# Twenty-Ninth Annual Report
of the
# Ontario Department of Mines
1920

PARTS I TO VI

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TWENTY-NINTH ANNUAL REPORT

OF THE

# ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXIX, PART I,

1920

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## LETTER OF TRANSMISSION

To His Honour Lionel Herbert Clarke,

*Lieutenant-Governor of the Province of Ontario.*

Sir,—I have the honour to transmit to you herewith, for presentation to the Legislative Assembly of the Province of Ontario, the Twenty-ninth Annual Report of the Department over which I have the honour to preside.

By the Department of Mines Act, 1920 (10-11 Geