with 1897 its production in the United States has risen from 19,000 pounds, valued at $3.42 per pound, to 4,000,000 pounds, valued at 37½ cents per pound; and so much progress in so short a time seems to be ample justification for the statement of Professor Richards made three years ago in the preface to his valuable book on Aluminium: "The abundance of aluminium in nature, the purity of its ores, its wonderful lightness and adaptability to numerous purposes, indicate that the goal of the aluminium industry will be reached only when this metal ranks next to iron in its usefulness to mankind."[7]

Probable occurrence of Gem Varieties.

None of the discoveries hitherto made in Ontario seem to encourage the hope that gem varieties of the corundum are to be found, although in some localities an occasional crystal is to be seen with qualities not unlike sapphire, being semi-translucent and of bluish color. Perhaps if search were made in the crystalline limestones it might be awarded with better success; not that corundum of any quality has yet been found in the limestones, but because their relations to the gneiss are not dissimilar to those which obtain in Burma. When the source of the limestones has been worked out, it may be shown that, like those of Burma, they heve been derived by metamorphosis from the felspar of the gneiss, or

---

[7] **Aluminium: Its history, occurrence, properties, metallurgy and applications, including its alloys. By Joseph W. Richards, A.C., Ph.D., Instructor in Metallurgy at the Lehigh University. Third edition. At page 474 Prof. Richards says:**

"It does not withstand chemical agents in general as strongly as the noble metals, but it withstands air, water, sulphuric acid, nitric acid and sulphuretted hydrogen—which is not the case with iron, copper or even silver. We have then a semi-noble metal; but while silver, gold and platinum have extremely small prospect of becoming noticeably cheaper, yet the time is probably not far distant when we shall have our semi-noble metal at the price of the base ones. This affords the immense future for aluminium. Whatever its price, it can only replace gold or platinum because of its lightness; it already replaces silver especially because of its resistance to sulphur, as well as for its lightness, besides being cheaper; it can only replace the common metals at its present price for uses where its lightness is an extraordinary advantage. But when its price is down to that of these baser metals, it will begin to replace them by virtue of its other superior qualities, chemical and physical; aside from its lightness it will win a large field simply in comparison with them on its merits as a metal. Thus there are wide applications now almost unthought of, because the high price has been a blank wall to stop its use; but as it cheapens more and more, we hear every day of new uses brought to light. Thus its sphere will widen until, since its ores are as cheap as those of iron, it will approximate in utility to that universal metal. At the time of this writing (1895) there are only four metals which are cheaper bulk for bulk than aluminium, viz.: iron, zinc, lead and copper; and the amount of aluminium produced yearly is increasing much more rapidly than any of these. Aluminium has therefore already won its place among the common metals of everyday life. It will, of course, be many years before it outstrips any of these, but I believe the ultimate goal of aluminium industry will be reached only when it stands next in importance and value of annual production to iron. From this time forth every year will see substantial advance towards this goal, and the next century may see this end attained."

perhaps from the felspar of the syenite ; and if so, the analogy would suggest that these rocks are worth prospecting for corundum in some of its more valuable forms. In a note received from Professor Miller on this subject he says :

"It is quite possible that corundum may yet be found in considerable quantity in crystalline limestone in Ontario, as in India and Burma. In India the mineral occurs under various conditions in metamorphic (limestones, etc.) and igneous rocks. Of course there need be no connection between the occurrence of the mineral in these two classes of rocks. If corundum occurs in our crystalline limestones, it is of a different origin from that occurring in the igneous rocks (the syenites)."

The crystals discovered by Sterry Hunt in Burgess, it will be remembered, were found in association with pyroxene in crystalline limestone.[8]

Scheme to Establish a Home Industry.

In view of the extent and apparent richness of the corundum fields in the Province, the Government has taken steps aimed at developing the deposits and establishing a home industry. Regulations have been drawn up under which the mineral rights in lands lying within the two corundiferous belts have been withdrawn from sale, and hereafter the mineral and mining rights in such lands can be acquired only under the leasehold system. Instead of allowing speculators to take up and hold lands with a view to sell out their interests to miners and capitalists at a large profit, it is proposed that the advantage of acquiring lands upon the lowest terms shall go to the miner and manufacturer direct ; and in the case of parties who will undertake to conduct mining and treating operations on the largest and completest scale, and who can furnish satisfactory assurance that they possess the requisite capital for the proposed operations (including separation of the ore from its gangue, milling for abrasive uses, manufacture of abrasive goods, and the production of aluminium), the Government may concede a preference in the selection of mineral lands. It is also provided that the Government shall have power to require that all corundum mined from lands leased under the Regulations shall undergo certain processes of treatment and milling at works to be erected in the Province to prepare it for market ; and may further require from time to time, as circumstances appear to warrant, that works be established in the Province for the manufacture of all useful or commercial products for which the mineral or ore is economically adapted. Following is the text of the Regulations, which were adopted by Order in Council July 4, 1898 :

Regulations governing the disposal of Corundiferous Lands

Text of the Regulations

1 All corundum-bearing lands the mining rights of which have been already or may be hereafter withdrawn from sale or lease, or in which the mining rights are or may be otherwise reserved by the Crown, shall, subject to the general provisions of the Mines Act, except as herein provided, be disposed of under the leasing provisions of the said Act, and shall continue to be held as leasehold lands only.

2. During the first period of ten years the lessee shall expend in stripping or in opening mines, in sinking shafts or in other actual mining operations, or in milling or otherwise treating the ore or mineral taken from a lot or location to prepare it for the market, exclusive of all roads houses, mills, machinery and other like improvements, a sum not less than at the rate of one dollar per acre per year ; and where an area of not more than 600 acres, consisting of two or more separate lots or locations, is held by the same person, partnership, syndicate or company within a block of 4,000 acres or two and one-half square miles, the whole value of the mining operations required to be done in one year may be expended on one lot or location at the discretion of the lessee, and so for every additional 600 acres or fractional part thereof that the same person, partnership, syndicate or company may hold within the same block.

3. In the event of failure on the part of the lessee to carry on mining operations as required in the foregoing section in each and every year of the first term of ten years the lease shall forthwith cease and determine, and all interests of the lessee in the land or lands shall revert to the Crown ; nevertheless it shall be competent for the lessee to prove that during one or more preceding years of the term the extent of mining operations carried on has been adequate to cover the requirements for the year in default, in which case the lease shall not be cancelled, and the lessee may also defeat forfeiture by an undertaking with satisfactory security to expend the full amount required for working conditions within the next succeeding year, including the expenditure in default.

4. At the expiration of the first term of a lease it may be renewed for a further term of ten years at the same

[8] Since this paper was written specimens of crystals very closely approaching sapphire gems have been found in Hastings, occurring in a narrow outcrop of syenite lying between two bands of crystalline limestone. Some are in nests, and others in isolated crystals.

rental and under the same working requirements if the covenants and conditions have been performed and fulfilled, and thereafter it may be renewed for successive terms of twenty years on such conditions and at such rent as the regulations may provide.

5. The person, partnership, syndicate or company to whom the mining rights may be awarded of any lands which have been located or sold under the Feee Grants and Homesteads Act, or sold for agricultural purposes, shall compensate or settle with the owner or locatee of such lands for injury or damage done or to be done to the surface rights thereof before beginning work thereon, and if the parties fail to agree upon the amount or method of compensation, the Director of the Bureau of Mines shall have power to order and prescribe the same.

6. The Lieutenant-Governor in Council shall have power to fix and determine the maximum price at which corundum taken from lands leased under these terms and conditions may be sold for use in the Dominion of Canada, whether the ore or mineral be in the natural state as raised from the mines or in any stage of treatment or manufacture.

7. The Lieutenant-Governor in Council shall also have power to require that all corundum mined from lands leased under these terms and conditions shall undergo certain processes of treatment and milling at works to be erected in the Province to prepare it for market, and may further require from time to time, as circumstances appear to warrant, that works be established in the Province for the manufacture of all useful or commercial products for which the mineral or ore is economically adapted.

8. The Commissioner of Crown Lands may receive tenders for mining lands and mining rights in the explored belt to the 15th day of September, 1898, which tenders shall be in the form of a cash bonus to be paid to the Treasury for each lot, part lot or location applied for in addition to the first year's rental; but in considering the bonus so tendered for a lot or location, preference in the selection of mineral lands may be given to parties who will undertake to conduct mining and treating operations on the largest and completest scale, and who can furnish satisfactory assurance that they possess the requisite capital for the proposed operations—including separation of the ore from its gangue, milling for abrasive uses, manufacture of abrasive goods, and the production of aluminium

Postscript.

Only one substantial tender was received under the terms of the foregoing regulations, but an agreement upon all details was not reached until 15th September, 1899, when a contract was entered into with the Commissioner of Crown Lands by Joseph N. Shenstone and B. A. C. Craig of Toronto. This agreement provides for the acquisition by the lessees, subject to the provisions and regulations of the Mines Act and the Water Powers Act, of the lands for which application had been made (not to exceed in the aggregate 2,000 acres) and two water powers on the York Branch of Madawaska river in the township of Dungannon. It also provides that they shall form a joint stock company for the better carrying out of the terms of the agreement, with a minimum capital of $250,000. Such a company has now been organized and chartered, with the title of The Canadian Corundum Company. The agreement further provides for an expenditure of $100,000 before 1st July, 1902, for the following purposes, viz:

Agreement to establish Works for treating and manufacturing Corundum

1. Acquiring from the Crown the mining leases of corundum properties.

2. Stripping and development of corundum properties and the production of grain corundum or other materials therefrom.

3. Development of electrical or other energy necessary to furnish motive power for machinery and works.

4. Erecting within Ontario a plant with capacity sufficient to treat not less than one hundred tons of corundum-bearing rock per day, together with factory, buildings, kilns, etc., and the installation of full machinery for the production of manufactured goods from corundum, and construction of necessary roads and tramways.

For these purposes an expenditure of $25,000 is required to be made before 1st July, 1900, and $50,000 before 1st January, 1901, and out of the whole of $100,000 not less than $25,000 is required to be expended for the objects enumerated in No. 4. In the event of corundum being found adapted to new uses, the lessees agree to expend such further sums as may be necessary for the full development of such uses. They also agree to expend $1,000 per year for three years for the purpose of making a series of experiments, to discover some method or methods for the production of materials of commercial value from corundum-bearing rock other than grain corundum, special attention to be given to the production of the metal aluminium, and on 1st July of each year to furnish the Government with a confidential report of progress. A bond in the sum of $5,000 has been given as security for performance of the terms of the agreement.

CORUNDIFEROUS NEPHELINE SYENITE

By Dr. A. P. Coleman

A considerable area of nepheline syenite was discovered about six years ago in Dungannon township, Hastings county, by Dr. F. Adams, who described the rock briefly in his Report on the Geology of a portion of Central Ontario, and more fully in the American Journal of Science [1] In 1896 corundum was found in the same region by Mr. W F. Ferrier, and in the following year Professor W G. Miller was instructed by Mr. Archibald Blue, Director of the Bureau of Mines, to examine and report upon the corundum-bearing rocks. In the course of his work it was found that the corundum occurred not only in ordinary syenites, but also in nepheline syenite.[2]

Discoveries of Nepheline Syenite and Corundum.

In November, 1898, the present writer examined an outcrop of the latter rock for the Bureau of Mines on York Branch of Madawaska river near the northeast corner of Dungannon township, or just within Monteagle, several miles from Dr. Adams' localities, and presenting a number of new and interesting features. The rock forms a ridge running nearly north and south for about 350 yards, with a width of about 20 yards, and having a well defined schistose character, so that at first sight it would be called gneiss It is light to dark gray in color, the darker layers containing much biotite, the lighter ones more nepheline and plagioclase. On much of the weathered surface numbers of small crystals of corundum stand out, having resisted weathering better than the other constituents. In hand specimens of the unweathered rock however the corundum is scarcely noticed, and the rock has quite the appearance of fresh gray gneiss, the nepheline looking like quartz. Near the southern end of the ridge an irregular dike a few feet wide crosses the gneissoid rock, reminding one of pegmatite. It is white and consists of immense individuals of nepheline and muscovite, often several inches or even a foot long, with small patches of blue sodalite. No felspar was seen in the dike, unlike samples described by Adams, and no corundum was found in it.

The Deposit in Monteagle.

Variations in the Nepheline Syenites.

As usual in nepheline syenites, there is great variation from point to point in the rock, easily seen on weathered surfaces and still more marked in thin sections. Adams finds, as essential ingredients of the outcrops near Bancroft, nepheline, plagioclase, and biotite or hornblende in small amounts ; but scapolite and calcite usually occur, as well as various minor accessory minerals. Thin sections from the locality here described show more variety in constitution. All the minerals mentioned occur except hornblende, and the felspars include orthoclase and also a little microline as well as microperthite. The soda-lime felspars are generally present in much larger amounts than the potash felspars, and seem to have a wide range in composition as determined by optical means. A few have angles of extinction of 4° or 5° from the twin plane and appear to be albite, as in the rock examined by Adams ; others having a very small angle are probably oligoclase, while a considerable number range from 17° to 23°, indicating labradorite. Some have broad and sharply cut twin lamellæ, others very narrow and obscure ones. All the felspars are beautifully clear and fresh as a rule, much more so than those of the associated Laurentian gneisses and granites.

Constituents of the Rock.

The nepheline also is generally very fresh and, as mentioned by Adams, has not the color nor oily luster of eleolite, though it seldom shows crystal forms. Large individuals often contain inclusions, minute crystals of hornblende, of biotite, and long rows of

[1] Geo Surv Can. 1892-3, part J, p. 5; Am. Jour. Sci, vol. XLVIII, July 1894, pp. 10-18.

[2] Bur. Mines, vol. VII, pp. 210-212.

tiny dots of a transparent doubly refracting mineral. Calcite inclusions sometimes occur completely enclosed in fresh looking nepheline. In one example the somewhat weathered nepheline contains crowds of slender transparent fibers or somewhat bent cords, having a little the look of apatite but with a small angle of extinction, perhaps tremolite. Occasionally decomposition products occur along fissures, having the appearance of kaolin but without any distinct structure.

Scapolite is found in about a third of the sections, sometimes almost to the exclusion of other colorless ingredients, and has the look of a primary mineral. Its anhedra meet the adjoining felspar or nepheline in a sharply defined way, with no hint of weathering in the latter minerals. Muscovite is a very common constituent of these rocks, being found in more than half of the thin sections examined, generally as large primary looking individuals, sometimes associated with biotite, though often without it. Biotite is practically the only dark mineral in the rock, hornblende not having been observed. As in the specimens examined by Adams, it is very dark in color and has a very small axial angle. Augite was found as small blue-green anhedra in one section only. Magnetite was not found, and apatite was rare.

The most interesting accessory mineral is corundum, which sometimes occurs in fairly well formed barrel-shaped crystals half an inch in length, but is usually smaller and often forms only minute rounded grains. Its color is gray or, less often, pale bluish. Owing to the hardness of corundum it was found difficult to prepare sections rich in crystals, and only two have been studied. Under the microscope their high refractive index and greater thickness than the rest of the section cause the corundum grains to stand out sharply. They are apt to be arranged in clusters in association with muscovite, often completely enclosed in it.

Microscopic Characters.

Although the rock here described has a well marked schistose structure, there is nothing in its microscopic characters to suggest shearing or crushing, no mortar structure nor granulation, and seldom even undulatory extinction to hint at a state of strain. The rock as a whole is hypidiomorphic granular, and except corundum none of its constituents show much tendency to crystalline form.

The coarse-grained dike with its individuals of nepheline half a foot wide is not easy to study in thin sections. The nepheline proves under the microscope to have been slightly fractured, very narrow fissures being filled with a rather brightly polarizing mineral, perhaps felspar. The few inclusions are much like those of the nepheline in the schistose rock, but in one section rather large portions of muscovite are enclosed. The large crystals of pale lavender muscovite have no unusual characters, except their often perfect idiomorphy as against nepheline and sodalite. The crystals are not hexagonal in cross section, but four sided, having one angle of about 60°. The basal cleavage is somewhat inclined to the prismatic edges, though a series of pyramids having a very long C axis makes it difficult to determine the angle. In thin sections cut across the cleavage this muscovite has an extinction angle of 3° to 5°.

If single thin sections were to be diagnosed alone four quite distinct types of rock could be described from this outcrop: a nepheline-muscovite rock; a rock made up chiefly of scapolite and muscovite with a little biotite, plagioclase, and nepheline; a rock containing about equal parts of plagioclase and nepheline with some mica, and a rock consisting of orthoclase, microcline and nepheline with some mica. There are however transitions between these varieties, and it would be unwise to split up what is so evidently a geological unit into rocks of different names when the whole is so well defined in general character, though each hand specimen shows differences from its neighbors.

Distinct types of the Rock.

No analysis has been made of this rock, but one specimen yielded nearly 10 per cent. of corundum in a heavy solution. As there was no magnetite nor other heavy mineral present the separation was very complete, corundum having a much higher specific gravity than the other ingredients. Since every mineral pre-

Alumina a prevailing Constituent

sent, except the trifling quantity of calcite and apatite, contains alumina, nepheline in particular to the extent of more than 30 per cent., this oxide must occur in very large amounts. On the other hand iron oxides must be very low, since the only iron-bearing constituent is biotite.

Specimens from Other Localities.

A specimen of nepheline syenite was obtained from Lancaster's farm, some miles southwest of the locality just described, from a small outcrop showing no schistose structure. It is coarser grained, but of the same color and general appearance as the rock from York Branch. Thin sections show however that it has been subjected to shearing forces, since there is a granulation round the larger pieces of felspar and nepheline suggesting mortar structure. Nepheline is present in large amounts, and also a peculiar type of microperthite having long fibrous looking inclusions of one felspar in another, the main mass being in parts very finely striated (anorthoclase?) with twin lines making an angle of about 23° with the most marked cleavage. Oligoclase and biotite occur in smaller amounts, the latter as usual very opaque. Some of its outer scales weather to a bronze-brown color, are dichroic, and have the optical axes much farther apart than in the fresh mica.

From Lancaster's farm in Dungannon

Specimens of a medium-grained white rock dotted with darker minerals come from a locality not visited by the writer, in Methuen township, Peterborough county, and are interesting as containing many dark brown corundum crystals having a bright bronze lustre on basal partings, as well as minute crystals of magnetite. Thin sections of one specimen disclose chiefly plagioclase, finely striated and with a low angle of extinction from the twin plane; a little microcline, nepheline and muscovite making up the rest of the rock. Sections of another specimen very similar in appearance contain more muscovite and a large amount of nepheline, or rather of a turbid decomposition product, confusedly scaly or fibrous, having high double refraction. The mineral seems to have parallel extinction, fuses readily without intumescence to a white glass, and gives water in the closed tube, so that it is no doubt a uniaxial or rhombic zeolite, perhaps natrolite. The corundum is very opaque, so that only minute particles of crushed crystals can be studied satisfactorily. It contains many inclusions of two kinds, slender black needles lying parallel to one another, and brownish red strips and plates somewhat irregularly shaped and placed. The latter are probably hematite, and produce the bronze lustre seen on basal planes of the corundum. Extinction is parallel to the needle-like inclusions, and there is a rather strong dichroism, violet when the needles are parallel to the chief section of the lower nicol and reddish-brown in the opposite position. Some fragments, no doubt parallel to the basal plane, are not dichroic.

From Methuen in Peterborough

The first of the two specimens might be named a plagioclasite (anorthosite contains a more basic felspar) if taken separately, but the second does not differ from typical examples of the York Branch nepheline syenite except in the complete weathering of its nepheline, and probably both are varying forms of the same rock mass.

Through the kindness of the Director of the Bureau of Mines specimens of corundum rocks from Raglan township in Renfrew county, about twenty miles northeast of Dungannon, have been placed at my disposal. One is white, somewhat schistose, and much like the Methuen specimens except that it contains biotite, and that the pale greenish corundum crystals are almost an inch in diameter and have no bronze shimmer on basal planes. Under the microscope it is found to consist mainly of plagioclase (oligoclase) and biotite, the latter pale greenish-brown, faintly dichroic and with a small axial angle. There are also a few large patches of colorless muscovite having a large axial angle. The specimen has the mineralogical composition of a diorite, though of a very unusual character: but Professor Miller states that nepheline syenite occurs close by, apparently part of the same rock mass, though not so highly corundiferous.[3]

From Raglan in Renfrew

These white rocks were taken for limestone by farmers of the region, and an attempt

[3] Bur. Mines Rep. 1897, p. 222.

was made to burn them for lime, of course in vain. Hand specimens, partly fused, were taken from the kiln and supposed to be nepheline-syenite, many of them doubtless having that composition; but the one provided for microscopic examination contains no nepheline. It is evidently part of a boulder, and is schistose and pale gray to white on the surface, but mottled bright blue and white where broken. Under the microscope the rock is found to consist of scapolite, sodalite and biotite, with a very little orthoclase. The scapolite forms the greater part of the rock, the spaces between its anhedra being filled with sodalite; the latter blue throughout when in small portions, but only on the edges when in large ones, the centre being colorless and isotropic. The boulders are said by Miller to be blue only after being burnt in the lime-kiln. The biotite is deep red-brown in color, has a high absorption and a wide axial angle, perhaps the result of heating; just as many dark biotites turn brown by weathering and have a wider angle between the optical axes. There are small quantities of an unknown mineral present, white, transparent and having a low double refraction, so as to give only dull blue or purple tints between crossed nicols. Two or three sections of it show an axial image consisting of a black cross opening out about as far as in many biotites, but without colored rings. It is optically positive.

Drift boulders at Cobourg, in Northumberland

About eleven years ago the writer collected a considerable number of specimens of *nepheline-syenite from drift boulders* in the neighborhood of Cobourg, which lies about south-southwest of the localities referred to above and from fifty to a hundred miles distant from them. At that time nepheline syenite had not yet been reported from the Province.[4] In a general way these specimens correspond in appearance and composition to those that have been described, though a number of additional minerals occur in them, the more important being hornblende, augite and garnet, both of the ordinary kind and melanite, the brown variety. Only one of the specimens collected then contains corundum; and it, though closely like the others in appearance, shows little or no nepheline and resembles in mineralogical constitution one of the specimens from Methuen. The purplish-gray corundum crystals are quite large, and thin sections show the same needlelike inclusions and dichroism as the Methuen crystals, but not the hematite plates. As there is not much doubt that the Cobourg drift boulders originated in the nepheline syenite region to the northeast, they have been referred to here and may be considered in connection with the rocks previously described.

[4] Trans. Roy. Soc. Can., 1890, pp. 14-18.

Uniformity in Variety.

Qualities in common exhibited in Types.

In spite of the great variations in mineralogical composition to be seen in hand specimens, all the rocks referred to have much in common; they are white to gray in color, generally schistose, often corundiferous, and present the same general habit, so that in field work they are naturally thrown together as nepheline syenite and can be sharply distinguished from adjoining Laurentian gneisses, granites and syenites. While not all of them contain corundum in large amounts, they serve as a general guide to the discovery of the corundiferous rocks, and are so used by prospectors for that mineral. Some of the ordinary syenites of the region however contain corundum also, and the largest crystals found occur in them.

Just why the magma which has solidified into the group of rocks described above should be so versatile in regard to mineralogical composition is not easily explained; but no other rock known to the writer shows so great a variety of types within short distances as may be found in the nepheline syenites. It may be that experiments such as those of Morozewicz[5] will give the clue to this variability, which seems to depend on the large proportion of alumina in the original magma. The corundiferous varieties of *nepheline syenite represent magmas* supersaturated with alumina but not saturated with silica.

[5] See Review by T. A. Jaggar: Jour. Geol., 1899, vol. VII, No. 3, pp. 300, etc.

MICHIPICOTON IRON RANGE.

By A. P. Coleman and A. B. Willmott

Instructions to Dr. A P Coleman

Instructions have been sent to Mr. Boyd to withhold all iron-bearing lands in the Michipicoton Mining Division from registration, pending an examination of the region by a competent expert, and a report on the apparent extent and value of the iron ores. I have to inform you that you have been selected to make such examination and report, and to request you to proceed at once to Michipicoton for that purpose. Prof. Willmott had better go with you, and you will exercise your own judgment as to other help, whether you take with you the men you have engaged for the season or depend upon getting men at Sault Ste. Marie or Michipicoton River. I think you have already examined the hematite deposits of Gros Cap, but it may be advisable to make a more careful examination of them with a view to determine their relation with the rock formations. I remember that there are some small showings of iron ore on the south side of Michipicoton bay, just south of the small creek which enters the lake at the foot of the mountain, but I am not aware that there are any deposits of value in that locality. The largest deposits are said to be north of lake Wawa, and I learn from Mr. Boyd that Mr. Ely, an American iron owner, has recently acquired nine claims which were staked out by one Alois Goetz, for which he has paid $35,000. Mr. Clergue, of the Sault Ste. Marie Pulp Works, has also acquired a number of claims staked out in the same vicinity, besides two or three of the Johnston locations immediately north of the east end of lake Wawa. Mr. Clergue believes that there are very extensive hematite deposits several miles north of the claims acquired by Ely, yet I do not know whether any discoveries have been made there by him or his explorers There is a third deposit of ore about twenty miles west of Magpie river, along the Herrick line, the locality of which is probably known to Prof. Willmott. It must be very near the head waters of Dog river, and is probably the same place as is marked "McDougall Mine" on your new map of the Michipicoton Division. I do not know how you can most easily reach this region, but if Herrick's line can be located where it crosses Magpie river the best plan, I should think, would be to follow that line from the river westward. When you have examined the known deposits of ore—and there may be others since discovered of which I have no knowledge, but which may have been reported to Mr. Boyd—you will be guided in the making of such further exploration of the region as you may think necessary. You are requested to make a preliminary report on this exploration work as soon as it is completed, and you are also asked to suggest or recommend such scheme in dealing with the lands as you think is best suited to serve the interests of an iron mining industry in our own Province, including the smelting of the ores.

July 8, 1899 A. B.

IN accordance with instructions given by Mr. Archibald Blue, Director of the Bureau of Mines, the geologists of the Bureau set out by steamer for Sault Ste. Marie on July 15. On July 18 Little Gros Cap was reached, canoes, supplies, etc., having been brought by the steamer Telegram, and the iron deposit near the harbor was examined.

Red and Brown Hematites.

Red Hematite at Little Gros Cap.

On the lakeward side of Little Gros Cap red hematite is found interbanded with thin bluish layers of cherty material. The banding runs about northwest and southeast, so far as can be ascertained, and the dip is 45° to the southwest. The ore is lean so far as it can be seen on the dump formed by the old workings; but Captain Grierson, who was employed in the mine, states that a body of good ore was found at the bottom of the shaft. Further details are given in last year's report of the Bureau. The property has been acquired by Mr. Ely for Minnesota and Illinois capitalists according to current reports. The rock associated with the ore is partly chert, partly fine-grained sandstone or quartzite, and the deposit suggests in some respects those of the Vermilion range, Minnesota; though no red jasper occurs at Gros Cap, as happens in the Minnesota iron ranges. The exact strike of the ore beds is not easy to determine. The nearest schistose rock has a strike of north 60° east.

The only other deposit in the region on which any work has been done is at Boyer lake, nine or ten miles to the northeast and about a mile and a half from Wawa lake. Here a large deposit of brown hematite or limonite is being opened up by the Clergues. The development consists mainly of stripping on claim 68 at the east end of the small lake, where the ore rises as low cliffs above the water and probably runs some distance below water. The ore is generally dark steel gray, and hard on fresh surfaces, but some parts are brown, or yellow, or red. It is generally very pure in appearance, no pyrite being seen, and few impurities of any kind, though some brecciated fragments of sandstone or chert occur on the north side of the deposit.

Brown Hematite at Boyer Lake.

Stripping shows an ore body more than 450 feet in length from east to west and 350 from north to south, rising at the highest point 94 feet above the lake. A drill hole 15 feet deep passed through solid ore, and the deposit is probably much thicker than that, but its total thickness can be determined only by the diamond drill or by sinking a shaft. The lowest estimate of the ore in sight would be 250,000 tons, and the actual amount is probably much greater than this.

The ore body stands apart from the adjoining rocks and seems to be of a different origin, probably of much later age. The surroundings are very peculiar. A very steep hill rises 460 feet above Boyer lake just to the east of the ore deposit, and steep rocky walls enclose the lake to the north and south. The lake is 115 or more feet deep and is enclosed in a rock basin. No ore of any account is found on the hill top nor on the adjoining rocky ridges; and at the west end of the lake sandstone heavily charged with pyrite occurs. The ore body does not lean up against the adjacent hills, but is separated from them by small ravines. The next lake to the west (Glen lake on the map, more properly Sayers lake) has very large deposits of pyrites on its shores; and it looks as though the mass of brown hematite originated from decomposition of the great masses of pyrites in the soft sandstone, which decayed away leaving the lake basins. The hills enclosing Boyer lake like an amphitheater may have served as a kind of funnel to concentrate the solution of iron, which was then deposited in the east end of the narrow valley of lake Boyer.

Probable Origin of the Ore Body.

If this theory is correct the ore deposit on claim 68, and reaching also into claim 69, is an exceptional thing due to the particular conditions found at Boyer lake. The ore is entirely different from that of Gros Cap or that of the Vermilion range in Minnesota, where jasper is the accompanying rock and the ore itself is red hematite. The other claims taken up in the Boyer lake region are of a quite different kind and show no large bodies of ore.

A Possible Iron-bearing Range.

Just north of the Boyer lake deposit dark cherty sandstones with a little iron ore occur, standing nearly vertical and striking about east and west. They look like the rock accompanying the Gros Cap iron ore, and resemble even more strikingly the iron-bearing rocks of the Vermilion range in Minnesota. The flinty iron charged rocks extend for more than a mile along the ridge east of Boyer lake, and are found also toward the west for some distance, though they appear to vanish before reaching Magpie river. Whether they are connected with those of Gros Cap has not been proved.

Nature of the Rock Formation at Boyer Lake.

The adjacent rocks at Boyer lake are chloritic and sericitic schists both to the north and south. Just east of Boyer lake a broad band of hard felsite, bluish and charged with pyrite when fresh, runs parallel to the iron-bearing sandstones, generally forming the crest of the lofty ridge locally known as Waterpower mountain. This felsite weathers dark brown, and is covered by a layer of brown iron ore an inch or a few inches thick. The latter has been held to indicate the presence of bodies of iron ore, and at several points trenches have been made across it. Wherever the trench goes into solid rock however it is seen that the ore forms only a crust, not a body of any dimensions.

About 150 feet below the summit of the ridge Mr. Ely has commenced to tunnel into the cherty sandstone, expecting to open up a large body of soft ore, since he thinks the formation is closely like that of the Vermilion range and the conditions favorable. At the time of our visit the work was just begun and little can be said as to results. The rock penetrated was banded sandstone or chert, with a little ore. A vein of brown hematite a few inches thick was cut by his work and contained good ore, though in small quantities. Mr. Ely considers the outlook promising and has already expended more than $50,000, if reports are correct, in purchasing options and in development work. His experience in the Minnesota iron region makes his opinions of importance, and it is to be hoped that he will find a large body of good ore.

Development work on Ely's Claims

As no work has been done elsewhere on the range it will not be necessary to describe other parts of it in detail.

Just south of lake Eleanor, and about 2½ miles northeast of the last portion of the iron range seen east of Boyer lake, rocks of the same kind occur on No. 14 of the old Johnston locations, sandstone and chert in thin layers with a little impure magnetite forming interleaved beds on the face of a steep hill. No ore of importance could be seen, however. From this a chain of small lakes was followed to the northeast, as shown on the accompanying map, and outcrops of the same rock with more ore less ore were found just east of Scott lake and Goetz lake, carrying the range four or five miles farther. East of Goetz lake, near Parks lake, Mr. Alois Goetz has staked ten claims of 40 acres each, covering probably more than a mile of the range. Here large masses of soft and hard red hematite lie scattered along the shore and in the soil, and some brown hematite also occurs. A little stripping has been done exposing red hematite in place, so that the deposit may prove of importance, since the rough fragments are scattered over a considerable surface, and some of them at least are of excellent ore.

Tracing the Formation towards the East and Northeast

Showings of Red and Brown Hematite

The next point at which the formation was seen by us is east of a lake expansion of Magpie river, about six miles north of Goetz lake, where sandstone and black chert with some red jasper occur. Seams of magnetite and red hematite are interbanded with them and thin beds of fairly good ore may be seen, but none of workable size so far as observed. This part of the range forms a series of lofty hills ending in a lake, and was followed by us for about two miles.

Near Magpie River.

As no discovery of the iron range had been reported west or north of Magpie river we did not attempt to follow these rocks farther in this quarter, but returned to Wawa and made our way by a new canoe route to Hawk lake and thence to Missanabie. On lake Manitowick we found two prospectors encamped. Though reticent, they left the impression that iron had been found by them seven miles to the west, not far from Jackfish lake. As their statements were vague and we could secure no guide to the supposed iron deposits, we passed on.

The Iron Range at Dog River.

Our next visit to the range was at McDougall's claims near Dog river, reached by ascending White river to Pokay lake, portaging across the mountain portage, and descending Dog river for about 14 miles to the outlet of Iron lake, three miles to the west of the main river. Here the same set of banded sandstones, cherts and iron ore occurs, with some red jasper. A small quantity of good ore is to be seen, but never in beds of more than an inch or two in thickness. Here also the rocks form a long steep walled ridge, being harder than the adjoining rocks.

McDougall's Claims

East of Dog river rocks of the same sort occur, but with some differences. North of Paint lake large quantities of very impure magnetite are exposed to a width of more than 100 feet. How long the deposit is cannot be determined until much more stripping has been done. The large amount of pyrites in the magnetite and the considerable proportion of rock matter in it will probably render the ore valueless. South of the hill disclosing the magnetite there is a bed of

brown hematite and yellow ochre on the shore of Paint lake, giving that body of water its name. This ore body has not been uncovered by stripping, but certainly extends 200 feet along the shore and has a width of not less than 30 feet. A drill hole has been made three feet deep through ore, but the deposit seems to be thin. The ore body resembles in some respects that now being developed by the Clergues on Boyer lake, though probably of much smaller extent.

Extent of the Range.

The portion of the iron range at McDougall's claims runs about east and west and has been seen by us at points about six miles apart. Whether it forms a continuous curve with the range starting at Boyer lake is not certain, though probable. If the range is continuous, it runs to the northeast nearly to lake Manitowick, and then bends sharply to the west to Dog river. Including Gros Cap, we have visited eight localities on its course and have walked along about 10 miles of it. Between Magpie river and Paint lake however there is a gap of about 16 miles where it has not yet been found. How far west of Iron lake it extends is unknown. The rough character of the country, its covering of forest and the large amount of swampy land in some parts make its exploration difficult. The band of rock described is often less than 100 yards in width, so that it might easily be missed by one passing in a canoe. This probably accounts for the late discovery of this iron range. At present many prospecting parties are in the woods and the whole course of the range will probably be determined before long. In spite of the withdrawal of the iron district from location by prospectors, many claims are being staked in the hope that those staking them will have first rights when the district is once more thrown open.

Probable continuation from Gros Cap to Iron Lake

Americans from Minnesota are showing a great interest in the region. Mr. Ely, who is stated to represent the Illinois Steel Co., was first on the field, but other parties of Americans are visiting the range. Near McDougall's claims on Dog river we met a party of Minnesota men under Mr. James. He was disappointed with what he had seen and was going out. One of his men, an experienced iron miner of Minnesota, spoke highly of the region, but thought the valuable ore bodies would only be found by a large expenditure for test pits, as had been the case on the Vermilion range.

American Prospectors in the Region

The iron deposit on Pic river seems to be of the same character as those of the range described, but is too far from them for the assumption that it belongs to the same range. Professor Willmott examined the deposit, and the following account of it is given in his own words: "About ten miles north of Heron Bay station on the C. P. R. an iron prospect discovered by Joe Morriseau has been taken up by American capitalists. This summer a little surface work has been done in the way of stripping. The west working, on the hill top, shows a very thorough breccia of sandstone and magnetite 15 feet in width. Small narrow lenses of apparently pure ore are seen in the breccia. The wall rock on the west is a slate carrying considerable pyrite, and some of this mineral is scattered through the ore itself. Fifty feet across the strike another hillock is uncovered for a width of 30 feet. Here also there is a mixture of siliceous matter and magnetite with some pyrite. Some distance down the hillside a third stripping shows the continuation of this band as a breccia of sandstone and lean ore. The resemblance to McDougall's property on Paint lake is quite striking, though in this case the yellow ore is lacking. Another stripping 100 yards west of this band shows a siliceous magnetite 10 to 15 feet wide, carrying a little pyrite. At none of the openings is there any body of merchantable ore, but the possibilities of finding larger amounts would seem to be good."

The deposit on Pic River.

Summary of Observations.

In general one may say that the Michipicoton iron bearing rocks resemble, often quite closely, those of the famous iron ranges of Minnesota and Michigan, the greatest producers of high grade iron ores in the world; and they have been traced more o

More Exploration and Development required to prove the Range.

less continuously for more than 30 miles. The only large body of ore found on the range up to the present, that of Boyer lake, is of excellent quality and contains at least 250,000 tons, probably very much more. This deposit however seems to be of rather a unique character. It is brown ore instead of red, and seems to have resulted from a special set of conditions which may not be repeated in other parts of the range.

The only other deposits that seem to us to promise well are those of Gros Cap, Goetz lake and Paint lake. The first of these was worked years ago without very good results, but is now in the hands of Mr. Ely, representing Chicago capitalists. The other two are absolutely undeveloped and one cannot say whether they will be of importance if opened up. Whether there are larger bodies of soft ore beneath the cherty and jaspery capping of many hills of the range can only be determined by the diamond drill or by mining operations. Minnesota men think that such ore bodies will be found, and their experience makes their opinion of weight; but up to the present this has not been proved. It must be kept in mind in any case that the iron ranges of Minnesota and Michigan show many miles on which no iron deposits of value have been found, and the same may be looked for on the Michipicoton range.

At present one can say with certainty only that one ore body of considerable size and of good quality has been found, and that there are indications suggesting that two or three others probably exist. It is likely that at least a few other iron deposits of value will be found in the range now known, but no evidence is yet at hand to show their existence at any particular point.

Whether the Michipicoton iron range will be found to extend farther west is not yet known, and the same may be said as to continuations of the deposit on Pic river.

COPPER IN PARRY SOUND DISTRICT

By Dr. A. P. Coleman

Preliminary Report.

While Dr. Coleman was employed exploring the iron range of Michipicoton in July of the present year (1899), he was notified that upon completion of the work there he would be required to examine and report on the copper-bearing lands of the Parry Sound region, to which attention was being drawn at that time by published accounts of discoveries of large and rich deposits of copper ore. The accompanying preliminary report lacks the high coloring of the practised real estate miner's hand, but it will serve a better purpose in restraining the expectations of land owners and steadying the judgment of moneyed men. A. B.

AS instructed by Mr. Archibald Blue, Director of the Bureau of Mines, the Parry Sound Mining region was visited and the more important mines and prospects examined during the latter half of August, and the results of the investigation are given in a preliminary way in the following report.

The McGown Mine.

First Discovery of Minerals in the Region.

The region first attracted attention to its mineral deposits in 1894, when the McGown mine about two miles east of the limits of Parry Sound was found to contain free gold. In October of that year the present writer was sent to examine the property, and a description of it may be found in the next report of the Bureau of Mines.[1] At that time very little work had been done upon the property, practically only some stripping and the sinking of a pit a few feet deep by the shore of a pond. This disclosed about 100 feet of an irregular bedded vein about three feet wide containing quartz mixed with dark schistose rock and carrying some free gold and copper ores, especially bornite and chalcocite. As the mine was opened for gold, and the amount obtained per ton was small, the owners grew discouraged and little further work was done until a year ago, when the finding of large masses of bornite and chalcocite on the shores of McGown lake a few hundred feet from the original opening once more attracted attention to the mine, this time as a copper deposit. The property passed from the hands of the McGown Gold Mining Company, consisting of local men, to those of the Parry Sound Copper Mining Company, formed of capitalists from St. Paul and Minneapolis, the transfer having been arranged by Mr. Robert Forbes, who was appointed manager of the new company. Since then the work of development has been carried on with energy, and under the stimulus of purchases of mining lands by the company prospecting for copper has been carried on extensively, proving that ores of the metal occur at many points in the district.

The Parry Sound Copper Mining Company.

The writer desires to express his appreciation of the great courtesy shown by the officers of the company, Mr. Forbes, general manager, Mr. Koren, superintendent of mines, and especially by Dr. Elftman, superintendent of reduction works, during his examination of the properties owned by the company. Without their aid and permission to travel on their steamer the work could not have been done as satisfactorily.

Description of the Property and of the Workings on it.

The McGown mine is on lot 146, con. 4, of the township of Foley, close to the road leading from Parry Sound to Rosseau. The rock enclosing the ore bodies is a coarse grained gray diorite schist, penetrated by dikes of pegmatite, and there are no well defined veins containing the ores, though small stringers of quartz occur frequently. In working the property the old inclined shaft has been

[1] Bur. Mines An. Rep. 1894, pp. 98-100.

straightened and continued, so that it is now 100 feet long with a vertical depth of 30 feet at the bottom ; and a new vertical shaft has been sunk to a depth of 65 feet on the hill between the two lakes. It is 9 by 11 feet in dimensions, has a two-cage department and is excellently timbered. The third opening is a quarry or pit about 50 by 25 feet on the surface and 21 feet deep, now partly filled with water coming from McGown lake a few feet away. There was a more or less distinct bedded vein at the old shaft, but the later opening beside the lake discloses only a few quartz seams, the rich ore which was produced from it having formed bunches and impregnations in the diorite schist. The ore pile shows much bornite, chalcocite and chalcopyrite with some iron pyrites, but very little in the way of gangue minerals except the country rock itself. Six carloads of this ore, 143 tons in all, were shipped to the Orford Copper Company in June and gave returns of 15.68 per cent. of copper, worth at current rates for the metal $7,571.13, and leaving a balance above expenses of shipping and smelting of $5,398.80. Another shipment of about 24 tons of ore made to the same firm in July appears to have contained about the same percentage of copper, with a little less than an ounce of silver and $5 in gold to the ton.

There are now on the stock pile, as estimated by the company, about 200 tons of selected ore which is expected to run from 25 to 30 per cent. of copper, and 3,000 tons of lower grade ore supposed to contain from 8 to 10 per cent. of copper. All of this ore apparently came from the open pit on the lake shore ; and if so the amount seems to have been somewhat over-estimated, since the contents of the pit can hardly have been sufficient for that weight of rock.

The rock coming from the vertical shaft, which is intended to tap the ore bodies far enough below the bottom of the lake to avoid trouble from water, contains some bornite and other copper ores, and from the results of Dr. Elftman's assays is expected to run about 3.1 per cent. of copper ; while the rock from the inclined shaft yields from 2 to 6½ per cent. of copper and from .19 to .25 oz. of gold per ton.

Extent of the Cupriferous deposit

The belt of rock carrying more or less copper is from 250 to 400 feet wide, and its length from the old workings to the end of the open pit 800 feet. Traces of copper have been found also 200 feet farther west than the inclined shaft. What proportion of this great mass of rock will contain enough copper to pay for mining cannot be said until the mine has been further developed. The rich ore is very irregularly disseminated through the rock, not as pockets, but rather as in a fahlband, since there are no large bodies of solid ore, and the boundaries of the ore body are very hard to define. Whether other bonanzas of rich ore like that from the open pit will be found can be determined only by mining.

At the time of my visit the foundations of a ten stamp mill were just completed and most of the machinery for it was on the ground. The amount of gold hitherto found in the ore seems too small however to justify putting up a stamp mill at this stage in the development of the property.

The Wilcox Mine.

A property in Cowper Township.

Next in importance to the McGown mine is the Wilcox property, owned by the same company, and situated in Cowper township, at the head of a long bay 12 miles from Parry Sound as reached by steamer. On August 25 a shaft intended to be 9 by 11 feet was down 22 feet; a few pits had been sunk at other points along the line of strike, and some stripping had been done. The country rock is gray garnetiferous gneiss, with a dip of about 70° to the north ; and the ore body is a fahlband of this rock impregnated with copper and iron pyrites, with small amounts of pyrrhotite, bornite, molybdenite and blende. The fahlband, or copper bearing belt, is 30 to 50 feet wide at the shaft and may be traced for about 1,000 feet. Beyond this, half a mile to the northeast, a pit has been sunk on a rusty belt of rock containing pyrites, and another small shaft has been sunk 1½ miles

beyond, with several pits between, all showing more or less copper pyrites. It is supposed that the fahlband is more or less continuous for this distance, and that it even reaches the Lafex mine, seven miles from the main shaft of the Wilcox. A large amount of work will have to be done however to demonstrate the continuity of the deposits. In any case there is certainly a large body of copper-bearing rock, and as the ore is simply a band of the gneiss of the country it may be expected to follow the dip to great depths.

Percentage of Copper in the Rock.

The rock is low grade, as might be expected in a deposit of such magnitude; and may have to be carefully selected so as to provide ore rich enough to treat. There are no sharply defined boundaries to the ore body, which seems to fade off into the adjoining rock; and similar but smaller bands of rusty gneiss carrying some copper run parallel to it. Dr. Elftman's assays show an average copper contents of four per cent. in the shaft, with traces of nickel and of gold.

According to Major Leckie, the Orford Copper Company intends putting up a smelting plant somewhere on Georgian bay, perhaps at Parry Sound; and it is stated that they will purchase copper ore reaching four per cent. or over at current rates less cost of transportation, and that this price will leave a good margin of profit after all expenses are paid. On this basis the property should prove a satisfactory one if the average throughout corresponds to the results of assays from the shaft.

Other Properties near Parry Sound.

The Lafex property near Parry Soun

The only other property which has been much developed is the Lafex, about two miles south of Parry Sound, where a shaft is down 65 feet and drifting is begun. The rock is rusty diorite schist, with a few good seams of chalcopyrite and some pyrrhotite, but iron pyrites is more common than either of the other sulphides. The extent of this copper deposit cannot yet be said to have been proved The ore body seems much narrower than that of the Wilcox, and differs considerably from the latter in appearance, so that it is doubtful if it really is an extension of the fahlband described above. The Lafex is owned by the Hattie Bell Company, which has several other properties in the district.

Undeveloped Prospects, with showings of Ore

Copper ores have been found at many points on the rocky farms of Foley and adjoining townships, as well as on islands along the coast; and a number of locations were visited. In most cases very little work had been done upon the deposits, and only trifling amounts of ore, bornite or chalcopyrite, were to be seen, while in some cases the only sulphide observed was iron pyrites. Hardly any of the deposits took the form of veins, almost all being larger or smaller bunches of ore with perhaps a little quartz in gray gneissoid rock. In a few cases the ore was contained in pegmatite dikes, and in others the country rock was coarse hornblende schist or diorite. While a few of these deposits look promising, none of them have been sufficiently developed to make their prospects assured, and it will be unnecessary in a preliminary report to take them up in detail. The point of most importance in this connection is the evidence afforded that the McGown and other more developed properties are not isolated deposits, but that copper ores are to be found widely distributed in the district, though perhaps not often in workable amounts.

Nickeliferous Pyrrhotite.

Besides the deposits in which copper is the important mineral, there are some containing also nickeliferous pyrrhotite and resembling the Sudbury ores. The best samples seen were from a point on the Indian reserve, Parry Island. These looked promising, but owing to the breakdown of a steamer the locality was not visited; and the lack of transportation prevented also a visit to the mouth of the Shebeshkong or Chepakonge river in the township of Carling, where Dr. Elftman reports extensive deposits of copper ores.

In the Northern Townships.

A drive was made north to Loring, a number of apparently unimportant prospects

showing copper and iron pyrites being visited on the way. In the township of McConkey near the shores of Caribou lake, there are a number of locations containing outcrops of a rusty diabase with more or less iron and copper pyrites and pyrrhotite. One deposit on lot 15, con. 4, contains a considerable amount of the mixed sulphides, and furnished a sample which gave an assay a little over one per cent. copper, 1½ per cent. nickel and $14 worth of platinum per ton. The assay was made on selected, not average, material; and the ore would appear to be more important for its platinum than for the other metals.

Ores carrying Copper, Iron Pyrites and Platinum.

The most interesting deposit in the region is on the shore of lake Messagamasheen in Hardy township; where a shaft has been sunk 30 feet by the Parry Sound Copper Mining Company. It is now partly filled with water, but the ore dump shows considerable quantities of sulphides, pyrrhotite, chalcopyrite and pyrite, and has a striking likeness to the Sudbury copper nickel ores. There are some thick seams of the ore, but much of the rock on the dump is not highly charged with sulphides. The country rock is coarse diabase, which seems to have penetrated the Laurentian, since pink gneiss shows on the rest of the lake shore.

General Conclusions.

In a general way one may say of the copper deposits in the Parry Sound district that ores are very widespread, that a few properties are likely to develop into valuable copper mines, but that the large majority of the prospects do not look particularly promising. The owners of these prospects seem to have quite exaggerated ideas of the value of their properties; a not unnatural state of affairs when, if current reports are correct, relatively large prices have been paid for farms on which little ore has been found and hardly any development work done. The largest purchaser has been the Parry Sound Copper Mining Company, which is said to own or to have options on 65,000 acres of land; part of this great area being handed over however to subsidiary companies for development. It is evident that the majority of these farms scattered over the district can never have been carefully explored, and have been taken under option in a speculative way. It is much to be desired that the two main properties should be far enough developed to prove their extent and value. They seem promising now, and it may be hoped will fulfil the expectations formed of them. If this is the case many of the other properties in the district on which traces or small pockets of ore have been found will be worthy of attention.

Caution should be observed in an Undeveloped Region.

It is often stated that the rocks of the Parry Sound region are Laurentian, and hence not likely to contain valuable ore deposits. In reality its geology has never been worked out in detail, and it is probable, if not certain, that much of the region corresponds to the Grenville series or Upper Laurentian of Eastern Ontario and Quebec, or to the Keewatin (Huronian ?) rocks of western Ontario. As both these rock series are well known to be rich in metals there is no reason to suppose that the so-called Laurentian of Parry Sound is necessarily barren; and the opinion of many inhabitants of the district that geologists have condemned it is not borne out by the facts.

Geology of the Country.

LOWER SEINE GOLD MINES.

By James A. Bow

Instructions to the Inspector.

Owing to some uncertainty as to the Golden Star mine and the fluctuations in the stock of the Company, I think it is very important in the public interest that we should have a report on it from an independent and trustworthy point of view. One or two parties connected with the old Company have been circulating disparaging reports as to the continuation and richness of the ore body, and the effect has been to largely depreciate the shares, almost all of which are now held in Canada. I have therefore to request that you will at once proceed to the locality and make a thorough inspection and report on the mine. Careful measurements should be made to show the size and depth of the vein, the length of the several levels, the amount of stoping done, the number of winzes sunk, etc. The measurements of the width of the vein should be taken at frequent intervals along the drifts, where the ore has been taken out from wall to wall, and a careful study of the vein made to show its relations to the country rock upon both sides of it, and as to the existence of a fault or other indication that the fissure is likely to be continuous in depth as well as in length.

You are required to sample the vein carefully across the whole width of it, perpendicularly and longitudinally, down the shaft as well as along each of the levels. You will number each sample and put a card on it to denote the locality of the mine from which it has been taken, and make a record of each sample to be forwarded here, so that they may be afterwards identified. When you have obtained a full set of the samples, have them boxed carefully under your own supervision, and then forward by express to J Walter Wells, Provincial Assay Office, Belleville, who will be instructed to make analyses of them and send a report to this office. I will subsequently put Mr. Wells' report in your own hands, so that you may use it in the completion of your report on the mine.

You will carefully report on the mill and machinery generally, with a view to show the character of the equipment and its suitableness for doing work economically.

You should also look carefully over the JO41 property, and endeavor to ascertain if the vein of the Golden Star extends into JO41; also whether it extends southerly from the Golden Star, and what it probable length may be. If there are other mineral-bearing veins on the Golden Star notice should be taken of them also.

I have further to request that you will make one of your ordinary inspections of the Olive Gold mine, and of other mining properties in the same locality, and make your report upon these at the same time that you report on the Golden Star.

July 7, 1899. A. B.

I BEG to report herewith, as directed by you, the result of my examination of the Golden Star and other properties in the Lower Seine River locality.

Varieties of Gold-bearing Formations.

There are four important varieties of gold-bearing formations in the Lower Seine, namely: 1. The well-known proto-

Varieties of gold-bearing formations in the Lower Seine.

gine or irruptive granite, containing numerous quartz fissure veins, and represented by such mines as the Foley, Ferguson, Lucky Coon, Golden Crescent, Decca and Manhattan, besides many other locations not developed. 2. A band of felsite schists filled more or less with quartz stringers from a fraction of an inch in width to two or three feet, both parallel with and crossing the strike of the schists. This formation extends about 20 miles or more from the west of the Olive to beyond the Sturgeon Falls and runs about east and west. It is represented by the Olive, Alice A Emma Abbott, Gold Bug, Independence and numerous other locations undeveloped. I think the Fighting Chance is on the same belt, but this property was not visited by me. 3. There is next a formation of hard green schists adjoining the felsite schist I believe, on both sides. This formation contains bedded quartz veins and quartzitic pyritiferous belts which would probably form both small high grade and large low grade propositions similarly to the felsite schists The Swede Boy mine is on this formation. A band of conglomerates extends for about 15 or 20 miles east and west, south of the schists above mentioned. 4. The

smallest formation, but equally important to any of the others, is that of the Golden Star, JO41, and two or three of the adjoining properties. It consists of massive porphyry and greenstone, cut by numerous dikes of greenstone, felsite, etc., of different ages. This formation is bounded by conglomerate and protogine on the south, as shown by the accompanying plan, and by green schists and trap on the northeast, north and northwest. A small body of conglomerate is found at one point on the north of JO41. The porphyry and protogine are later than the conglomerates, as proven by the study of the contacts. Inclusions of the conglomerate in which traces of the boulders are almost obliterated are found not more than 100 feet from the main shaft of the Golden Star, both north and south, and conglomerate pebbles are found in the protogine near the contact. Doubtless the porphyry is the latest formation of the three. Both the porphyry of the Golden Star and the greenstone of JO41 are intimately associated. Dikes of greenstone and felsite are found in the porphyry, and dikes of lighter colored siliceous rock are found in the greenstone. The relations of these two formations to each other is difficult to understand. To sum up, the formation changes from that of a siliceous porphyrtic and felsitic nature on the southern part of the Golden Star property to a coarser-grained greenstone on the northern part of JO41, and great disturbances must have taken place at the time of their production as evidenced by the dikes and inclusions of other rocks in each.

Golden Star Mine.

The main shaft of the Golden Star is 260 feet from the eastern boundary and 680 feet from the southern boundary of location AL114. The protogine is about 1,000 feet from the shaft, and the conglomerate about 300 feet. As to whether these formations dip towards the shaft, it is difficult to say. Nothing of any vital economic importance can be determined in the matter. Going south from the main shaft the ground rises gradually to a height of perhaps 70 or 80 feet for a distance of about 300 feet, or to the conglomerate contact. The Golden Star vein has a strike of about north 35° west. North of the shaft there is no evidence of the continuation of the vein visible at the surface on the Golden Star property, owing to the fact that the rock is not well exposed, although on JO41 a vein outcrops which will be mentioned later. The first evidence now visible of the vein on the surface is in a test pit eight feet deep and 80 feet south of the shaft. The vein is six feet seven inches wide, and consists of four stringers of quartz, aggregating two feet seven inches. About 20 or 30 feet south of this the vein branches, one branch bending to the east slightly and the other to the south, the latter with a strike of north 15° west. The evidence of this consists of lines of faulting more or less distinct, with occasional outcroppings of quartz, the rock being covered more or less with soil and a sparse growth of bushes and small trees. At a distance of 60 or 70 feet south of the first mentioned test pit an exposure of the vein occurs, with two or three stringers of quartz aggregating 14 or 15 inches and a distance between the walls of over four feet, only one wall being exposed. The fault line evidently branches again south of this, the most easterly branch of which consists of a distinct line of faulting, visible a little over 200 feet from the main shaft. The central branch is shown by a five-foot test pit about 230 feet south of the shaft. There are two distinct walls five feet apart, with an inch stringer on the hanging and a six-inch stringer on the foot wall. The west branch is traceable by a line of faulting for over 350 or 400 feet south of the shaft. At a distance of about 300 feet from the shaft a test pit has been sunk 22 feet on this branch, which is from two to eight or ten inches wide on the surface at this point. A considerable quantity of felsite occurs south of the shaft, which gives rise to the theory that the vein is contained in a felsite dike, but such is not the case.

Surface indications of the Property

A systematic examination of the vein underground was made according to directions. The workings were measured up and plotted to scale as per accompanying sketch (the dotted outlines of stopes being approximate). The

Underground workings of the Mine.

depth of the shaft, as near as it can be arrived at, is 380 feet. There are five levels, with an aggregate of 930 feet of drifting. The amount of stoping done is best shown by the sketch. The width of the stopes is extremely variable, ranging from 18 inches to about 12 feet. The numbers on the sketch indicate the points at which the vein was measured and sampled for assay. The positions of these points are also plotted to scale. The vein in the shaft was sampled on the north end at every five feet of depth, with a few unavoidable variations. In the drifts and stopes the distance between the points of sampling was made greater. Usually samples were taken at all accessible points, at reasonable distances apart. In many parts of the stopes access was impossible, owing to the lack of timber, etc. The north end of the second level could not be reached, but from previous inspections the vein there is known to be unpromising in appearance. At the north end of the overhand stope in the same drift there appears to be no vein as far as can be seen. It pinches out near No. 125. Corresponding to surface conditions, the conspicuous feature south of the shaft is the branching of the vein, which is well defined in the first, second and third levels; and this is in accordance with what would be expected from surface indications. At the fourth and fifth levels not sufficient work has been done to demonstrate the nature of the vein in this respect at those depths. The dotted line shows approximately the line of branching of the vein as far down as could be determined. The last 17 feet of the first level is on the west or hanging wall branch, the vein dipping to the west. In the second level the south drift was commenced on the hanging wall branch and ended upon it, the central portion being widened out to include both branches. In the third level south the vein branches three times, but not very strongly. The widest and best portion of the vein occurs at what may be called a junction of the branches, or just north of the line of splitting of the vein, as suggested by the stoping done. As far as development work reveals, the workable portion of the vein consists of a shoot from three to 12 feet in width and about 100 feet in length, extending through all the levels and pitching to the north. The walls of the vein are well defined in almost all parts of the workings. Places in which the vein is frozen to the walls are rare. The wall rock is usually decomposed next to the vein, and selvage is common. At the ends of the drifts beyond the main ore shoot the veins or branches are usually fairly definite, although selvage does not occur to the same extent. In some cases only one wall is reached. Near the surface the ore shoot is mainly south of the shaft and crosses to the north as shown, and gives evidence of continuity on that side of the shaft. At the ends of the first three levels south the branches of the vein, although well defined, are comparatively small. Mr. Flaherty, the manager, intends to drift further on the west branch of the vein at the second level towards the 22-foot test pit south of the shaft, where there is promise of a payable body of ore, and crosscutting will be done in both directions. The fourth level south is rather discouraging in appearance, but the fifth level shows a fairly strong vein south of the shaft. In the north drifts of the upper levels especially the country rock changes from the usual felsite or porphyry to greenstone; the contact cannot however be easily located. But this may be only a dike which would be passed through on further drifting. The vein is strong at the ends of the drifts, and it is possible that further drifting may reveal workable ore. In the shaft the vein varies considerably in width. A few feet of broken rock prevented access to the bottom of the shaft, but as far as can be seen the vein in the lower portion of the mine is wider than usual, the foot wall not being reached at all in parts of the workings, but the quartz is lean looking and the walls have little or no selvage. The character of the ore varies considerably in different parts of the mine. I understand that a very rich body was found between the second and third levels north. Mr. Flaherty struck the continuation of this, though much narrower, while stoping in the fourth level, and he informed me as I was leaving that there were evidences of its coming in at the fifth level

north also, where stoping and drifting were in progress. In the fourth level stope the rich streak is only from six to eight inches wide and extends along on the hanging wall side of the vein. It is heavily charged with galena.

Before the stamp mill was installed and in operation, which was on 9th November, 1898, the shaft was considerably over 300 feet deep and four levels had been established with an aggregate of over 700 feet of drifting, besides upraises and winzes. This meant, of course, besides the large amount of ore blocked out, an extensive ore dump on the surface. Since the mill has been in operation development work has been practically suspended, with the exception of the establishment of the fifth level and a little drifting at the third and fourth levels. For the past six months practically no development work has been done, until lately under the new management. Thus, with a large amount of ore blocked out and a dump on the surface representing the product of development work, completely equipped hoisting, transportation and milling plants, the owners were enabled by a knowledge of the distribution of the different grades of ore under ground to stope out accordingly and govern the output of the mine from month to month as they desired. By suspending development work, and otherwise keeping down temporary expenses, the profits were additionally enhanced for the time being. But although the blocked out portion of the mine has been mostly gutted, there is no reason why development work should not even now be kept sufficiently advanced to keep the mill running steadily. The ore shoot has every appearance of continuity and depth, and the vein shows no positive indication of discontinuance in length. The present management must pursue a conservative policy for a few months, until development work has been sufficiently advanced to insure a future reserve compatible with the capacity of the mill.

Suspension of Development Work by the former Owners

The mine was left by the old management in a poor condition. The timbering in the stopes was meagre ; the loading stations in the shaft are not safe ; the ladderway required considerable improvement, and the skipway was insecure, besides other matters of less importance. Under the new management these defects are being remedied as fast as convenient. The ventilation is not very satisfactory at present. An air shaft to connect with the north end of the first level was advised. There is a considerable quantity of water coming down the shaft, but this is easily controlled by a pump at the third level and one at the bottom of the shaft. Machine drills operated by compressed air are employed ; five are in use altogether for stoping and development work. The hoisting plant includes a skipway constructed as far as the fifth level, with a 2000 lb. skip, automatically dumping at the surface ; a $\frac{3}{4}$-inch steel wire hoisting cable ; a duplex hoist with $8\frac{1}{2}$ by 12-inch cylinders ; band brake and friction clutch ; and drum 42 inches in diameter. Owing to the irregularities in the shaft the skiproad is poor, the exercise of considerable care being required to prevent the skip from leaving the track. This can be avoided by providing proper back timbers, such as has been done from the surface to the first level. Instructions were left to provide such timbers for the full length of the skiproad. A small auxiliary hoist has been provided at the fifth level for sinking in the shaft, which work has been delayed pending the arrival of the needed machinery. A satisfactorily timbered pentice has been constructed under the skipway. Tramways are laid in all working levels. The ore stoped out is broken down upon a row of stulls with mill holes in these to convey the ore to the cars in the levels. Both overhand and underhand methods of stoping are employed.

Condition of the Mine

The ore is conveyed to the mill on an Otto Aerial Tramway 2700 feet in length. The uneven contour of the ground necessitates ups and downs in the cable way, which is supported by fifteen standards at varying distances apart. The discharge terminal is 10 feet lower than the loading terminal. Three or four horsepower is sufficient to operate the tramway. Ten buckets are in use having a capacity of 500 lb. each and a speed of about $4\frac{1}{2}$ feet

Tramway from Mine to Mill

per second. The buckets dump directly into the crusher at the mill. The tramway, and of course the crusher also, only runs 10 hours out of the 24. One man is required at each end to load and unload the buckets, etc. Fifty feet of tramway extends from the shafthouse to a pocket at the loading terminal. This pocket (lately constructed) has six separate lips for the discharge of the ore into the buckets. The different grades of ore can be thus kept separate, and mixed as required in order to maintain a uniform output of bullion.

The stamp mill, which is on JO41, has a very good site on the Bad Vermilion lake. The foundation is solid rock. The buckets discharge at a sufficient elevation to admit of all handling of ore and tailings by gravity. The building is commodious, and substantially and neatly constructed. The machinery consists of the following :

The Mill on Vermilion Lake

1 Comet D Crusher with a 100-ton ore bin underneath
2 Batteries of 5 stamps each.
2 Challenge Ore Feeders.
2 Brown's Two-Compartment Hydrometric Sizers.
4 Frue Vanners with 6-foot plain belts.
12" by 36" Corliss Engine and two 80 h.p. Boilers, besides the Air Compressor.

The mill and other buildings in connection with the mine are lighted by a 60-lamp dynamo. Mr Flaherty estimates the capacity of the mill at 30 tons per day, but it is possible that this figure would be found too low if an exact method of estimation were employed. Mr. Kerr, the former superintendent, told me that about 35 tons on an average were being treated daily, and as much as 41 tons had been put through in 24 hours. The ore of course varies in hardness, richness, and in free-milling character. Rich ore with a considerable amount of concentrates requires longer treatment, and hence reduces the capacity. The following details of mill practice are now adopted : Weight of stamps 1020 lb. ; number of drops, 96 per minute ; height of drop, seven inches on an average ; materials of shoes and dies, forged steel ; depth of discharge, variable, usually from 2½ to three inches, although the range extends from 1½ to eight inches according to the nature of the ore. Rich ore with a large percentage of concentrates requires a deep discharge, thus allowing of finer comminution and longer treatment. Screens, 40-mesh diagonal slot, with area of 4′ 2″ by 9¼″, single discharge. No inside amalgam plates are used. Apron plates, 12′ long by 4′ 7″ wide with 1½ drop in centre ; inclination, 1¾″ per foot. There is only a small percentage of concentrates in the ore, as is usually the case with the mines of Western Ontario, but their value is high. They are not treated at the mine. The hoisting, transportation and milling machinery is in a satisfactory working condition and has been installed with a view to reasonable economy to the handling of the ore. About seven or eight cords of wood per day are used at the mine and mill, and it costs delivered $2 37½ per cord.

The following buildings are on the property : Shaft house, engine house, blacksmith's shop, dry, store house, mill building, tramway terminals, office, powder magazine, boarding camps, stables, several private dwellings, and others. The following force is employed : In connection with mining—four drill men, four trammers, three timber men, two landers, two engineers, a blacksmith, and several temporary laborers. The mine captain is Mr. E. J. O'Brien. In connection with milling — superintendent, George M. Kugler, a carpenter, a night amalgamator, two engineers, two firemen, wood passer and helper in mill. In connection with transportation of ore—one man at each terminal.

Buildings and Employes.

Mr. Flaherty furnished me with the following summary of costs per ton : Mining $2.78, milling $1.34, and transportation 17 cents, making a total of $4.29 per ton. Wages are higher here than in other parts of the district. Machine men are paid $2.75 a day ($3 at some of the mines in the vicinity,) and other workmen in proportion. Board is obtained for $20 to $22 per month.

Costs and and Wages.

A small steamer is employed by the Company for the transportation of supplies, &c., on Bad Vermilion lake. The Government road from Mine Centre, which is at a distance of 4½ miles, has been in poor condition for the greater part of the

Transportation

season, but improvements are now in progress.

Sampling of the Mine.

In the selection of the samples from which the assays were made a piece from half to three-quarters of a pound was taken at intervals varying from a fraction of an inch to eight or ten inches, according to the width of the vein and the character of same. Where the vein was narrow, from a couple of inches to eight or ten inches in width every inch across was sampled. Where the width was about five feet or more, pieces were taken at equal intervals of six, eight or ten inches, according to circumstances. For other widths of the vein intermediate pieces were taken at correspondingly smaller intervals. At each place sampled the pieces were of uniform size, or a uniform amount was taken at the different points across the vein as nearly as could be judged, and at equal distances apart, although, as stated before, if the vein were narrow or the quartz variable in character the pieces were taken at smaller intervals or more frequent than if the vein were wide or uniform in character. Considerable care was exercised to have a thoroughly uniform sample in each case, so that the assay value would represent the average value across the vein at that point. The samples were taken by hammer and moil, with the assistance of a miner, and they were put up and sealed under my direct supervision for shipment by express to the assaying office at Belleville. The results obtained are given in the following table.

Assays of the Samples

No	Width of vein		Width of quartz.		Assay Value	Remarks
	Feet.	In.	Feet.	In.	$ c.	Total width of vein sampled unless otherwise stated.
1	3	7	1	6	1 65	
2	3	10	3	0	1 85	The vein at all points sampled possesses definite foot and hanging walls except where otherwise remarked.
3	4	9	4	9	—	
4	6	1	5	11	trace	
5	6	3	4	7	"	
6	6	4	3	10	1 22	
7	5	8	5	8	trace	
8	6	0	6	0	—	
9	7	4	7	4	1 65	
10	6	7	6	7	1 20	
11	6	3	6	3	trace	
12	6	0	5	8	—	
13	5	4	4	10	trace	Foot wall not reached between fourth and fifth levels except near the fourth.
14	5	3	4	6	—	
15	4	3	4	3	1 44	
16	4	0	4	0	5 98	
17	4	0	4	0	33 04	
18	3	0	3	0	6 60	
19	1	1	1	1	1 22	
20		11		11	82	
21	2	6	2	6	trace	
22	3	0	3	0	1 02	
23	2	0	2	0	23 57	
24	1	5	1	5	5 57	
25		2½		2½	—	Vein pinched out entirely between 24 and 25, leaving only a seam.
26		6		3	trace	
27	2	9	2	7	3 51	
28	4	10	1	6	2 88	
29	4	3	1	2	1 02	
30	9	10	1	8	trace	Quartz in two branches 7" on hanging and 13" on foot. Quartz only sampled.
31		7		7	7 43	Hanging wall branch exposed. Foot wall, branch only exposed at level where sample 30 was taken.
32	4	4	3	10	8 46	
33	2	10			84	Stringers of quartz mixed with felsite.
34	1	8	1	3	1 02	
35	1	0		10	1 44	Vein pinched out between 35 and 36, leaving a distinct seam.
36		8		6	3 91	
37	1	2		9	3 09	
38	1	5	1	0	35 47	
39	1	4	1	0	3 91	
40	1	9	1	9	5 78	
41	1	0	1	0	5 57	
42	1	6	1	6	2 47	
43	3	10	2	6	15 28	

Assays of the Samples

No.	Width of vein.		Width of quartz.		Assay Value.	Remarks.
	Feet.	In.	Feet.	In.	$ c.	Total width of vein sampled unless otherwise stated.
44	4	10	4	0	8 05	Foot wall not reached.
45	2	10	2	10	50 63	
46	2	0	2	0	56 58	
47	1	3	1	0	5 36	
48	2	0	1	7	10 11	
49	1	3	1	3	34 89	
50	2	0	2	0	4 74	
51	2	3	2	3	9 70	
52	2	6	2	6	4 54	
53	2	10	1	6	3 52	
54	3	0	3	0	4 33	
55	3	5	2	7	117 06	
56	3	3	2	3	1 44	
57	2	2	2	2	11 97	
58	1	8	1	8	74 92	
59		10		10	2 68	
60	1	0		11	trace	
61	1	5	1	0	1 02	
62	1	8	1	8	1 44	
63	2	6	2	6	2 47	
64	1	9	1	9	3 09	
65	1	10	1	8	3 29	
66	1	6	1	6	10 73	
67	1	6	1	6	1 44	
68	1	7	1	3	84	
69	2	7	1	4	9 08	
70	2	3	1	6	43 15	
71	2	0	2	0	101 59	
72	2	10		11	45 63	
73	2	3	2	0	17 55	
74	1	10	1	10	17 10	
75	..	...	..		1 22	Sample of foot wall material adjacent to vein Thickness of wall rock sampled, 2′ 1″, where slope has been suddenly widened.
76	...	.	.. . .		2 27	Sample taken from about a dozen points on foot wall, covering a distance of 50 or 60′, where portion of vein is left in wall.
77	1	1	1	1	17 34	
78			. .		—	Sample of country rock across drift adjacent to vein on foot wall side. Width sampled, 1′ 10″.
79	7	8	3	0	7 43	Vein here really consists of two branches, one on each wall. Hanging wall branch, 1′ 7″. Foot wall, 1 5″. (Quartz only sampled.)
80			.	.	trace	Sample of country rock between branches of vein at 79. Width sampled, 4′ 8″.
81	7	0	3	3½	13 21	Vein in two branches similar to 79.
82	6	2	4	0	37 58	Whole vein sampled.
83	6	5	6	5	8 67	Country rock pinched out. Calcite mixed with the quartz in the centre of the vein
84	3	6	3	6	4 54	
85	3	11	3	5	9 91	Quartz in foot wall of stope.
86	3	3	3	3	113 06	Quartz mixed with foot wall rock.
87	3	7	3	1	22 50	A little quartz in foot wall.
88	3	10	1	11	2 67	Walls rather indefinite compared to other places on vein.
89	1	1	1	1	2 89	The vein in the 2nd level south is in two branches. Hanging wall branch drifted on near shaft.
90	1	1	1	1	3 50	
91	6	3	3	8	2 27	Both branches of vein exposed at this point. Country rock between not sampled.
92	5	3	5	0	3 50	Country rock pinched out.
93	4	4	4	4	14 26	
94	4	4	4	0	trace	
95	6	2	3	4	82	Branching of vein in evidence here. Sample taken all across.
96	6	2	1	9½	—	Branch on each wall. Hanging, 13½″ quartz; foot wall, 8″.
97		.	.....		—	Sample of country rock between quartz stringers or branches of vein at 96. Widfh, 4′ 4″.
98	11	6	1	2½	1 22	Only quartz sampled.
99	. .		... .		trace	Sample of country rock between stringers at 98. Width, 10′ 3½′
100		7		7	2 06	Hanging wall stringer or branch.
101		3		3	1 44	" " " "
102		2		2	82	Widens to 12″ between 101 and 102. Hanging wall branch.
103		7		7	2 68	" " " " " " "
104	9	10	5	0	2 26	Consisting of quartz and country rock mixed.
105	8	0	4	0	1 65	" " " " "
106	7	10	7	10	3 10	
107	9	6	... .		1 86	A little country rock mixed with the quartz in centre.

Assays of the Samples

No	Width of vein Feet	In.	Width of quartz. Feet.	In.	Assay Value. $ c	Remarks
						Total width of vein sampled unless otherwise stated
108	11	10	2	4½	2 47	Only 1½″ of quartz in hanging wall branch Only foot wall branch sampled.
109		3		3	82	Foot wall branch.
110		8		8	—	" " "
111		2		2	1 62	Hanging wall branch (Vein branched a second time.)
112	3	6	3	6	1 84	Foot wall branch.
113	7	6	2	6	5 99	Only foot wall branch sampled. A little quartz is mixed with the country rock right across drift. Hanging wall branch very small
114	6	6	2	1	—	Vein branched again near end of drift. Only the quartz sampled.
115	7	0			84	Sample taken across roof of drift consists of quartz and country rock mixed, mostly country rock. Branches of vein on each side small.
116	6	0	1	3	84	Sampled all across. Quartz mixed with the foot wall rock
117					1 22	Sample of vein matter consisting of quartz and country rock mixed About 2′ in thickness on foot wall
118	....				84	Sample taken along crosscut. All country rock. Sampling commenced 18″ from vein. Taken across a distance of 7′ 8″.
119	.		.		1 22	Sample of about 12″ of vein matter, (quartz and country rock mixed) in foot wall.
120			..	.	trace	Sample of vein matter left in foot wall. Sample taken from several points along wall of drift.
121		.			1 02	. " "
122	2	11	.		30 79	Mostly quartz. Sample of vein. Both walls exposed.
123	3	0	1	8	21 91	Quartz in several stringers.
124	2	1½	2	1½	19 01	
125		9		9	3 30	
126	3	9	3	9	1 02	
127	2	4			15 70	127 is a continuation of 126, there being 2′ 4″ of quartz and felsite mixed, adjacent to the vein on foot wall.
128	3	10			2 47	Quartz and felsite mixed, mostly quartz. Foot wall indefinite.
129	3	4		6	—	Stringers of quartz in felsite. Walls are not very definite
130	2	10½	2	10½	32 45	
131	2	8	2	6	84 12	
132	2	1	2	1	56 42	
133	1	1	1	1	20 23	
134	1	0	1	0	7 01	
135	2	0	2	0	67 79	
136	1	10	1	10	10 06	Quartz in foot wall mixed with country rock.
137	1	10½	1	10½	41 14	Stringers of quartz in foot wall.
138	3	7	3	7	17 77	
139	4	0	4	0	13 43	
140	3	0	3	0	25 21	
41	2	4	2	4	19 02	
142	2	1	2	1	31 21	
143	1	8½	1	6	33 89	
144	1	8	1	8	17 97	
145	3	2	3	2	84	
146	3	8	3	0	4 96	
147	4	3	4	3	3 72	
148	4	7	4	7	2 06	
149	5	0	4	0	1 62	Quartz in foot wall.
150	1	11	1	11	1 82	
151	1	5			3 64	Mostly quartz Slightly mixed with country rock
152	2	5	1	11	trace	
153	2	0	2	0	59 52	
154		11		..	2 47	Mostly quartz. Mixed.
155	1	2	1	2	5 37	
156	2	0	2	0	4 12	
157	6	7		.	1 62	On hanging side of vein is a well defined quartz body 2′ wide, with definite walls Remainder of vein is mostly quartz mixed with country rock. Regular foot wall not reached.
158	3	4	2	5	1 82	Definite vein 2′ 5″ on hanging side. Sample taken across roof of drift. Regular foot wall evidently not reached.
159	.	..	2	1	62	Definite vein on hanging side. Sampled across roof of drift Width 4′ 5″. Rock on foot wall side consisting of quartz and country rock mixed, mostly country rock.
160	3	3		.	82	Mostly quartz; 8″ or 10″ of felsite on foot wall side. Vein narrower at bottom
161	4	4	4	4	62	Foot wall not reached
162	5	8	5	8	82	
163	6	4	6	4	—	

Assays of the Samples

No.	Width of vein		Width of quartz.		Assay Value.	Remarks.
	Feet.	In.	Feet	In.	$ c.	Total width of vein sampled unless otherwise stated.
164	6	8	6	0	trace	No selvage on hanging wall. A little on foot wall.
165	5	10	5	10	—	Hanging wall indefinite. Foot wall definite with selvage.
166					2 26	Sample taken across a horse of country rock; width 2½'; a little quartz mixed with the rock A little stringer of quartz had been followed by the drift, under the belief that it was the hanging wall, but the drifting and stoping is now carried on east of this, where a wide body of quartz (the regular vein) was crosscut.
167	3	5	3	5	trace	Samples taken only where possible, the timbers having been removed. Shaft timbered to first level.
168					82	Sample taken across 2' 6" of the vein starting at foot wall side. Hanging could not be reached
169					2 06	" "
170	4	2	4	2	3 30	
171		2		2	2 26	Sample taken at mouth of 22' test shaft over 300' south of main shaft.
172	6	7	2	7	1 02	Sample from 1st test pit 80' south of shaft Quartz in four distinct stringers. Definite walls. Test pit 8' deep. Point where sample taken shown on plan.
173		8½		8½	82	Samples from 22' feet test. Shaft over 300' south of main shaft Depth of sample, 21' 10", north end of shaft.
174		8½		8½	—	Same depth at opposite end of shaft.
175		11		11	62	Depth, 16' 3" Foot wall indefinite; hanging definite, showing selvage.
176	1	8	1	8	1 24	Good hanging wall; indefinite foot wall; depth, 13' 2".
177	1	0	1	0	1 02	Depth, 7' 5".

The average value of the 177 samples is $10.31, which must be regarded as quite satisfactory in view of the fact that the samples were taken fairly from all parts of the workings, regardless of the quality of the ore. With selected ores such as would be possible for milling when development work is adequately maintained, it is obvious that a considerably higher average might be looked for; but with ample supplies of ore blocked out, and the milling capacity doubled (as is planned by the new management), an average of $10.31 per ton would assure the payment of liberal dividends.

Locations adjoining Golden Star.

JO41. JO41 is a location of 105 acres adjoining the Golden Star property on the northwest. The Golden Star vein has been generally spoken of as extending on to JO41 property. The greater part of this property is covered by swamp and bush, and the vein could not be traced northward without great expense in stripping. But there is a vein outcropping at a distance of 1,300 feet northwest of the Golden Star shaft, where the first exposure of rock occurs on JO41. It may be the continuation of the Golden Star vein, but I doubt it, as the variation of strike would necessarily be considerable. This outcropping is three or four feet wide, and is exposed at both ends of a test pit sunk a few feet upon it. The walls are fairly well defined, but the vein is only traceable for a short distance at this point. About 800 feet farther north, on about the same line of strike and separated by a muskeg, the ground rises rather abruptly, exposing a vein one to 2½ feet in width and traceable for over 100 feet. This probably is the continuation of the preceding vein. Near the southwest corner of JO41 and 50 or 60 feet from the eastern boundary an outcropping of quartz 10 feet wide occurs. This is the continuation of the vein which is traceable for over 500 feet with a strike of about north 60° west on the adjoining location. Over half the vein is stripped. It averages 2½ or three feet in width and has well defined walls. The country rock is massive greenstone. The vein certainly looks promising.

AL114 and 116. On the western side of AL114 a quartz vein outcrops which is traceable for over 200 feet with a strike of about north 40° west. It ranges from a few inches to two feet in width. Near the southeast corner of AL116 an outcropping four feet

wide occurs which is a continuation of the Randolph vein on AL115.

Randolph Farm

What is know as the "Randolph Farm" or mining location AL113, adjoining the Golden Star on the west, has recently changed hands, and operations have been commenced by the present owners. There were on August 12 only three miners at work test pitting, but a double crew was to have been put on in a few days and camps erected. Mr. Neil Berger is foreman of the work. The formation is similar to that of JO41. There is a strong quartz vein of a promising appearance traceable for five or six hundred feet, from two to 10 feet in width, with well-defined walls and a strike of north 15° to 20° west. The quartz contains copper and iron pyrites, galena and zincblende. Two test pits have been sunk about 300 feet apart on the vein; one 3½ by 10 feet in cross-section by 10 feet in depth, showing the walls well separated from the vein matter; the other six to eight feet in cross-section by eight feet in depth, apparently on a junction of this vein with another.

Randolph Mine

Work is also in progress on AL115, a 40-acre location adjoining the Golden Star on the east, known as the Randolph mine, and owned by the Randolph Gold Mining Company of Ontario, Limited. The formation is a continuation of that of JO41 and the Golden Star, with conglomerate on the south half of the location. The vein is traceable for about 500 feet on the surface and varies in width from a few inches to three or four feet. A six by eight foot shaft is being sunk which on July 20 was 54 feet in depth. A small steam hoist is employed. A shaft house, blacksmith shop and boarding camps have been erected. There are six miners working in day and night shifts and four other workmen, under the superintendence of Mr. Neil Berger.

Olive Mine.

An extensive Band of Gold-bearing Rock.

The Olive ore body consists of a small, rich quartz vein in a large body of felsite schist. A two-stamp mill was installed two years ago which successfully treated the quartz from the small vein, and also a certain amount of the felsite schist adjoining the vein. A ten-stamp mill was erected last year with the object of treating a larger quantity of the schist, the quartz vein being too small for a mill of that capacity. As a result of continued testing the opinion grew that the whole body of felsite schist, several hundred feet in width, contained sufficient values for treatment by a large mill. This summer diamond drill testing was done with a view of determining the values contained in the schist and the width of the body. Two horizontal holes were bored at the bottom of the main shaft, a depth of 245 feet. The first hole north for a distance of 150 feet revealed 132 feet of an ore body and 18 feet of diorite beyond. The second hole was bored south from the end of the crosscut, revealing 218 feet of ore and 20 feet of diorite. This makes altogether, including the crosscut, a width of about 425 feet of ore, with an indefinite length and doubtless great depth. Whether the ore is sufficiently high grade for treatment even with a large mill is a matter that has yet to be settled. However, the foundation is being prepared for an additional 15-stamps to be installed this fall alongside the present mill. This will of course necessitate the treatment of a still greater proportion of the schist, or "dike" as it is erroneously called. It is not likely that a further increase in the milling capacity will be made after this until the new railway (which passes within a very short distance of the mine) is in operation.

Sinking and drifting

The main shaft is 251 feet deep, with sinking suspended for the present. There are three levels, with a total amount of drifting of 615 feet, and 72½ feet of crosscutting. Considerable stoping has been done in the first level east and west, and a little at the third level west. A good body of high grade ore was passed through in the third level west. Shaft B, which is 345 feet east of the main shaft, is 70 feet deep, with 262 feet of drifting at the bottom. An additional 90 feet of drifting west will make connection with the east drift at the first level of the main shaft, thus affording good ventilation as well as giving a large amount of stoping ground.

Drilling is all done by compressed air. Five machines are in use. No stoping is in

progress at present. The 10-stamp mill is kept supplied by the product of development work, five drifts being under way altogether. Mr. N. B. Hall is manager of the mine. There is a total force of 52, including 22 miners.

On G69 (a part of the Olive property) a shaft is being sunk on a band of green schist impregnated with quartz and heavily charged with pyrites. The shaft was 29½ feet deep at the time of my visit, with crosscutting commenced north and south at the bottom.

Location G69

Swede Boy Mine.

The Swede Boy mine was visited on August 9th. This property is situated about four miles east of the Olive, and consists of location E237, owned by the Headlight Gold Mining Co. of Ontario, Limited. John McLeod is manager, with a total force of 13, including eight miners. The formation consists of dark green schist, impregnated with small seams of quartz and charged with pyrites. There are two quartz veins about 100 feet apart and parallel to the strike of the schists, which is nearly east and west. These are exposed at several points with a width of from three or four to eight or ten feet. A shaft has been sunk 81 feet on the north vein. At a depth of 75 feet a crosscut has been driven south towards the other vein 40 feet, and one north 16½ feet. It is possible that the rock between the veins may be ore. A small steam hoist is employed, and office, boarding camps and engine house have been erected.

Lucky Coon Mine.

The Lucky Coon mine, recently bought by the Lucky Coon Gold Mining Co., has been in operation by that company since early in the spring, after several years of suspension of work. There are five shafts on the property, on different veins. Two of these have been worked all summer. One, No. 5, has been recently temporarily closed down owing to inadequate ventilation. It is said to be 78 feet deep, but is half full of water. The other working shaft, No 2, is 108 feet deep. Drifting will be commenced at the 100-foot level as soon as a few feet more has been sunk. The shaft is on a good strong vein with a nearly vertical dip. Parallel veins also occur on both sides which can be economically reached by crosscutting from the same shaft. Steam hoists will be installed immediately, one at each shaft, and work on No. 5 resumed. There are at present three miners and three surface men employed under the managership of Mr. A. W. Robertson.

Ferguson Mine.

The Ferguson mine is owned by the Seine River (Ont.) Gold Mining Co., Limited, with head office at 1 Castlecourt, London, Eng. While I was in the vicinity the shafts were all pumped out and examined by a Cornish mining engineer named John Angove. If the report is satisfactory work will doubtless be resumed.

Golden Crescent Mine.

The Golden Crescent mine, formerly known as the AD2, has been bought by the Golden Crescent Mining and Exploration Co. of Ontario, Limited, with head office at Duluth, Minn. Work has been resumed this spring after a period of suspension. The shaft on the Gem vein has been sunk to a depth of 88½ feet, and a little work done at one or two other places on the property. A steam hoisting plant has been installed. Mr. W. G. La Rue is manager of the mine. There is a total force of eleven, including six miners, working by day and night shifts.

Decca Mine.

There are two shafts on the Decca, about 1,200 feet apart on the same vein. No. 1 is 115 feet deep and will be continued to 150 feet before drifting is commenced. Steam hoisting and air compressing plants have been installed. No. 2 shaft is 110 feet deep. Operations in it are temporarily suspended. Mr. F. C. Fisk is manager of the mine.

Manhattan Mine.

The Manhattan consists of location K231, adjoining the Decca, and owned by the Manhattan Gold Mining Co. of Canada, Limited; head office at Montreal. The vein is one of the widest known in the protogine. A shaft has been sunk 100 feet and 40 feet of crosscutting done at the bottom, exposing 16 feet of quartz. Steam hoisting and drilling plants have been installed. The property was ex-

amined by John E. Hardman, M.E., of Montreal, during my visit, and work which has been suspending, pending the results of Mr. Hardman's investigation, will be resumed immediately. Mr. Frank Peterson is manager.

Alice A. Mine.

The Alice A. mine is reported to have been sold to an English company under an agreement to install a large mill of 100 or more stamps. At present sinking in a test shaft is in progress. A depth of 95 feet has been reached. At 100 feet crosscutting will be done in both directions, and sinking continued at the same time. A steam hoist and small compressor have been installed. A two-stamp Tremaine mill, still on the property, made some mill runs from test pits at various points, with apparently satisfactory results. Mr. T. D. Prideaux is manager, with a force of 14 or 16.

Gold Bug and Emma Abbott Locations.

The Gold Bug, P660, and Emma Abbott, K215, were both visited and examined. They adjoin the Alice A. on the west and east respectively, and contain the extension of the same body of ore. Small test pits have been made on veins on each property. Both properties are promising looking, especially the Gold Bug, which is full of small quartz stringers and should carry gold uniformly.

Foley Mine.

The Foley mine remains in the same condition as at the former report; it is continually stated that work will be resumed immediately.

Independence Mine.

The Independence mine, near Sturgeon Falls, has been closed down for some time, but it is expected that it will be opened again very soon.

On the whole, mining in the Lower Seine is in a very healthy condition. The people of Duluth and of the eastern cities are taking more interest in the district than ever. When the railway is completed there will doubtless be a great boom in that section.

NOTES ON WORKING MINES

By J. Watson Bain

DURING the summer of 1898 the writer was instructed by the Council of the School of Practical Science to carry on Summer Mining Schools at several points in Western Ontario, under an arrangement with the Bureau of Mines, and in addition to the regular work it was decided that a series of visits should be paid to the working mines in order that, wherever possible, addresses of an instructive nature should be delivered to the miners. In the performance of this work an opportunity of inspecting many of the mines was afforded, and the following notes are the results of these visits.

Visits to Mines in connection with Mining Classes work

Mr. James A. Bow, the Inspector of Mines, whom I accompanied on his first visit of inspection for 1898, describes minutely the condition of each mine and its adjuncts, and the observations which follow are intended to be complementary to these descriptions by dealing with the more general aspect of the work.

Silver Mountain Mines.

While at Port Arthur in May a visit was paid to two of the old silver mines, the East and West End Silver Mountain, which after a long period of idleness were being operated once more. At the West End 21 men were at work under Captain Tonkin and very encouraging results were being obtained. There are four shafts in all, but only in one, which had been pumped out to the 100-foot level, was there any active work in progress. The vein, which strikes 105° and dips at about 80°, is somewhat variable in width. At the working shaft, No. 2, a cross-section of five feet can be seen, while in a tunnel driven to crosscut the vein 850 feet to the east only three small lodes, 10″, 18″ and 22″, are to be seen. It is quite probable that the vein has split up into these several branches at some intermediate point, although this cannot be seen from the present workngs. Two small stringers, with a gangue chiefly of barite, meet the main vein on the north side at a small angle ; rich deposits of silver were found at the junction in each case. The vein filling consists of well crystallized calcite with green fluorite, yellowish barite and a little amethystine quartz, together with native silver, argentite, zincblende, galena and a little pyrite. The manner in which the argentite or sulphide of silver occurs is quite interesting. In several places along the north or hanging wall it had been deposited in the partings of the slates, and after knocking down a few loose fragments leaves of the mineral quite as thin as paper could be stripped from the flat surfaces of cleavage. The rich ore is carefully put aside in the mine and the contents of each bucket are subjected to a careful hand picking at the surface, while the poor ore is dumped on the stock pile to await treatment in the stamp mill.

The West End Mine.

At the East End mine the old workings are quite extensive, including a shaft 800 feet deep and a tunnel 1,800 feet long, but as work had just been commenced and there was still a great deal of water in the mine there was not much to be seen. The vein, which is continuous with the one at the West End, is much the same in appearance and general characteristics.

The East End Mine

No other properties in the district were in operation, so that we may pass on to Wabigoon where the next stop was made.

Western Gold Mines.

About a mile north of the town is the Northern Queen mine, with its curious ore, so heavily charged with sulphides of iron, as described in the Seventh Report of the Bureau. The shaft, said to be 50 feet deep, was full of water, so that it was impossible to determine whether the common report that sulphides were diminishing in quantity as the depth increased was true or not. However that may be the deposit is

At Wabigoon.

almost unique in western Ontario, and resembles somewhat closely the auriferous pyrites and pyrohotites of Rossland.

Circumstances prevented me from visiting any properties in the Manitou district, and all save one in the New Klondike region, one of the most recently discovered gold fields. This property, which is known as Tabor and Stevenson's claim, is situated near the falls of Long Lake river, SV258, and is interesting because of the occurrence of the ore as a series of lenses along the edge of a dike of felsite cutting chlorite schists. The quartz is white or slightly yellowish in color, and gives a very handsome ' tail " of gold in the pan, but from the surface indications and from what could be seen in the six feet of shaft which was not under water only a small amount of good ore could be obtained.

On Lake of the Woods Waters

Turning next to Lake of the Woods, work was progressing steadily at the Mikado with a staff of about 60 men. The main shaft, which is vertical, has struck the lode at a depth of 185 feet and crosscuts are driven every 60 feet to connect with the levels. A considerable body of felsite, said to run $40 to the ton, is found on the second level, and this was being opened np at the time of our visit. The mill is not equipped with any concentrating machinery, and the installation of a cyanide plant, which is being carried on at present, will add greatly to the efficiency of the plant.

At the Cornucopia and Ontario Limited everything was at a standstill, with shafts full of water, so that we pushed on to the Yum-Yum. Here one is struck with the large amount of prospecting work which has been done, and some of the veins, after stripping, look quite promising ; no work was in progress however.

Four miles to the west of Yum-Yum lies Cameron island, only some 200 yards across. On the north side, at the water's edge, can be seen exposed a dike of felsite which shows an interesting structure. A band of black felsite 18 or 20 inches in width is bedded between walls of the same rock, but red, or whitish green in color. The black material shows signs of slickensiding, and the whole occurrence would seem to indicate two separate generations of dike matter. The strike is almost north and south, and close to the centre of the island. The main shaft, 6 by 12 feet, increasing to 7 by 14 feet, had been sunk at a slight incline to a depth of 103 feet upon a somewhat wider section of the dike. The ore may be described as a felsite more or less intermixed with quartz, so that while some portions have the characteristic appearance of the latter mineral, others resemble the barren country rock very closely indeed. The whole veinstone is quite heavily charged with pyrites, which appears as strings of fine crystals along the seams in the ore. A lot of 200 tons is said to have yielded $12.40 per ton at the Keewatin reduction works, although picked quite indiscriminately—a result that should certainly encourage further exploitation.

Another locality which has been brought into notice of late is the Camp Bay district, on the east shore of Whitefish bay. Two miles south of Camp bay is the property of the Boulder Gold Mining Co., of which Mr. Gifford is manager. A shaft was being sunk here on an 11-foot vein, which could be traced for a considerable distance, and although the ore was admitted to be low grade an ample supply could be had at a small expense for mining if the same width were maintained to a fair depth. There is always a possibility that there may be a marked improvement as the workings are extended, but even apart from this hope it is probable from the present aspect that those mines which are working upon ore of fairly uniform value, even if small, will be the more successful in their enterprize.

At Camp Bay, three-quarters of a mile from the water's edge, is the Bully Boy mine, which was idle at the time of our visit. The ore is a series of lenses in a dike of quartz porphyry, which cuts dark green rocks of Keewatin age. The shaft, over 100 feet deep, was partly filled with water, and little could be seen.

A mile further inland from the Bully Boy is the camp of the Combine Gold Mining Co. Development work was being vigorously prosecuted at a number of points, and the outcroppings on various parts of the locations

had been carefully stripped. The most interesting deposit is that known as the Jumbo vein, about half a mile east of the camp. There, upon the top of a knoll, is exposed a large body of quartz four feet deep, resembling a true bed with slight dip. An open crosscut had been run into the mass, and it displayed a layer of quartz of the thickness just stated, resting upon the dark green country rock. A short distance away a shaft had been sunk to a depth of 21 feet with no sign of the ore body, so that at the time it was impossible to arrive at any reasonable conclusion as to the nature of this peculiar mass. Another vein 200 feet to the west is three feet wide, and dips 60° northeast; it has been opened up to a slight depth by a test pit, and gives good promise.

On our arrival at the Regina we found that the mill was being entirely reconstructed, and that no underground work was in progress at all. The shaft had reached a depth of 450 feet, and showed great improvement in the vein; a good deal of drifting had also been done and some stoping, in preparation for the start of the new plant. The old equipment, which consisted of ten stamps of 850 lb. each with two Perfection concentrators, has been replaced by seven Tremaine steam stamps and two 3-compartment jigs for concentrating, the tailings from which flow over gyrating amalgamated plates, and thence to waste. The concentrates are ground in Berdan pans, and pass to the cyanide tanks for leaching. The Blake crusher which was formerly used has also been replaced by a Gates gyratory rock breaker, which is said to be more satisfactory. The whole plant is a bold and radical change from the usual types of milling machinery, and the results of the experiment will be of much interest and value to all who are engaged in treating gold ores.

Three miles inland from the foot of Andrew bay lies the Stella property, under the management of Mr. Neil Campbell. There are three shafts at short distances from one another. The first and most easterly is sunk on a large fahlband, and was at the time full of water. The second was for the exploitation of a small but rich vein, and was also full of water. The third is the present working shaft, and had reached a depth of 80 feet. The vein outcrops on the face of a hill at this point, and a tunnel had been driven on the lode for a considerable distance, exposing a mixture of quartz with a varying proportion of country rock, the whole being said to carry gold. At the mouth of the tunnel the shaft had been sunk with a dip of 75° on a body of ore of the same nature as that in the tunnel, and had reached that stage when a steam hoist was necessary.

Our next visit was to the well-known Sultana, which from the water presents the appearance of a bustling village. The new mill is first-class in all its appointments, with an equipment of the most approved design, and the process of ore treatment has been rendered complete by the installation of the chlorination works.

In the Lower Seine Region.

Another of the important gold fields of western Ontario lies at the mouth of Seine River, which, before pouring its waters into Rainy lake, expands into the shallow basin known as Shoal lake.

On the western shore of the latter sheet of water is the Foley mine, the most fully developed property in the district. At the time of our visit no work was being carried on, although the plant was in first-class condition for an immediate commencement.

Three miles to the north lies the Ferguson, Lucky Coon and AD2 properties, all of which were idle.

The mine which is being most actively worked at present is the Randolph or Golden Star, half a mile north of the Ferguson. The mining is done on a dike of felsite which carries lenses of quartz of varying size and shape, and in August the shaft had attained a depth of 300 feet, with a good showing of quartz at the bottom. The dike may be traced somewhat indistinctly up the hill to the south for a considerable distance, while to the north it plunges into a small valley and is lost beneath the drift. Just a short distance to the south of the shaft is the northern edge of that huge eruptive boss of granite upon which are situated the Foley, Ferguson, Lucky Coon, etc., and it is quite possible that the felsite represents an offshoot

from the molten granite, although this could not be determined for want of time. The country rocks at and near the shaft are porphyrites. A considerable quantity of ore consisting of a mixture of quartz and felsite, the latter carrying it is said fair values, had accumulated on the dump to be transported by a tramway to the shore of Bad Vermilion lake for milling. At this point a bench had been prepared on the side of the hill for the foundations of the mill, which has since been erected and put into service with satisfactory results. The distribution of the quartz throughout the dike is exceedingly interesting. As has been said above, the lenticular form is the most prevalent, although some of the lenses, to judge from sections afforded by the shaft and levels, must be quite irregular. To illustrate : The ore body in the first level south is at the shaft two feet wide ; a few yards in, and the width increases to eight feet, which continues for a short distance and then splits into two divergent branches, six inches and 10 inches wide, which had not at that time been followed further. An encouraging feature of the deposit is the fact that with one exception the dike at all sections is of good width. It will probably continue also to great depths, and taking into consideration the felsite, which it may be possible to work as a low grade ore, the cost of further development should in a measure be met by the proceeds from the material excavated, even although the richer quartz may be entirely absent for a time.

Lying to the southwest of the Golden Star, at a distance of a mile and a half, is the Emperor, belonging to a Minneapolis company. A shaft was being sunk on two small veins and had reached a depth of 90 feet, showing a marked increase in the width of the lodes. From a level at the bottom of the shaft a crosscut was being driven to a cross vein which could be seen outcropping at some distance to the northwest. Operations were being vigorously carried on, and the company deserves credit for its enterprise.

Adjoining the Emperor to the south is the Decca, which was hardly as much developed as the former property. The shaft, which was being sunk as fast as possible, exposes a good vein, and the venture has good augury of success should the lode prove rich enough.

Both of these properties are situated in the so-called protogine granite, within a few minutes walk of the Ferguson, AD2 and Lucky Coon.

Some eight miles northwestward of Mine Centre is the Olive or Preston gold mine, which has earned a reputation as a producer of the precious metal. The lode is one of the few bedded veins of the district, and is enclosed in dark gray compact schist of Huronian age. The width varies somewhat, but to a depth of 200 feet would perhaps average five inches. The quartz however is rich, and the small Alaska two-stamp mill crushing 12 to 15 tons per six days of 10 hours manages to produce some very nice gold bricks. The ore is rather heavily charged with pyrites, and the concentrates are estimated at five per cent. and quite rich enough to form a valuable asset. For lack of ventilation only a little work was being carried on during our visit, and until the arrival of the compressor plant, which was on its way, not much could be done.

With this our series of visits terminated, as it was impossible for me to visit the mines of the Upper Seine region. Al-

An Encouraging general Outlook

though at a number of points one was disappointed by the abandonment of all work, in many places steady progress was being made, and the continual working of such mines as the Sultana, Regina, Mikado, Golden Star and Olive can hardly be construed otherwise than favorably. A number of prospects were being developed carefully in the different districts, and while the bustle created by the boom of 1897 was lacking, a feeling of determination to explore further had possession of many of the miners and owners to the great benefit of the industry at large. With two thoroughly equipped reduction works at Rat Portage, with cheap water carriage in most cases and low treatment charges, there seems to be no reason that custom work should not prevail on Lake of the Woods as it does in some of the Western States.

Geological Notes.

Half a mile south of the town of Wabigoon is the northern edge of a boss of intrusive granite which has not yet been noted on the maps. The mass has a northeasterly and southwesterly diameter of at least two miles, and is of unknown width. The northern contact with the Keewatin rocks of the neighborhood can be seen very well on the shore of a small bay not far from Wabigoon, and presents the same evidence of its intrusive nature as can be seen at other well known localities on Lake of the Woods and Seine river. A small island three-quarters of a mile south is composed entirely of this rock. The granite is somewhat coarse in texture, and is of reddish color. Under the microscope it is seen to consist of crushed quartz, badly weathered felspar and biotite, with numerous accessory crystals of sphene.

Intrusive Granite at Wabigoon

On location 200SV, three miles northwest of the town, there is an interesting contact, which is unfortunately covered by the drift. In approaching the location a series of massive greenstones of Keewatin age is passed over, and after a short traverse of muskeg an area of fine-grained, evenly laminated gray gneisses is entered on. Interbedded at intervals are beds of mica and tourmaline schist, with much the same texture and close foliation. These are probably members of the Couchiching series, and if so are not likely as far as can be judged at present to contain deposits of any great value.

Contact of Greenstones and Gneisses

At the Emperor mine, three miles north of Mine Centre, there occurs a system of dikes so curious in certain respects that it has been thought worthy of description. The first is a large body of quartz porphyry, averaging in width 25 feet, which crosses the protogine granite of the locality in an easterly and westerly direction. The dike matter is yellowish in color, with good sized phenocrysts of quartz. It can readily be distinguished from the other rocks of the neighborhood. Passing directly through this once molten mass, and a little to one side, is a second dike consisting of a dark brown rock which has been so badly weathered at the surface that nothing definite can be determined as to its characters. In it are embedded rounded and angular boulders of protogine granite of all sizes and shapes. By tracing the system to the east the younger of the two can be seen to quit in part its host and branch off into the granite, while the other portion continues to accompany the quartz porphyry. The curious feature of one dike occurring within the body of another is quite unusual, and would repay more careful study than would be given in the short time at my disposal. No occurrence of this nature has been recorded by Lawson in his observations on the post-archaean dikes of the locality.

A Dike within a Dike

SUMMER MINING CLASSES

Lectures to Prospectors

DURING the season of 1898 the Legislature's appropriation of $1000 for Summer Mining Classes was divided between the School of Practical Science, Toronto, and the School of Mining, Kingston, each school being authorized to select its own instructors for the work. The western portion of the Province was assigned to the Toronto School, which was represented by Mr. J. Watson Bain, one of the teaching staff. The eastern portion was assigned to the Kingston School, which was represented by two of its teachers, Dr. W. L. Goodwin and Prof. William Nicol. An account of the work done by the instructors is here presented.

Instructors taken from the Toronto and Kingston Schools.

Mr. Bain's Report.

I have the honor to present herewith my report on the Summer Mining Schools, which were under your instructions held by me in Western Ontario during the past season.

The programme, which was outlined in Toronto, provided for a course of instruction lasting for two weeks in each of the following places, viz. : Port Arthur, Wabigoon, Rat Portage and Mine Centre ; while at each of the principal mines addresses were to be delivered to the miners, with the object of increasing their knowledge of local geology and mineralogy, and thus assisting them in their work.

Programme of the Work.

The first class was held in Port Arthur, commencing on the 5th of May, and 12 students were enrolled. During the first week the attendance was good, but when the ice on the inland waters broke up on the 10th of May nearly all the members were forced by their engagements to leave for the field, and in view of the small number who remained it did not seem advisable to continue the classes, so that the school was closed on the 11th of May. At the next station, Wabigoon, the classes were started on the 25th of May and closed on the 7th of June, with a good general attendance. The total number of students was 32. In Rat Portage the session lasted from the 14th to the 29th of June, with 15 students enrolled, and in Mine Centre the last class for the season was held from the 20th of July to the 3rd of August, with a total of 20 students. The general attendance varied considerably, but whatever the size of the class a lively interest was shown in the work which was being carried on. At each station some of the men attended regularly all the sessions, and these students made very substantial progress, becoming expert in the practical work and adding to their knowledge of the subjects discussed in the lectures. Others, who were less regular, also benefited by the instruction, and it is hoped laid the foundation for a more exact and thorough training.

Port Arthur, Wabigoon, Rat Portage and Mine Centre.

Wabigoon, Rat Portage and Mine Centre.

At the close of the work in Port Arthur a trip was made to two of the old silver mines, the East and West End Silver Mountain, at which work had commenced once more. On the East End property there were only 8 men and no stop was made, but at the West End 21 men were employed. Capt. Tonkin, who was in charge, informed me that nearly all were foreigners, to whom the English language was quite unfamiliar, so that no address was delivered.

Visits of Instruction to the Mines.

From Rat Portage, in company with Mr. J. A. Bow, Inspector of Mines, a series of visits was made to the working mines on Lake of the Woods. At the Mikado a large number of men were employed, and a lecture on the local geology of the district, with a short account of the chief minerals occurring in it, was delivered to an audience consisting of almost the entire force. The Cornucopia, Ontario Limited, and Yum-Yum mines were

lying idle, and at Cameron Island mine the number of men was so small that only a short visit of inspection was paid.

No underground work was being carried on at the Regina, although a number of men were engaged in building the new mill and setting up the machinery; but as these were carpenters and engineers, who would not be interested in the subjects under consideration, it was not thought advisable to deliver any lectures. At the Stella all the miners were away in town for a holiday, and the next visit was to the Sultana. Here Mr. Hunter, the manager, informed me that almost all the miners were Swedes, with a very limited knowledge of English, and on that account no addresses were given there.

In the Seine River district no work was going on at the Foley, Lucky Coon, Ferguson or AD2, but a large force was employed at the Golden Star, and a lecture was delivered one afternoon to all who cared to attend. The audience was large, and an address similar to that given at the Mikado was listened to with appreciable interest. At the Emperor mine another lecture was delivered, which was also well attended and well received.

Attendance at the Classes

The attendance at the classes is of course influenced largely by the state of the mining industry, and this was noticeable during the past summer. In 1897 there was abroad a feeling of excitement over the numeral resources of the country, and many persons were anxious to become to some extent familiar with mineralogy and geology. In addition, the number of prospectors was large, so that from these two sources very good classes could be formed. In the summer of 1898 a reaction had set in, and although much steady and useful work was being carried on the excite- had very largely subsided and the attendance at the schools fell off in consequence. If report be true, the number of prospectors in the field during last summer had diminished to one-third of what it had been in the previous year, while many who had been exploring in 1897 were hard at work developing and preparing their properties for sale.

The course of instruction was intended to be as helpful and interesting to prospectors and miners as possible, and on that account the more scientific side of the work was entirely omitted. In illustration, it may not be out of place to give the following syllabus of the course:

Course of Instruction.

Geology.

In geology, the changes that are now taking place at the surface of the earth were described at some length, and it was pointed out that a careful study of the present conditions was the key in a great measure to the records of past action as they have been preserved in the rocks. From this standpoint the formation and significance of different rocks were described and the means of determining their age were discussed, while the importance of these tests in identifying in new districts those rocks which had been proven metalliferous in older and better known regions was pointed out. In dynamical geology, the folding of rocks and the production of faults and fissures, with their significance, were treated in detail, while the action of volcanoes, important as that has been in western Ontario, was described somewhat thoroughly. When the elementary work had received attention, the local geology was developed, and the relations of the rocks in the vicinity were described. As might be expected, this particular branch of the work attracted more attention than any of the others, and I was assured upon several occasions that the field work could afterwards be prosecuted with much clearer ideas as to the relations of the different rocks, an end which was well worthy of the time spent in reaching it.

Lithology.

Since a prospector spends the greater part of his time among the rocks, the subject of lithology received careful attention. In the lectures the origin and mineralogical composition of rocks were described, and afterwards field determination was practised upon specimens gathered from the immediate vicinity as far as possible.

Mineralogy.

In mineralogy, the value of the physical properties, color, streak, hardness, etc., for the rapid determination of minerals was demonstrated by practice with specimens, and lectures were given describing the common minerals of the country, with

their economic value and identification. Each student was supplied with blowpipe, forceps, platinum wire, etc., and was taught to use them for the determination of minerals. After a fair degree of proficiency had been attained, minerals unknown to the student were given for examination, and were in most cases named correctly.

Assays for Gold and Silver.

The field assays for gold and silver ores by which the values may be ascertained in the field with simple apparatus were shown in practice, and a number of samples belonging to members of the classes were tested in this manner.

The Mineral Collections

The mineral collections which had been provided by the Bureau of Mines at Port Arthur and Rat Portage were of great service, and enabled the students to become familiar with more minerals than could be carried about in a travelling collection. Any person who is interested has access at all times to the collections to study the specimens, or compare them with others which he is anxious to determine. The benefits thus conferred will be apparent to everyone, and it is undoubtedly a step which is in the best interests of the mining industry.

For great courtesy in providing accommodation I have to thank Mr. D. F. Burke of Port Arthur, the town of Wabigoon, the town council of Rat Portage, and L. Hamel & Co. of Mine Centre; and my acknowledgments are also due to many gentlemen who assisted me in various ways. J. W. B.

Dr. Goodwin's Report.

I beg to submit the following report of mining classes conducted during June and July by myself and Professor Nicol:

The places selected for holding the classes were Parry Sound and Mattawa. I left Kingston on June 14th and went to Ottawa to take the Ottawa and Parry Sound Railway for the west. On the way from Ottawa to Parry Sound I took two days to go west to Mattawa and arrange for a class there. The mayor and council of Mattawa received the suggestion favorably, and it was decided to begin work there early in July.

Proceeding to Parry Sound, I was there joined by Professor Nicol. We were given the fire hall in which to hold classes, and tables and seats were provided by the town council. Considerable prospecting is being done in the neighborhood of Parry Sound, and discoveries of iron and copper ore have been made. Garnets are very abundant, and might be mined as an abrasive. The prospectors were eager for instruction in mineralogy and geology, and some came from long distances to attend the class The total number of students who attended the class was fifty-two, and the average daily attendance was about twenty—very good considering the long distances and the difficulty of arranging a time table to suit the circumstances of all. The classes opened on June 20th and closed on July 2nd. A number of prospects and test pits were visited at the request of owners and others interested. Bornite, chalcocite and chalcopyrite are often found, but so far not in paying quantities. At the Wilcox prospect zinc-blende and pyrrhotite were noticed in considerable quantities; also a little molybdenite. Those students of the class who were able to accompany us on these excursions had the advantage of examining the minerals and rocks in situ. Two classes were held each day, one at 9 a.m. and one at 6.30 p.m., each class lasting for about two hours. The greater part of the time was spent in the examination of mineral specimens from our collection, as well as large numbers brought in by members of the class, some of whom became quite expert in identifying minerals by the aid of a simple table printed especially for the work of these classes.

At Parry Sound.

At Mattawa

We left Parry Sound on July 2nd and distributed corundum specimens at Kearney, Rainy Lake, Canoe Lake, Cache Lake, Whitney, Barry's Bay and Killaloe, points on the line of the Ottawa and Arnprior Railway. Reaching Mattawa on July 3rd we began classes there the next day. The council had provided excellent accommodation in the town hall, and the success of the classes there, as in Parry Sound, was due largely to the energetic manner in which the subject was taken up by the mayor and council, and by citizens interested in minerals and mining. The opening of the

classes had been well advertised, and they were begun with a large number in attendance. The total number who did systematic work was 73, and the average attendance was about 45. Two classes were held each day, one from 9 a.m. to 11.30 a.m., and a second from 6 p.m. until dark. The students brought in large numbers of specimens for examination, and many specimens were determined at odd times, as those who had them were met during the day. In addition to those counted as students, there were many visitors who came in to examine the mineral and rock specimens and to ask for information. Several experienced prospectors have been at work up the Ottawa and around lake Temiscamingue. The Huronian areas there are receiving attention. Good specimens of magnetite and limonite, said to have been obtained within a few miles of Mattawa, were brought in by members of the class. The instruction was confined mostly to identification of minerals and rocks and to elementary geology ; but some time was given to methods of sampling and to the relations of geology to prospecting. Many members of the class identified upwards of 50 specimens of minerals and rocks. The classes closed on July 11th.

Practical results.

There can be no doubt that these outside mining classes are serving at least two purposes—first, to call attention to minerals in general and to valuable minerals in particular ; and secondly, to give professional and occasional prospectors correct ideas as to how to find out the value of a discovery. The prospector has often a very limited knowledge of minerals, and may miss valuable discoveries which even a small extension of his acquaintance with mineral species would enable him to make. He also has sometimes quite incorrect ideas about sampling for assay. For this reason it is well to give special attention to this subject We also found it useful to carry an assay outfit with us, not for the purpose of teaching assaying, but to illustrate the nature of the process of assaying for gold and silver. This serves to warn prospectors against incompetent assayers.

Thanks are due to the many citizens of Parry Sound and Mattawa who assisted to make our work pleasant, and to the Canada Atlantic and Canadian Pacific Railways which gave free transportation for our heavy luggage.

W. L. G.

PROVINCIAL ASSAY OFFICE

By J. Walter Wells

I HAVE the honor to present the first annual report of the Provincial Assay Office, which was opened for public assay and analytical work on July 3, 1898. The report includes the operations of the office up to December 31, 1898.

The Record for Six Months.

Organizing the Office.

Instructions were given me by the Director of the Bureau of Mines on May 29 to proceed to Belleville and attend a meeting of the City Council when the agreement between the Bureau and the Council was made. The latter leased the present quarters of the Laboratory for a period of one year at a rental of $200 free from taxes. Three days were spent in Montreal personally selecting apparatus and supplies. The occupant of the two rooms in the Falkener block provided by the Council moved out on June 10, and July 3 the laboratory work was started, the intervening time being spent in cleaning the rooms, setting up furnaces and apparatus and directing the plumbing and carpentry work.

Advertisements were inserted in the local newspapers and the following circular was sent out to the Crown Lands agents and to the various mining and prospecting centres :

PROVINCIAL ASSAY OFFICE.

The Assay Office and Laboratory equipped at Belleville under direction of the Bureau of Mines is prepared to assay and analyze ores at the following rates

Assay in duplicate for	1 sample	3 to 5 samples at one time, each.	6 or more samples at one time, each
Gold	$1 00	$0 90	$0 75
Silver	1 00	0 90	0 75
Gold and Silver	1 25	1 00	0 90
Copper	1 25	1 00	0 90
Arsenic	1 25	1 00	0 90
Nickel	3 00	2 40	2 00
Lead	1 25	1 00	0 90
Iron Ores.			
Metallic Iron	0 50	0 40	0 35
Silica	0 75	0 60	0 45
Sulphur	1 00	0 90	0 75
Phosphorus	1 50	1 20	0 90
Titanium	1 50	1 20	0 90
Manganese	2 50	2 00	1 80
Corundum			
Alumina	2 00	1 80	1 50
Silica	0 75	0 60	0 45
Iron	0 50	0 40	0 35

Analyses of Limestones, Marls, Clays, Peat and Economic Minerals at corresponding rates.

Gold ores tested as to free-milling qualities by Amalgamation Assay

DIRECTIONS for proper Selection of Sample If the commercial value of a deposit is desired, an average sample for assay may be taken thus Detach a small piece (½ to ¼ lb) every 10 or 12 inches across the whole width of the deposit Repeat this operation every 8 or 10 yards, going the whole length of the deposit. The total amount of ore collected represents an average sample. If the deposit is opened up, samples from each shaft and level taken in a similar way must be included with surface samples. Amount of ore for average sample, 5 to 40 lb. Deposits of variable character (e.g gold ores) require more than those of uniform character (e g iron ores.)

DIRECTIONS for Quartering Down—Large quantities of ore for assaying may be reduced by "quartering down" thus: Crush the whole amount to size of a walnut make into a round heap, mix thoroughly and divide into four equal parts Select one quarter, crush to size of a bean, mix thoroughly and quarter as before. Proceed in the same manner until the quantity is reduced to 1 or 2 lb weight

DIRECTIONS for sending Samples to be Assayed—Crushed samples representing the average of large quantities, or samples less than 5 lb. in weight, may be sent by mail as 5th class matter (1c. per oz., limit weight 5 lb) or per parcel post (1c. per 4 oz , limit weight 24 oz.) Place in a canvas bag, tie securely, and address to the undersigned. Write your own name and address plainly on the tag and send instructions with money in payment of fees in a separate letter When more than one sample is sent at one time, each sample must be distinctly marked or numbered, so that they may be identified by instructions in letter.

TERMS—Money in payment for assays and analyses must invariably accompany ore. Assays and analyses are confirmed in each case by a check or duplicate and guaranteed correct. The pulp of each sample is held for future reference

J WALTER WELLS, B Sc ,
Assayer to the Bureau of Mines,
Belleville, Ontario

Operations of the Year.

Shortly after the announcement of the opening of the Laboratory by the Bureau, samples for assay were sent in from various points. The receipt of samples has steadily increased in number up to the time of writing. The first certificate was issued on July 5, and to 31 December 239 samples were received for assay or analysis. Of this number 41 were done for the Bureau of Mines, on which no fees were collected.

The total number of assays made was 227, and the total number of analyses 116, being in all 343 tests or determinations on the 239 samples.

The fees charged by the office for assays and analyses are nominal. They are based on the cost of the materials—chemicals, fuel, etc.—used in each operation. The fees for gold, arsenic and iron ores are relatively lower than for others, as most of the prospecting and development work is done on these ores. As may be seen in the circular, a liberal discount is allowed on a number of samples sent in at one time. Up to 31 December the fees collected by the office aggregated $241.30. The cash receipts were forwarded to the Bureau of Mines at the end of each month as follows :

The Scale of Fees.

July	$17 25
August	30 75
September	57 25
October	66 30
November	36 15
December	43 60
Total	$241 30

Some difficulty was experienced in collecting fees, and in several instances samples were treated and certificates not issued as no fees were received.

Numerous samples were received for identification. In each case a full description of the rock or mineral as determined by field tests was given, accompanied by information as to uses, market value, probable value of sample, etc. No fee is charged for this class of work, although in many cases it involves the getting of the mineral in solution and applying wet qualitative separation tests.[1] This work often saves an assay or analysis, and is greatly appreciated by the public. No record was kept of samples received and reported on in this way until November 6. From that date to the end of the year forty-five samples were reported on, either personally or by letter. In each case, when necessary, full information was given as to commercial uses, market value, etc.

Samples for Identification

Two trips were made to the back country to become better acquainted with the district. One of these was to Madoc and the surrounding country, where the various deposits were visited as far north as the Craig gold mine in Tudor township. The other was to the Coe Hill iron ore mines and the adjacent deposits of iron ore. Samples from each of the deposits visited were collected and placed on exhibit. I am often obliged to answer enquiries regarding the minerals in Eastern Ontario, and the most satisfactory method of obtaining reliable information is to visit the deposits personally.

Trips to the Mining Centres

[1] A scale of fees for this class of work has been adopted for 1899.

Equipment of the Laboratory.

The Laboratory is at present located on the ground floor of two rooms. The equipment is adapted to the needs of a Laboratory prepared for assay work on gold, silver, copper, lead and nickel ores ; also for the quantitative analysis of common economic minerals and ores, such as those of iron, corundum, nickel, zinc, lead, peat and coal. The assay part of the Laboratory has a first-class modern equipment. For those assays requiring fluxing down or fusion a complete set of gas furnaces, consisting of roasting, crucible fusion, scarification and cupellation furnaces is used, together with a universal Hoskins' muffle furnace heated by gasoline under pressure. For testing gold ores as to free-milling qualities, a laboratory arrastra together with amalgamation pans is used with good results. Copper and nickel estimations are done by both fire and electrolytic methods, the metal in the ore being deposited in the latter method on platinum cylinders by an electric current from a set of gravity cells. In the fire assay the system of breaking crucibles, rather than pouring and using again, is employed. The ordinary requisites, such as pulp balances, ore scales, fluxes of various kinds, reducing agents etc. are in use.

Equipment for Assaying Work.

The ore samples received for treatment are prepared by crushing in a small hand crusher and pulverized from 80 to 100 mesh in a mortar. With regard to the sampling down of large quantities of ore sent in for treatment, the commonly approved methods are adopted. All assays and analyses are done

in duplicate, the results being checked off so that errors can be reduced to a minimum. This method can not be adopted however unless a sufficiently large quantity of ore is received. The samples are in each case, both the rough and the pulp, retained for future reference. The Laboratory is prepared to send out the returns on samples received for gold, silver and copper assays the same day that the samples are delivered providing there is no rush. Under present circumstances the Laboratory cannot handle more than a limited number of samples for gold and silver assay in duplicate per day. A fine Becker assay bead balance in use allows the weighing of gold residues down to 20c. per ton in gold.

Equipment for Analytical Work.

The analytical part of the Laboratory is not altogether satisfactory as regards location and equipment. Since expenditure of capital often depends on the results of an analysis of ores, a first-class equipment in proper quarters is a necessity. In fitting up the Laboratory it was not expected that many samples for quantitative analysis would be received at first, but the record for the past six months shows considerable work done in this line and justifies the fitting up of this part of the Laboratory in a more elaborate manner. At present analyses of ores are done in the front room, which is also used as an office and contains three cabinets for the exhibit of mineral specimens. The public has free access to this room, which in some measure interferes with careful analytical work.

As regards methods used, it may be said that none but the well-tried ones are pursued. The ores are prepared by crushing, pulverizing and in most cases reducing to an impalpable powder in agate mortars before treatment with acids or fluxes necessary in making the ore pass into solution. For the latter process, a fume cupboard having burners, baths, etc. is used. This is connected with the outside air by a horizontal galvanized iron pipe, at the end of which is an exhaust fan run by a 2-inch water motor drawing the fumes to the outside air. This is not satisfactory, as a fume cupboard properly constructed should have a strong direct vertical current of air, preferably that of a large chimney flue. There are three working tables. One is for volumetric estimations of iron, zinc, etc. supplied with standardized solutions. Another is for general purposes, being supplied with water taps, sink, filter pump, steam bath connected to exhaust fan, shelves for solutions and cupboards underneath for various apparatus. The third is for ignition of precipitates and fusion of ores, being supplied with a bath, platinum crucibles, blast lamp, etc. Distilled water, used almost exclusively, is secured by an automatic Jewell still heated by gas. A Becker analytical balance reading to one-tenth milligram is used in weighing precipitates. The pulp balance, assay bead balance and analytical balance, each with a set of weights, are at present placed in a vault at the back of the suite of rooms. This is very damp in winter, but is otherwise satisfactory. The following forms of certificates are used in sending out reports on samples. They seem to answer the purpose fairly well, being convenient to carry in the pocket and for reference.

Forms of Certificates.

No. Made for Date

Sample Marked

Assayed in Duplicate for

Laboratory of the Assayer to the Bureau of Mines, Belleville, Ontario. J. WALTER WELLS, B. Sc., Official Assayer

No.	Gold. oz. per ton.	Value per ton of ore.	Silver oz. per ton	Value per ton of ore.

.....Assayer.

No. Date Sample Marked

Analyzed in Duplicate for

Laboratory of the Assayer to the Bureau of Mines, Belleville, Ontario. J. WALTER WELLS, B. Sc., Official Assayer.

No.	Metallic Iron. per cent.	Silica per cent	Sulphur per cent.	Phosphorus. per cent.

Analyses made for .....

..... Chemist.

State Assay Offices Elsewhere.

Several of the mining States of America, notably Colorado, have at some period in their history maintained State assay offices.

The general practice has been to maintain such an office for a more or less indefinite time during the prospecting and developing stages of the mineral industry. This has been done by the State Governments as a direct aid in stimulating the industry. In almost every instance the action has been received with favor by the prospectors, mineral property holders and mining men in general who require the assaying and analyses of ores. Where the mining industry is best developed, the State aid seems to be the least, the necessary assay or analytical work being done more by commercial laboratories in proximity to the mining centres. States having a Bureau of Mines as a sub-department of the Government invariably maintain an assay laboratory in connection with the department, which in several instances are located in the mining districts.

Practice in the Western States.

Many of the States maintain a Geological Survey staff in connection with the State University or School of Mines, and all of these institutions have testing laboratories—assay, analytical and metallurgical—some with elaborate and expensive equipments. The State of Colorado, the principal mining State in the Union, has for many years conducted a State assay office and a Mining Bureau at Denver, where the economic minerals of that district have been elaborately advertised by means of exhibits, lectures, literature, etc. A considerable amount of money seems to have been spent by the State in this way. The results have amply justified the outlay, as Colorado has steadily advanced as regards production of metals, such as gold, silver and lead.

The Province of British Columbia has maintained a Government assay office for the past twenty years. There seems to be no doubt that it has proved a stimulant to the mineral industry in that Province by giving to prospectors and mining men reliable returns upon which they might invite or safely invest capital. The British Columbia Assay Office is at present located in a building constructed for the purpose, and the equipment is to be elaborate.

There seems to be a movement on foot at present in that Province to prevent the Government Laboratory from entering into competition with private laboratories. The proposal does not seek to abolish the office entirely, but to limit its function to that of acting as an umpire assayer; that is, in case of dispute between parties handling ore the certificate issued by the Government Laboratory on the value of the ore in question is to be accepted as final. It is suggested by the petitioners to the Government in regard to this matter that the fees charged for the latter work should be double the ordinary commercial rates, thus compensating for the limited function of the Laboratory.

In Hamburg, Germany, there is a Government assay office which has been operating since 1895 with remarkable success.

With regard to the fees charged for assays and analyses, various practices seem to be followed. The Government assay office of British Columbia charges the usual rates, and a comparison of the fees as copied from the list of official charges with the fees charged by the Ontario Laboratory may be of interest.

Schemes of Fees in Operation.

Minerals.	B. C office.	Ontario office.
Gold and Silver	$1 50	$1 25
Gold, Silver, Copper together	3 00	2 50
Copper	2 00	1 25
Lead	1 50	1 25
Iron	3 00	0 50
Nickel, quantitative assay	10 00	3 00
Zinc	5 00	2 00

The quantitative analysis of ore in British Columbia is $25 to $50 according to constituents, while in Ontario it is $5 to $10.

Some of the States in the United States have followed the practice of doing the work for the public free of charge, lodging discretionary powers with the assayer as to what samples are worth testing. Other States, on the contrary, have charged nominal fees to prevent the testing of worthless samples which might otherwise be sent in for examination.

In Ontario as in other countries a great deal of unreliable assay and analytical work has been done which has encouraged in some cases the outlay of capital without reason. Work done by the Government tends to pre-

vent this, and the results are guaranteed so far as the samples are concerned. A number of such unreliable reports, more especially in gold and silver assays, have come under my observation during the last year and it has been shown that those who have paid for such assays have been simply humbugged.

State of the Mineral Industry in Eastern Ontario.

The outlook for the mineral industry in eastern Ontario is encouraging, as there seems to be no doubt as to the existence of workable deposits of various economic minerals. More capital is being spent at present in actual development than ever before in the history of the district, and the mines treating ore are getting good results. The ores showing the most activity are those of gold, iron, arsenic and lead.

Evidences of a substantial Industry

As for gold, three mines are raising ore for treatment. At the Belmont mine, owned and worked by the Cordova Exploration Co., of London, England, a low-grade quartz carrying a small percentage of sulphurets is successfully treated by a well-managed ten-stamp mill made by the W. B. Hamilton Co. of Peterboro. At the Deloro mine, near Marmora, owned by the Canadian Gold Fields Syndicate Co., of London, England, an arsenical ore is treated by a modern Fraser and Chalmers ten-stamp mill, the concentrates being treated by the Sulman bromo-cyanide bleaching process with excellent results. At the Boerth mine, near Ardoch, a Detroit company is working a free milling quartz, apparently high grade, which will shortly be treated by amalgamation. Several other properties are being developed with every promise of becoming mines, notably the Diamond at Queensboro, an arsenical ore body carrying high values in gold.

Gold.

As for white arsenic, small quantities of fair quality have been made in trial furnaces at the Toronto Smelting Co 's smelting works at Madoc ; also by Mr. Joseph James at Actinolite. This product found a ready sale in the New York markets at a fair price. There seems to be no reason why capital should not find a safe investment in the manufacture of white arsenic and its products, as fuel, labor, and high grade arsenical ore can be got cheaply in North Hastings. White arsenic is rising in value owing to apparently diminishing ore supplies in Germany and England, which now control the market, combined with increasing uses of the article and the various products made from it in the arts. White arsenic is quoted in the New York markets at an average price of $80 per ton. The process of extracting it from the North Hastings arsenical ores is comparatively simple and should yield a fair profit on money invested.

Arsenic

Iron ores (hematite) have been shipped steadily from two deposits near Madoc, and from Calabogie station on the K. and P. Railway to the Hamilton blast furnace. A magnetic iron ore has also been worked near Malone on the C. O. R. ; also at Bedford on the K. and P. Railway. The Deseronto Iron Co., making charcoal pig iron, is also in the market for Ontario iron ores of Bessemer quality.

Iron Ores

The large number of iron ores received for analyses at this Laboratory indicates a considerable activity in this district Judging from the samples analyzed and from personal inspection, there seems to be numerous deposits of magnetite of more or less extent which may be classed as lean ores. Some of these can no doubt be made into Bessemer grade by magnetic concentration. Similar deposits of lean magnetic iron ores are being successfully worked in New Jersey and the Southern States by a system of magnetic concentration Much of the Swedish charcoal iron which commands such a high price in the markets is made from more or less low grade magnetic iron ores. With an active demand for iron ores in Ontario, there seems to be no reason why these low grade ores cannot be placed on the market at a profit.

Lead ore (galena) is being shipped to Belgium from a deposit near Bannockburn, Hastings county. It is reported that a lead smelter is to be erected at Madoc.

Galena

A few shipments of felspar from Bird's Creek, in Hastings, have been sent to the English potteries, which pay about $8 per ton delivered at Liverpool. There are several

large bodies of almost pure orthoclase felspar in this county, which are probably of commercial value as fluxes in the manufacture of pottery ware of various grades.

Felspar.

The corundum deposits in North Hastings and Renfrew show no active development as yet, but a few good properties owned by private parties have changed hands.

Corundum.

The limestone quarries at Crookston station and at Point Ann, near Belleville, have been worked steadily for the past six months with a large staff of men at both quarries. The Inspector's report will no doubt give a description of the operations.

Limestone.

A small shipment of sodalite from the nepheline syenite areas in Dungannon township was made to a Philadelphia jewellery firm, to be made up into ornaments.

Sodalite

Future of the Assay Office.

The Laboratory needs more room so that the analytical part may be put in a more satisfactory condition. A separate room is also needed for the display of mineral samples which are sent in to be placed on exhibit to such an extent that it is becoming impossible to make room for them under present conditions. As under the agreement with the Bureau of Mines the Council is to provide suitable quarters for the use of the office, it is earnestly advised that as soon as possible the Laboratory be given the use of a building with the requisite amount of room suitable to the present needs of the office.[2] No attempt has been made to make a systematic collection of the ores and minerals of this district, as my instructions are to attend to Laboratory work for the present.

Needs of the Laboratory.

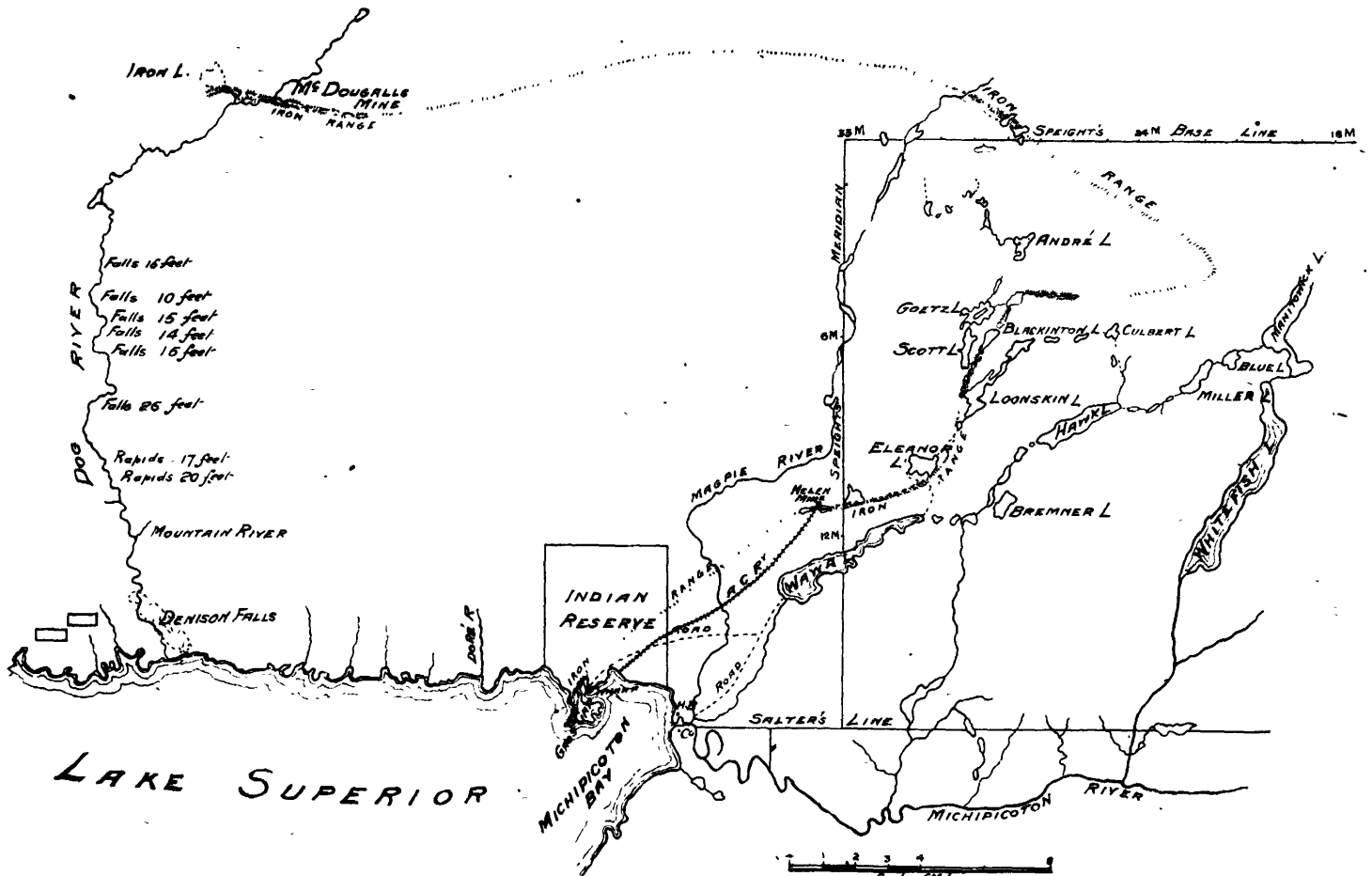
It is the desire of many business men in Belleville and the mining district in North Hastings that a Bureau of Information be maintained in connection with the Laboratory for an exhibition of the economic minerals of eastern Ontario as well as assisting in every way possible to advertise the district, so that legitimate capital may be induced to operate. Such a function will no doubt fill a public need in this district, but it will require an addition to the office staff. Taking the action of the State of Colorado as an example with regard to this matter, the scheme properly carried out would probably meet with considerable success.

As may be seen by the record of work done by the Laboratory for the past six months, the location of the office seems to be central and convenient to the mining public. Belleville has good communications with all parts of eastern Ontario.

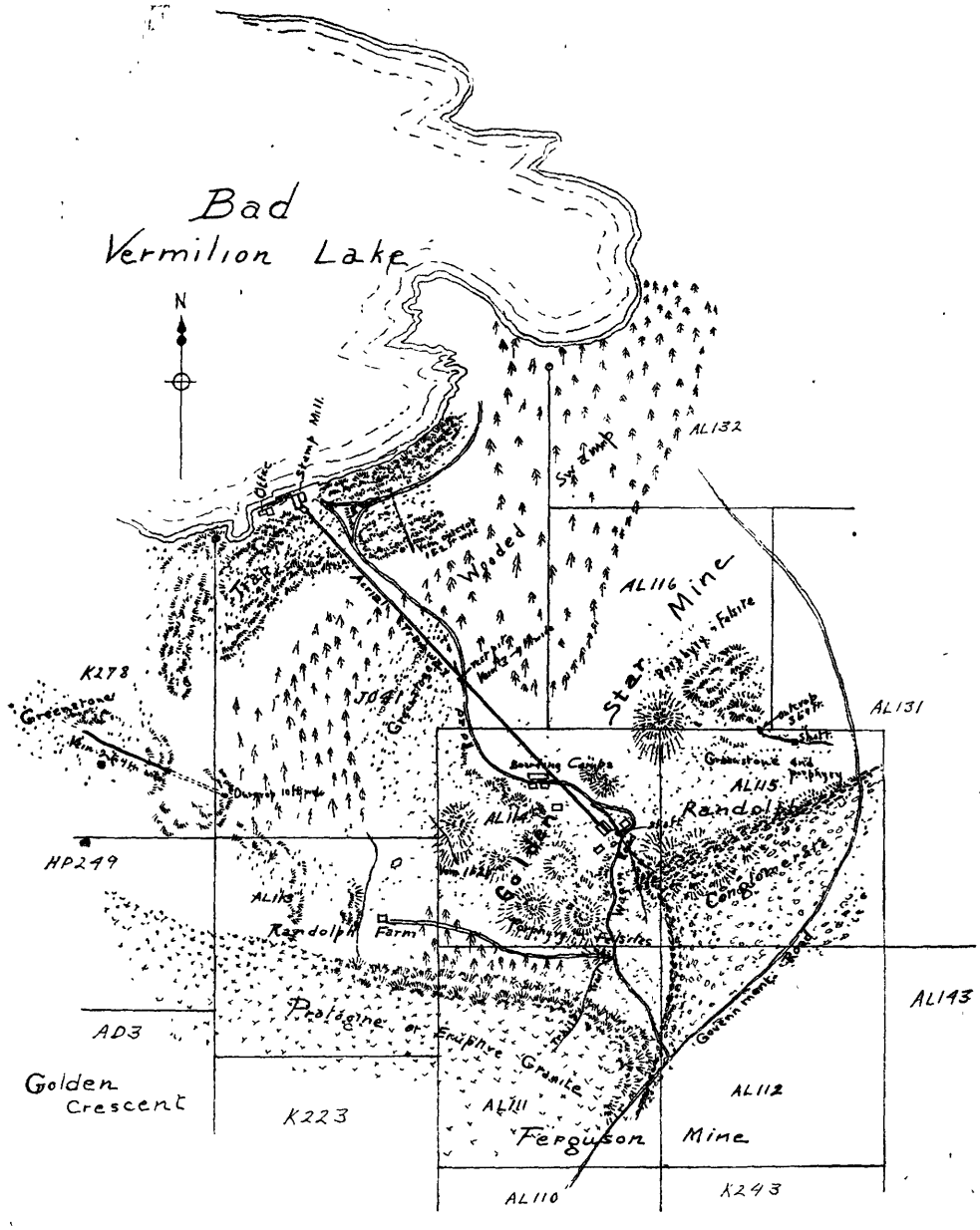
The letter book shows that 287 letters were sent out exclusive of certificates, circulars and reports on specimens for identification. For the first two months a large number of circulars were sent out by mail to the various centres and to mining men. The letter file shows that 190 letters were received at the office. For the first two months a large number of visitors called at the office, more through curiosity than on business. This was a considerable hindrance to the Laboratory work, but my instructions are to receive all visitors with courtesy.

Correspondence and Visitors

[2] Suitable quarters in another building have been provided by the Council during the present year (1899), and the office is now well housed.



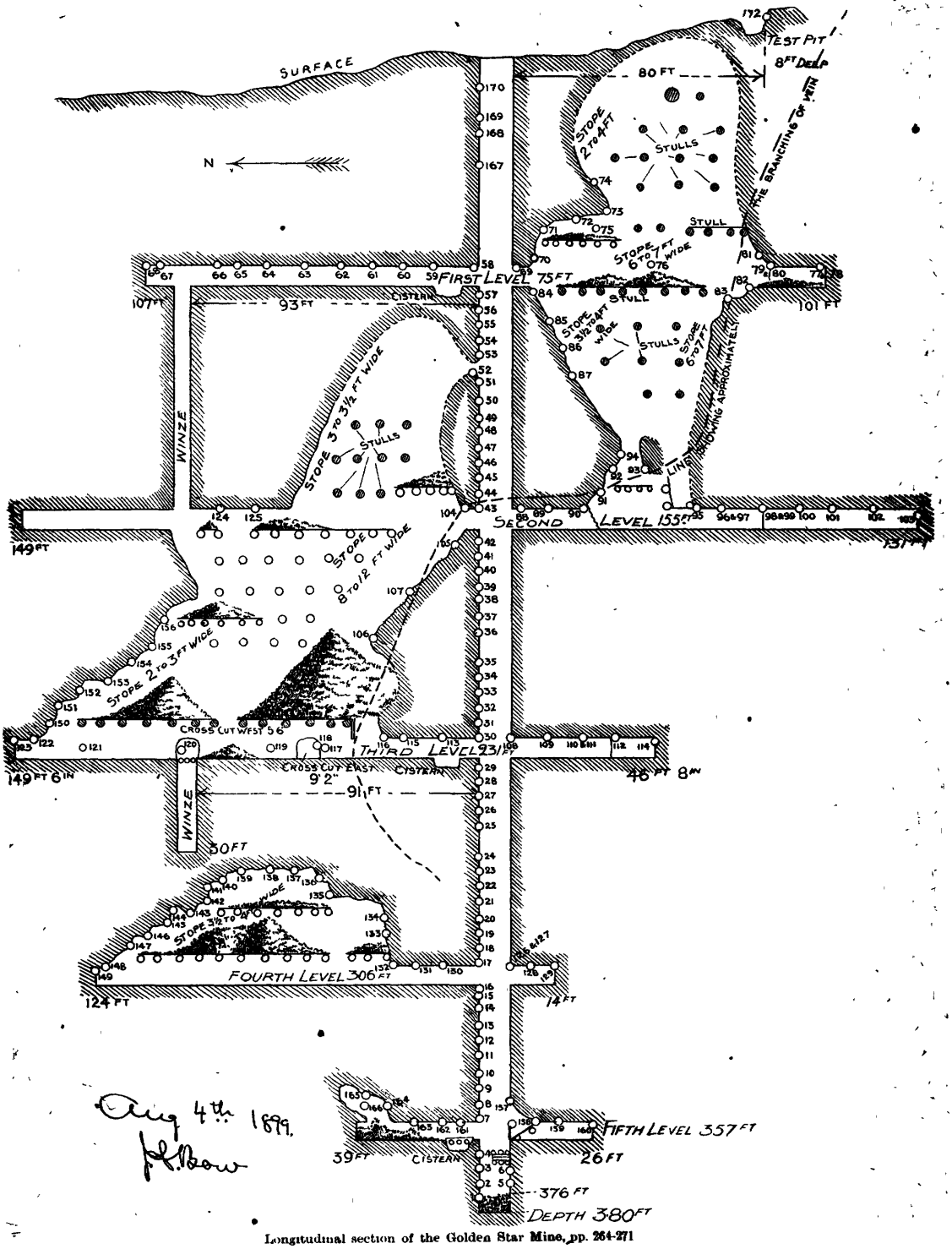
Map of the Michipicoten Iron Region. By A. P Coleman and A. B Willmott, 1899 Scale 4 miles to an inch—pp. 254-255.



Plan of Golden Star, J041
and adjoining Locations.
Scale—10 chains = 1 in.

J. H. Bow

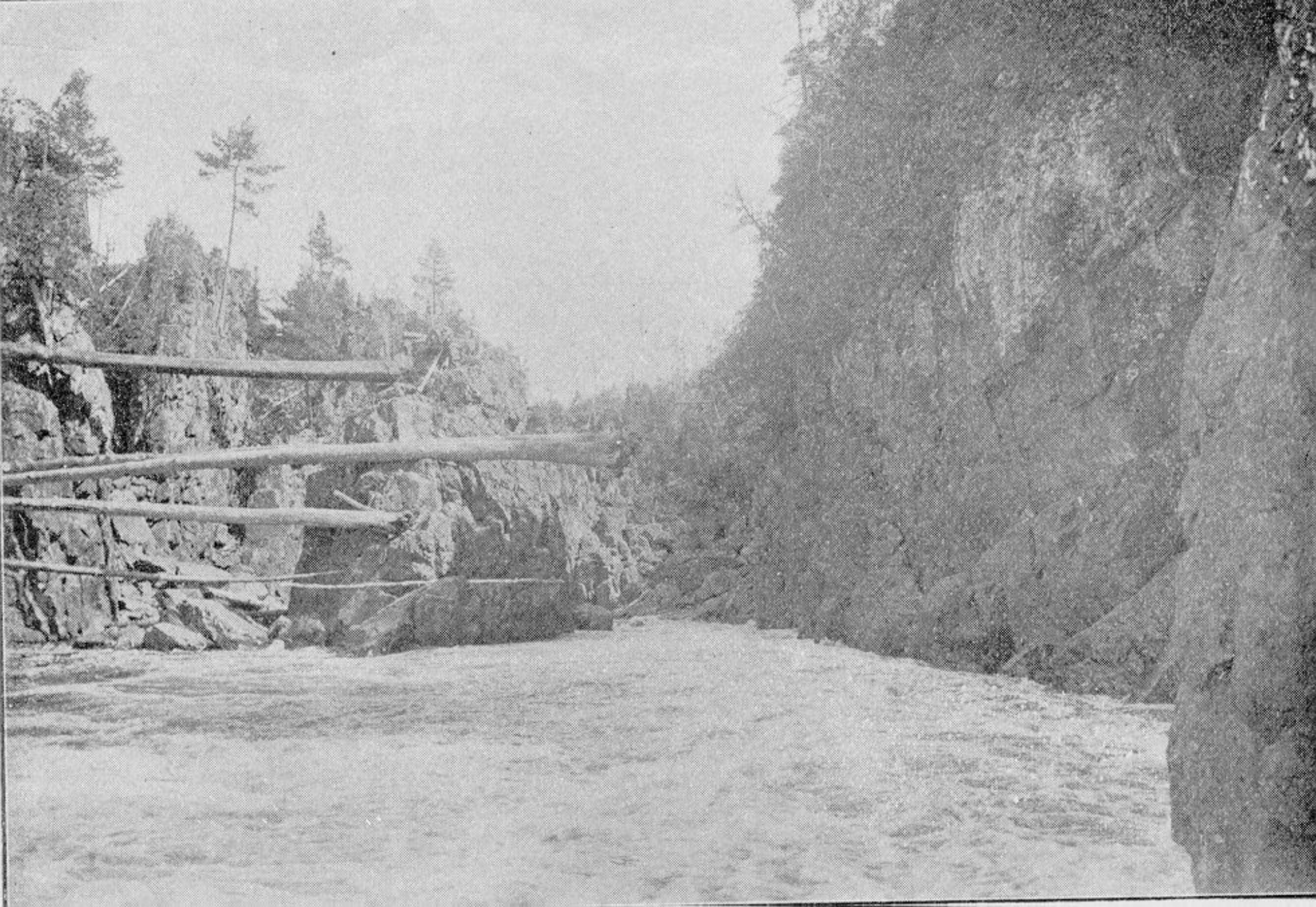
See pp. 264-271.



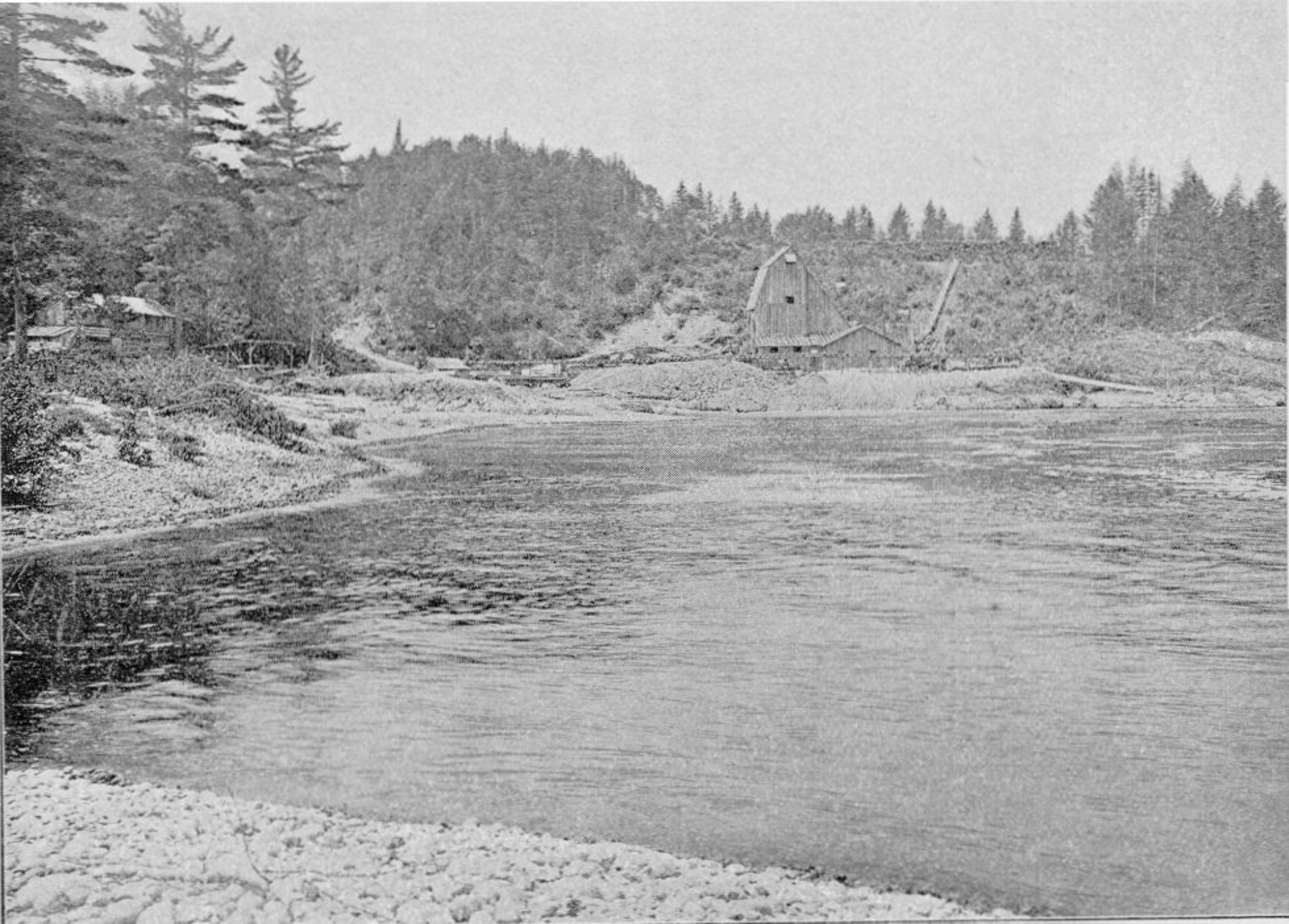
Longitudinal section of the Golden Star Mine, pp. 264-271

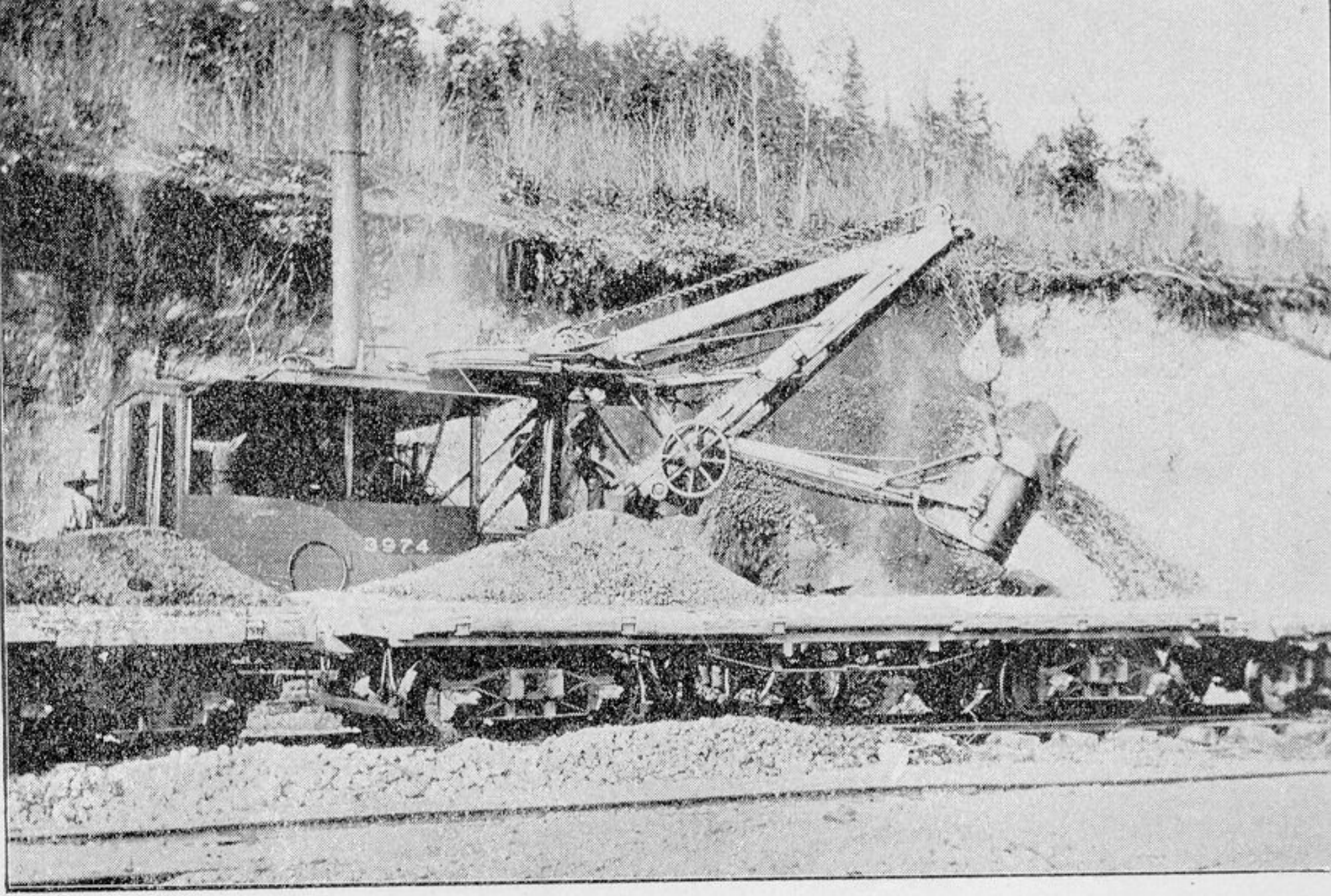






















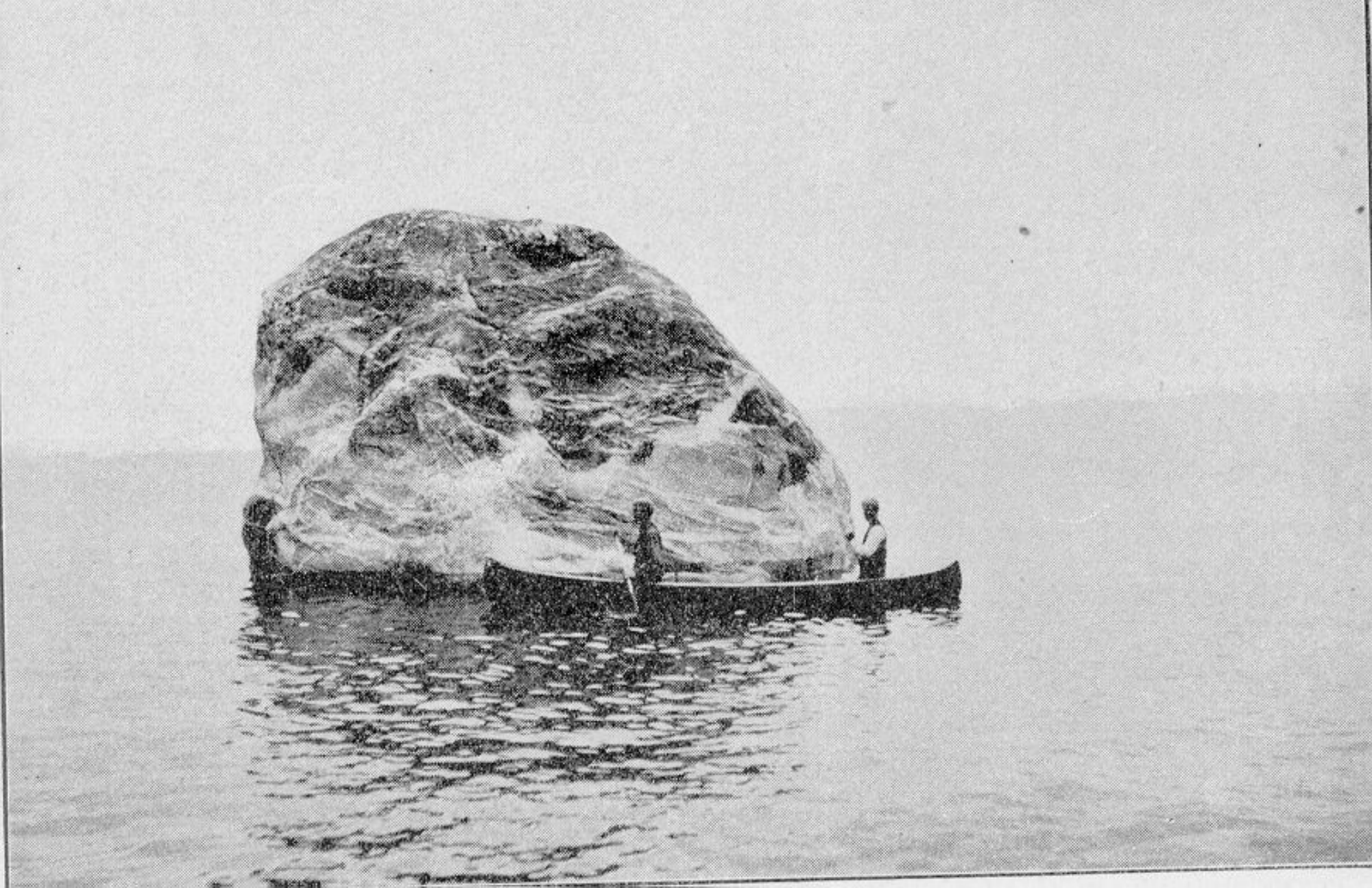


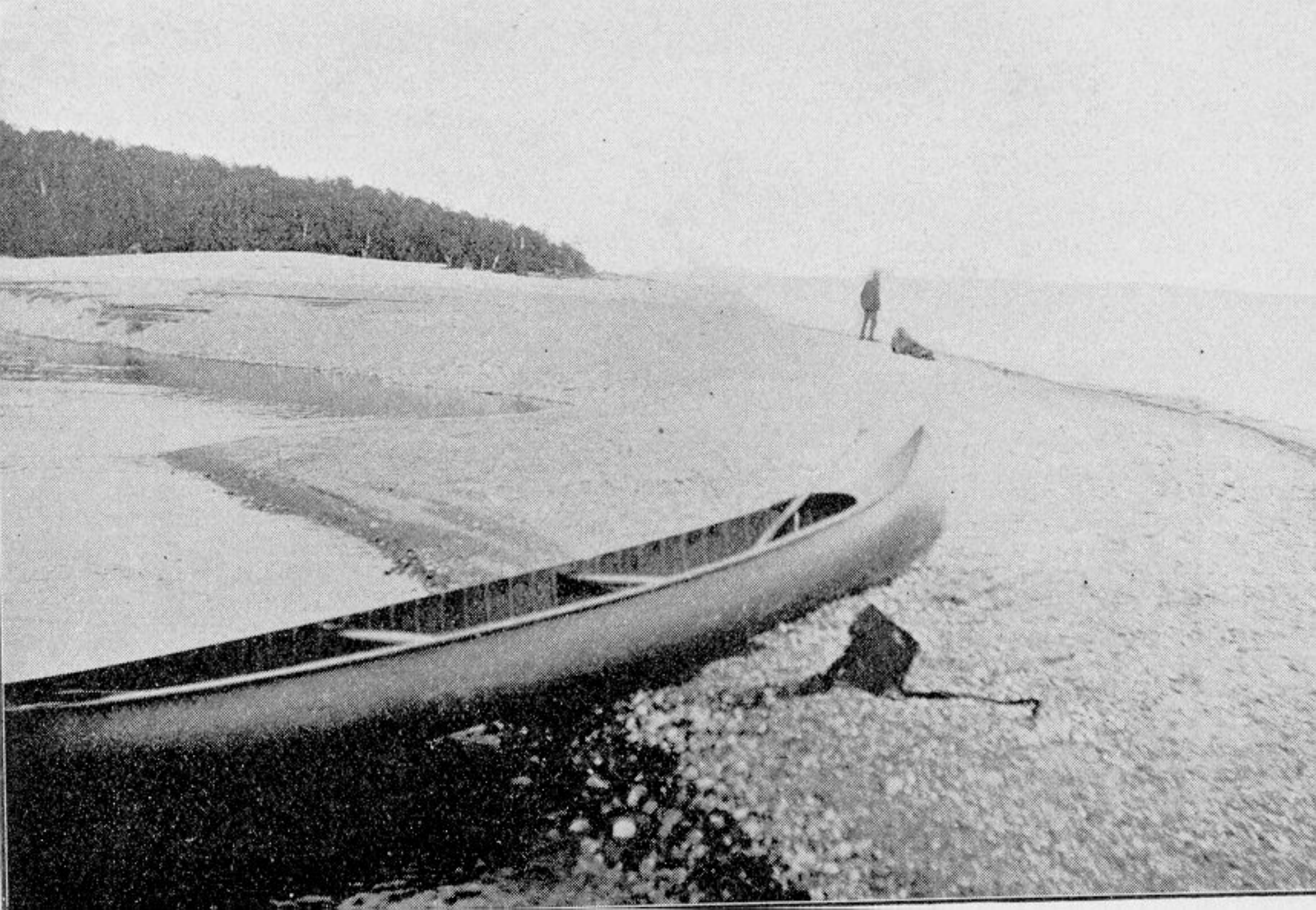


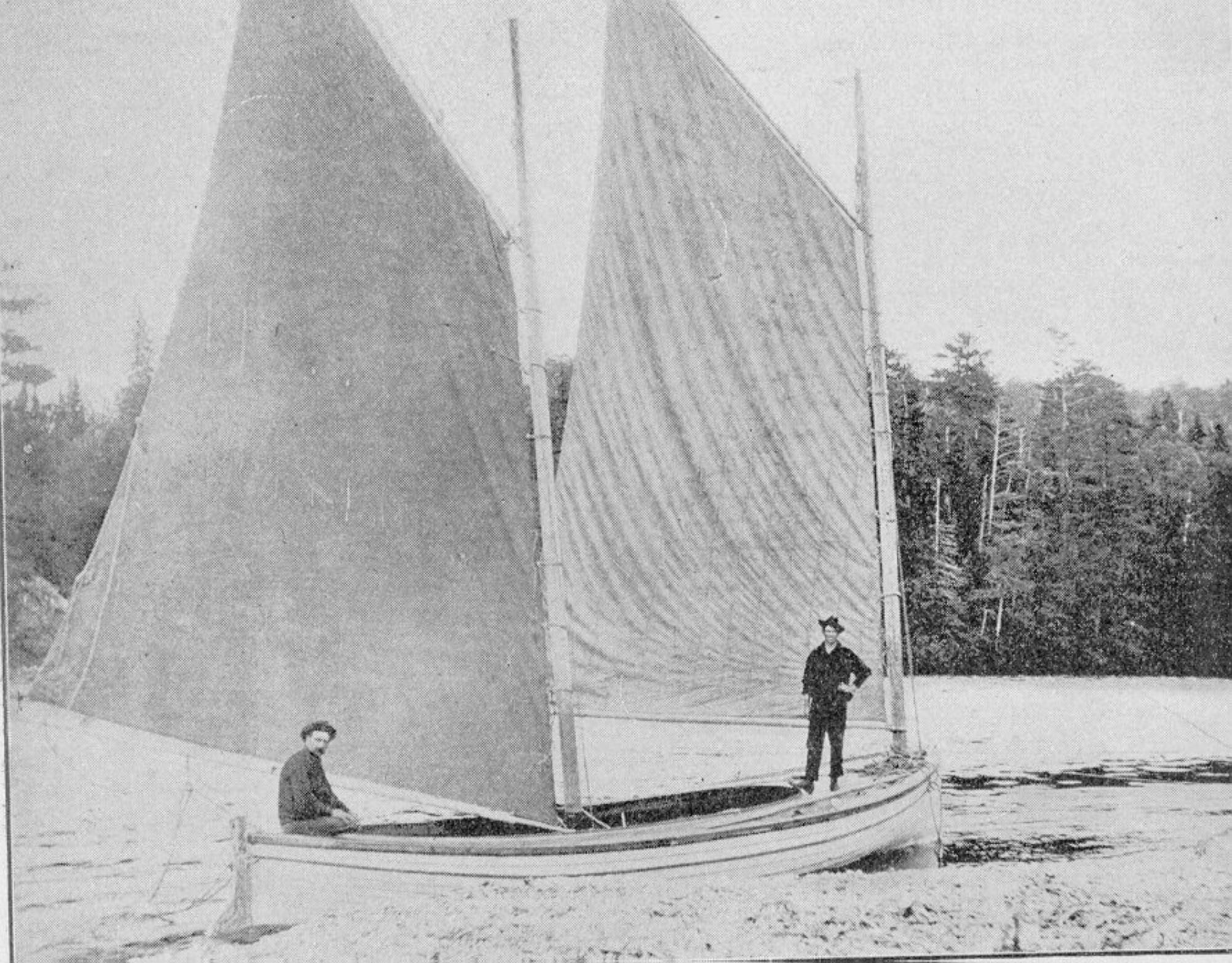


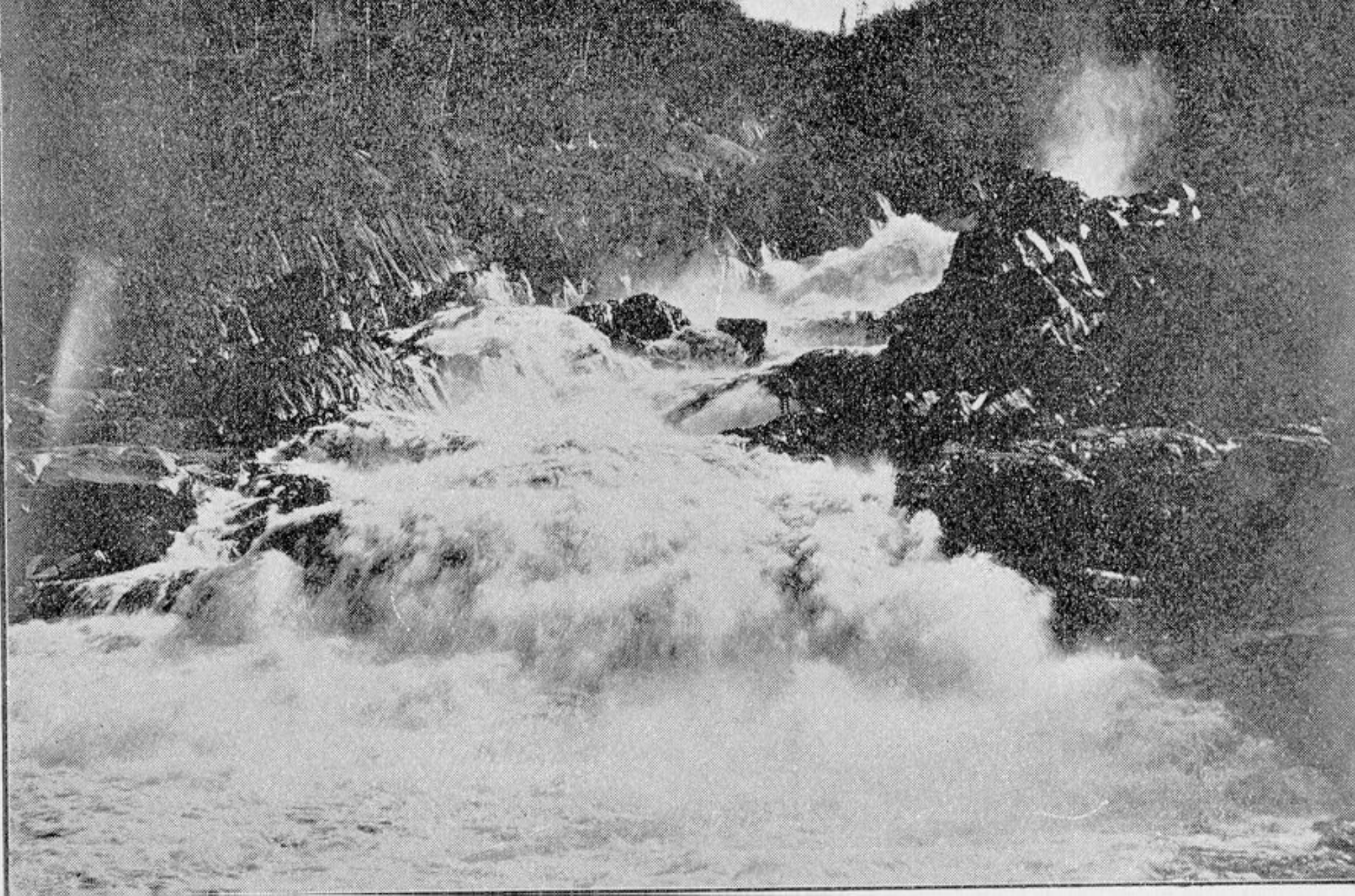


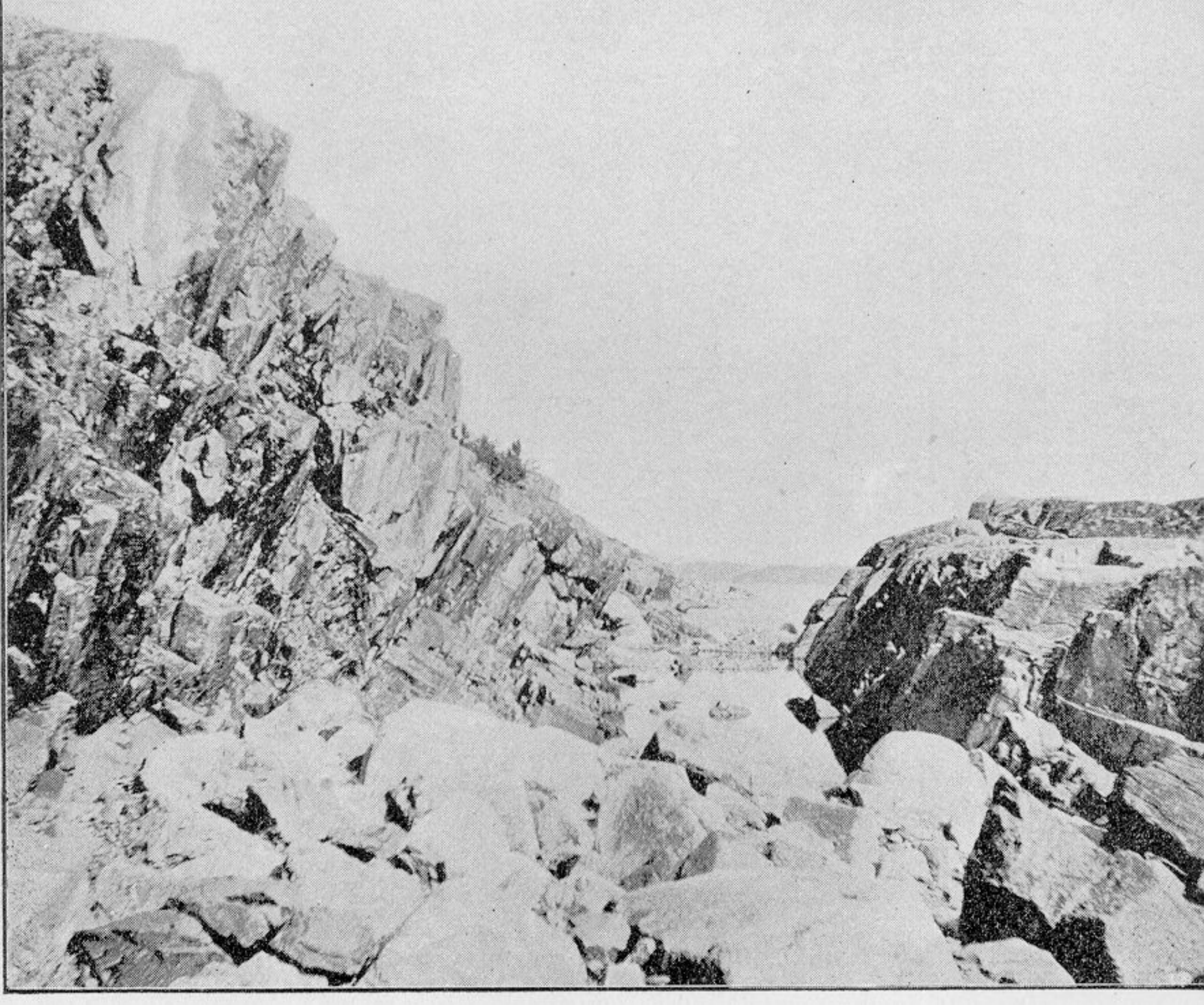












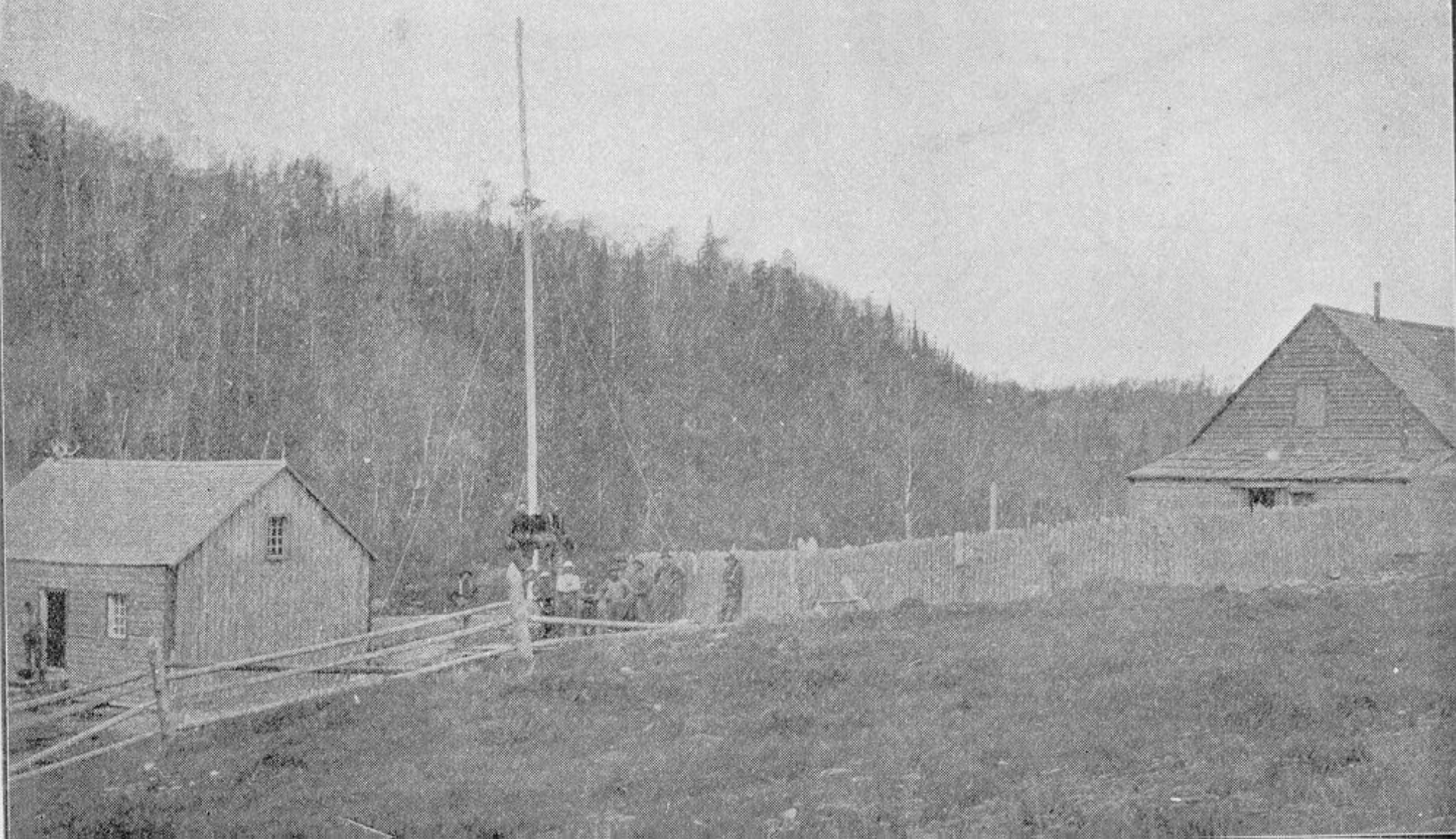
















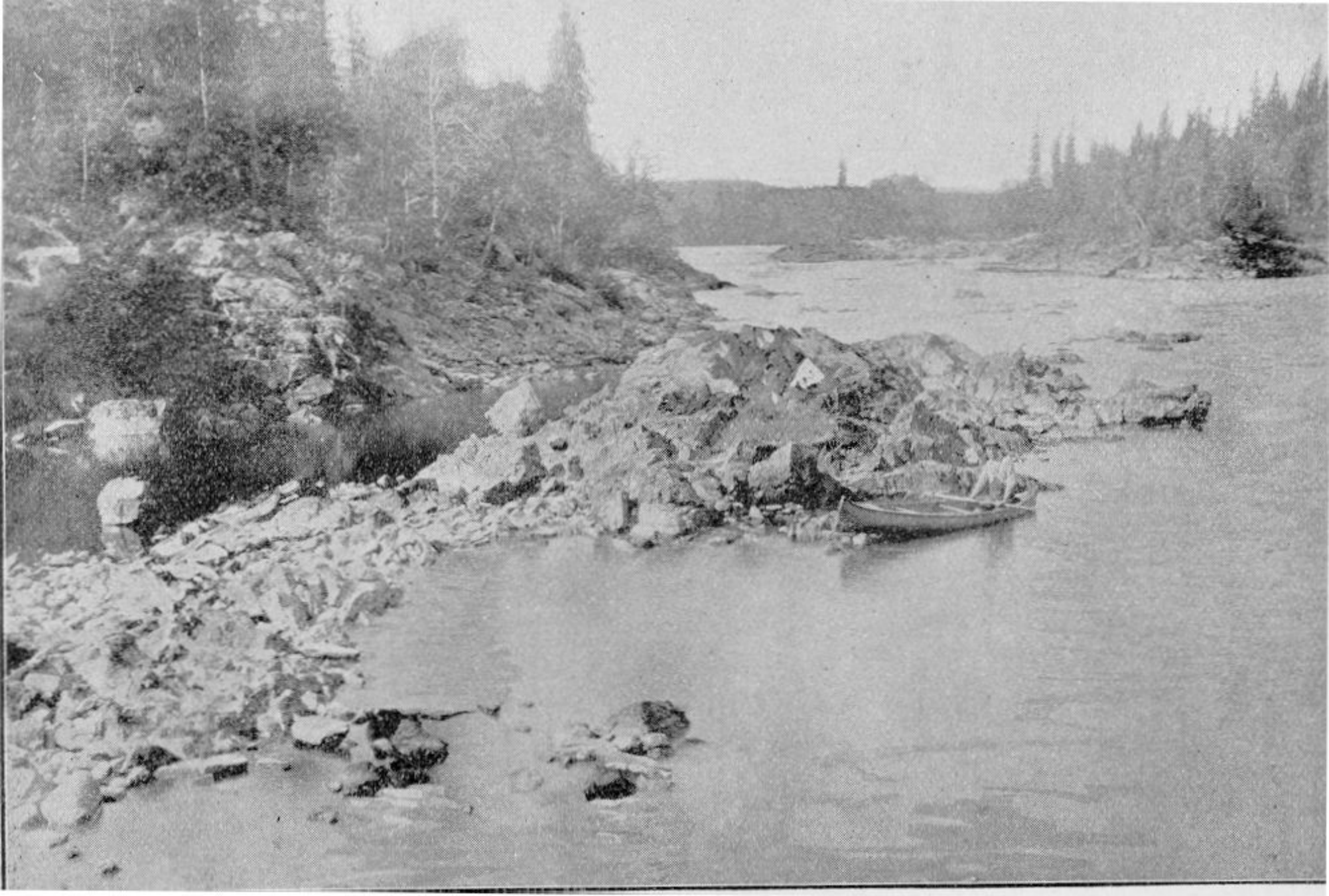






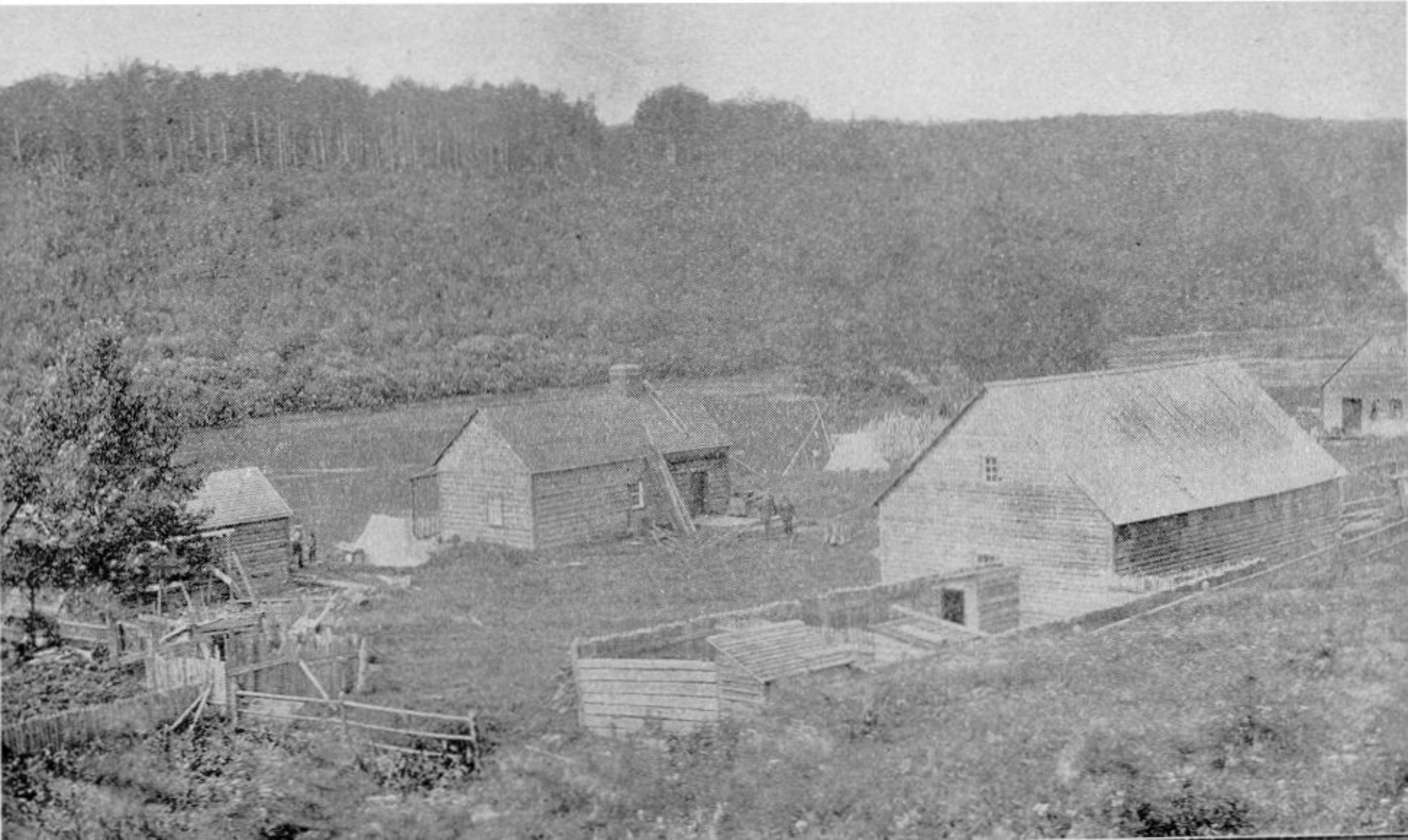








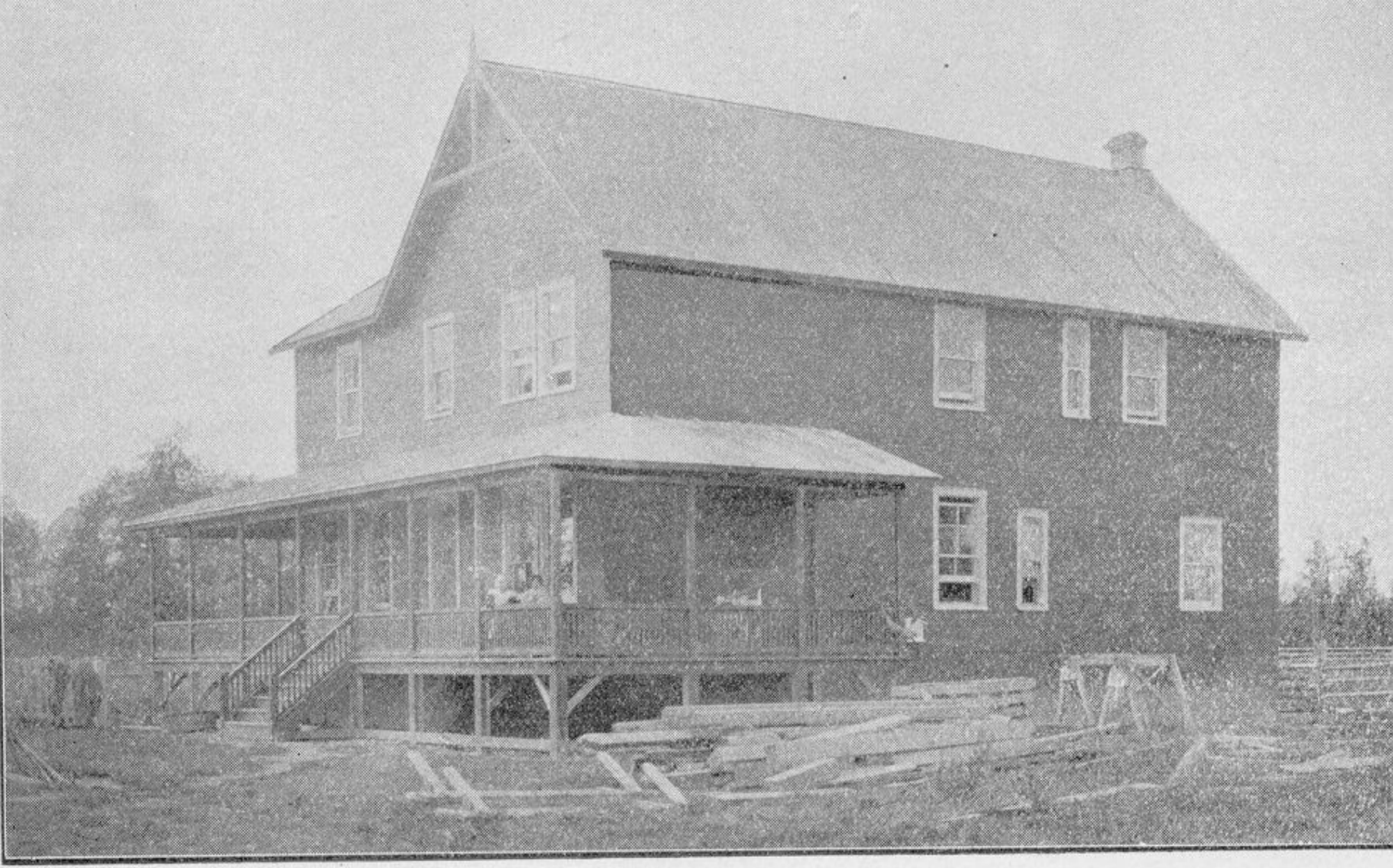










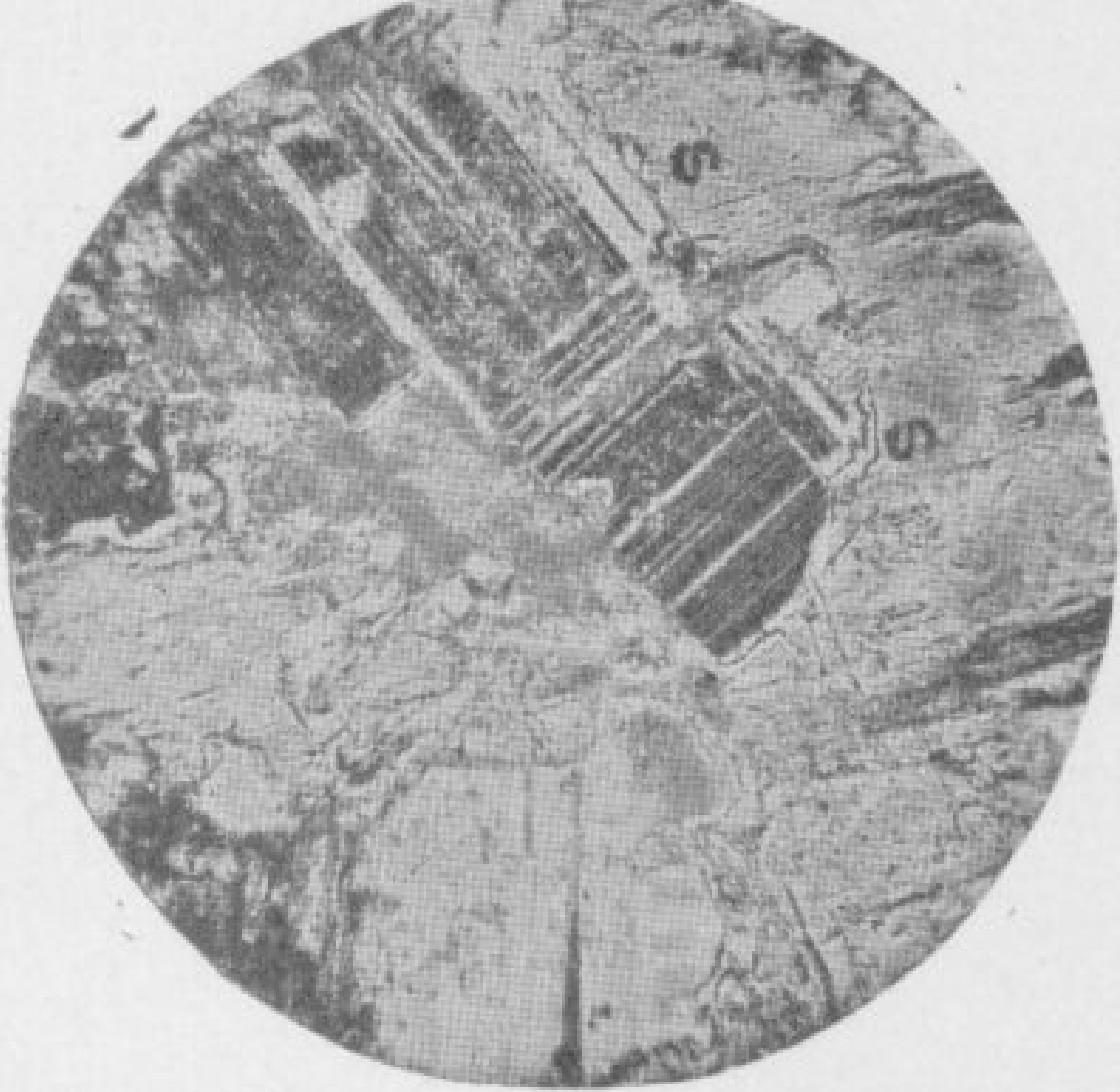






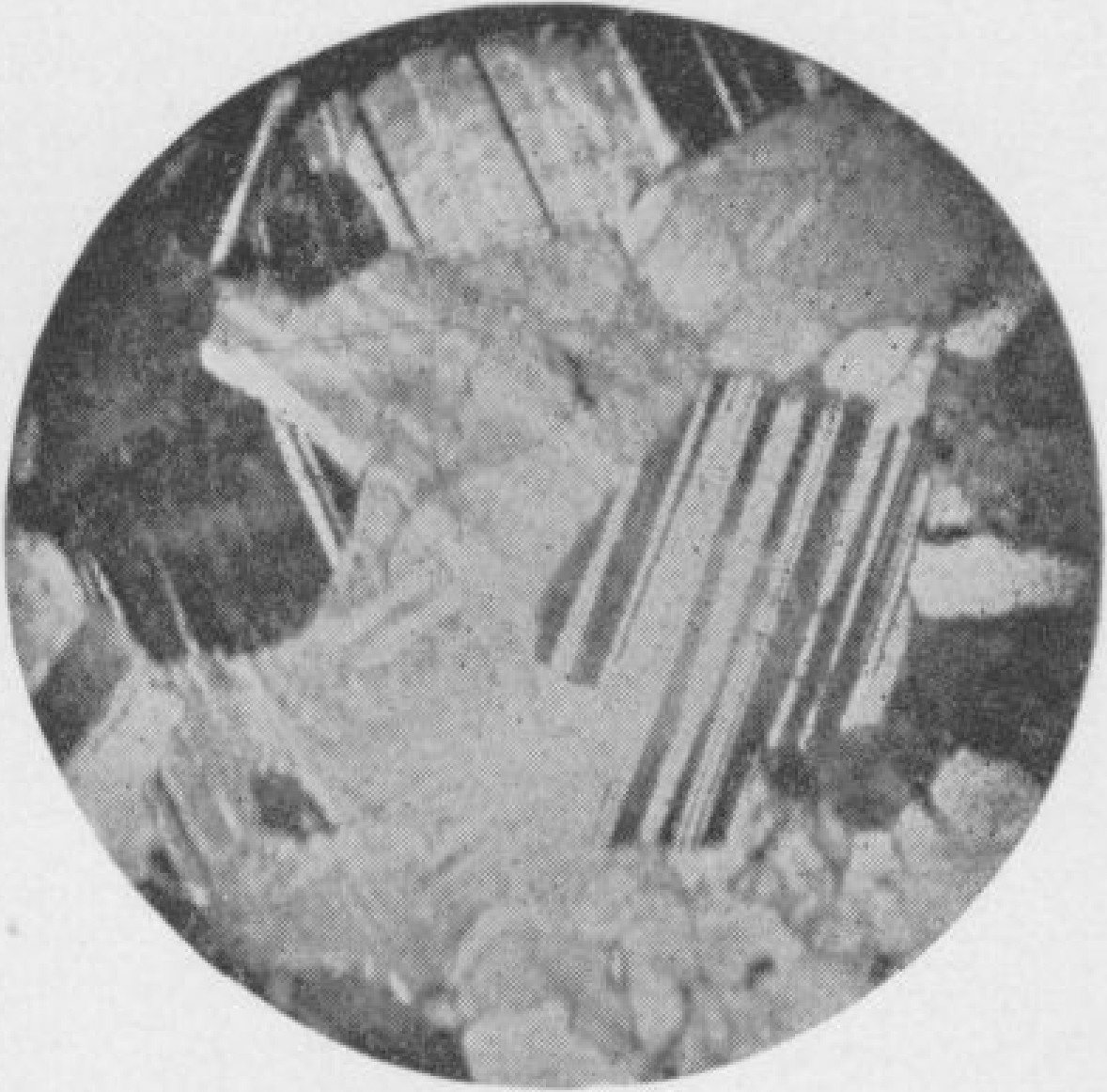




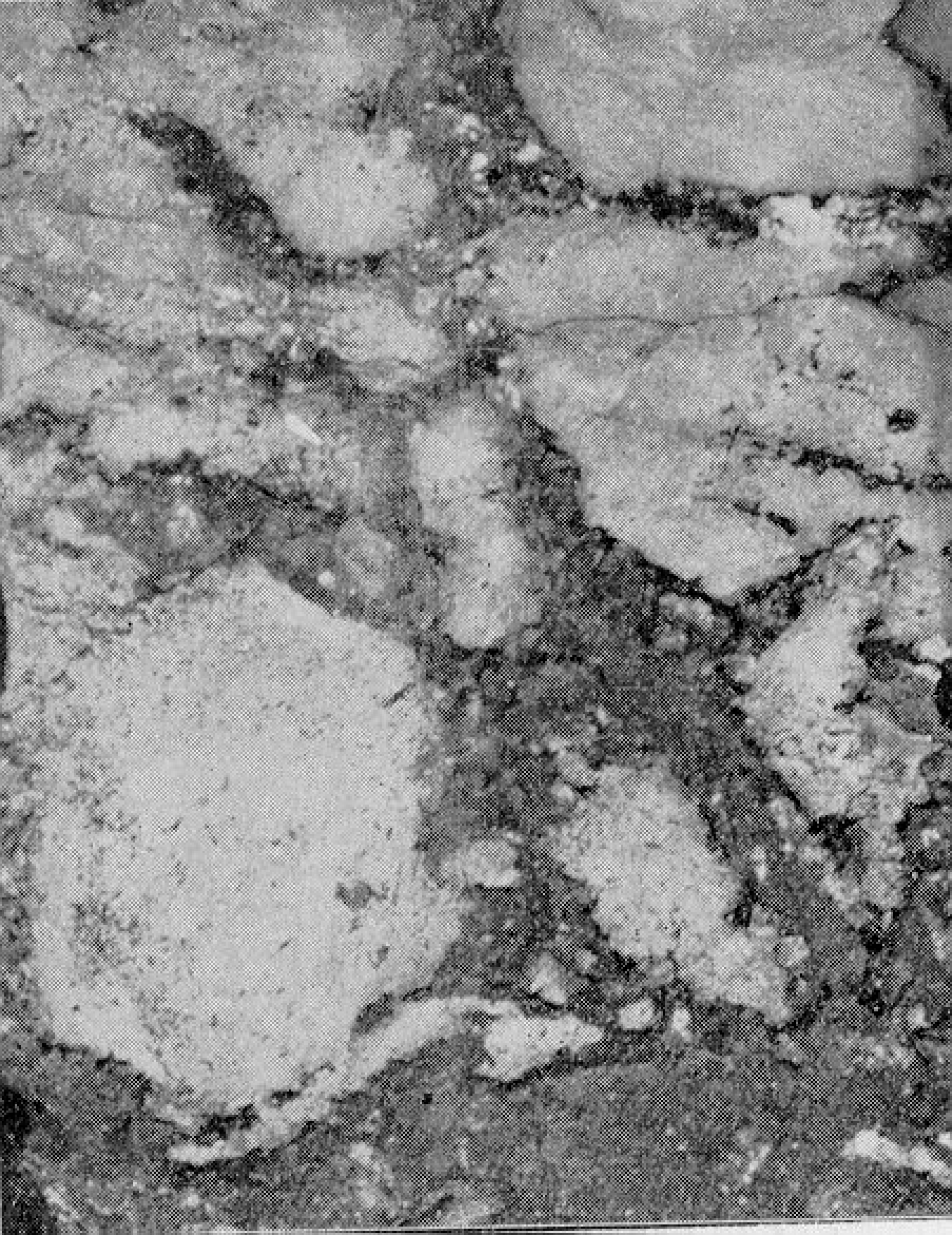


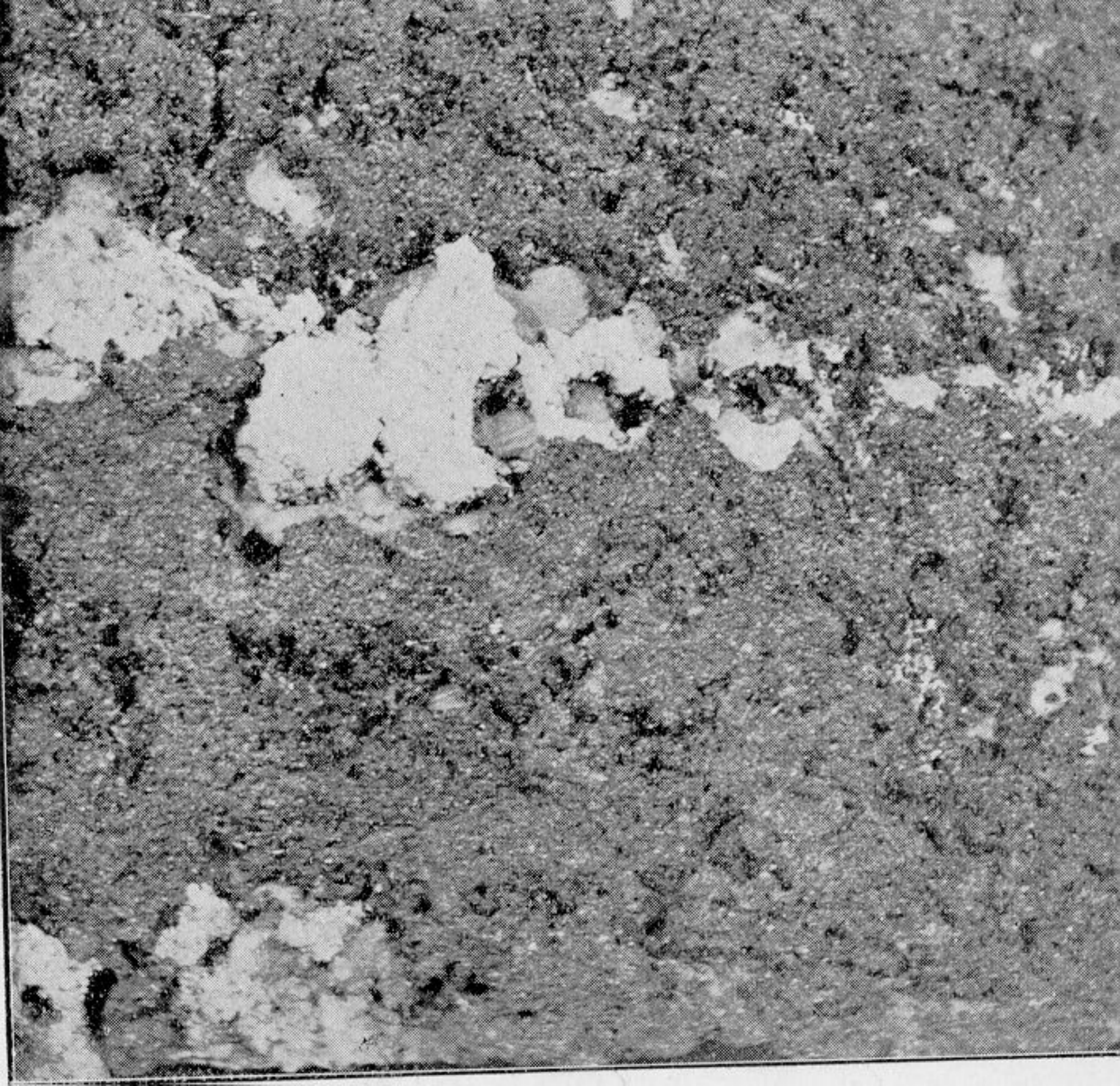


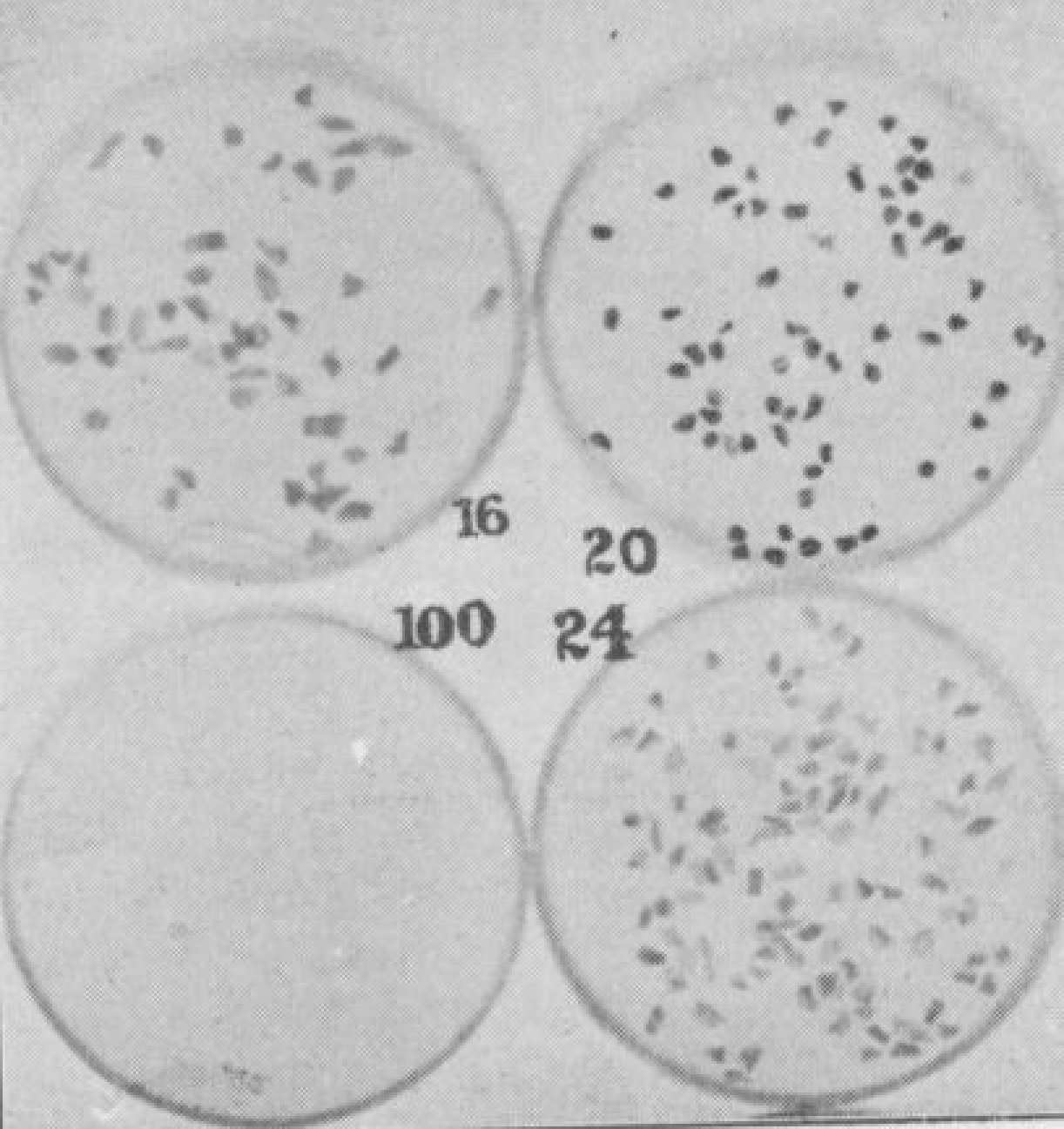

c
c



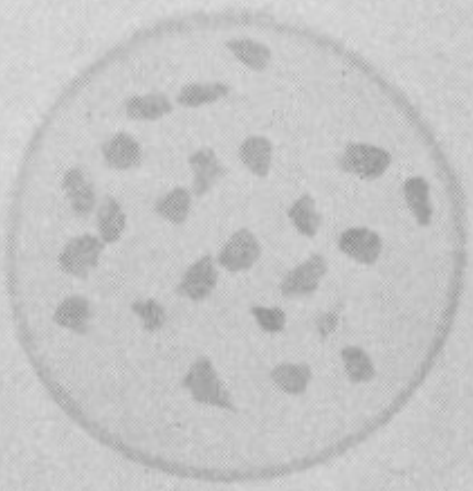




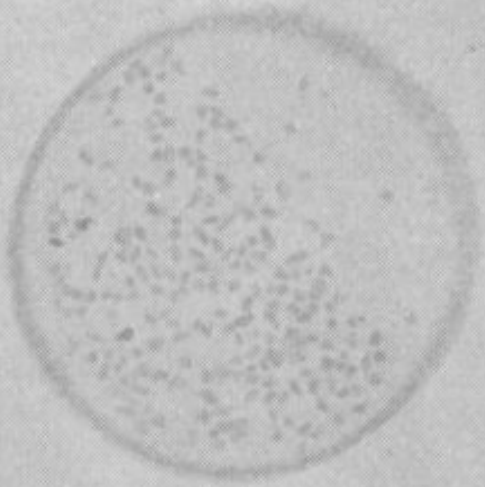



16
20
100
24

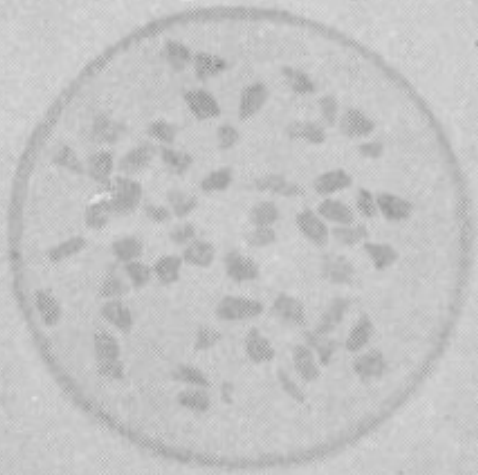
12



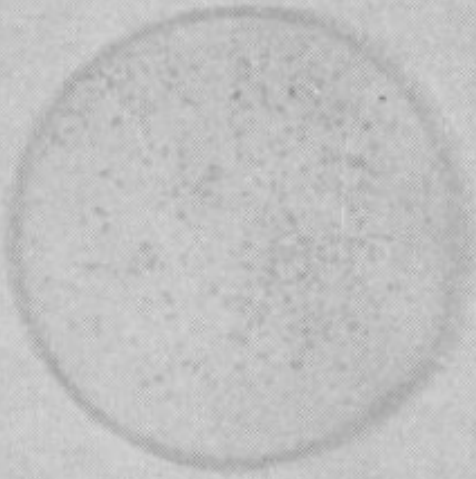
30



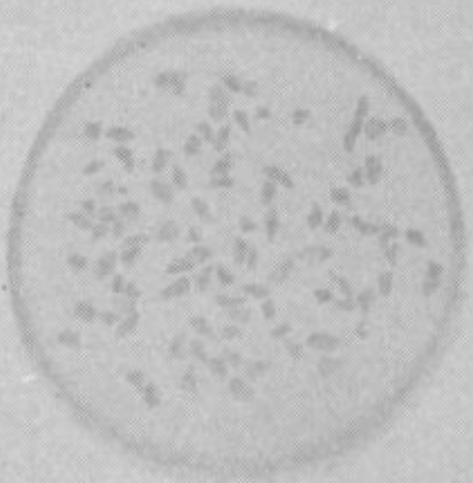
16



40



24



60

















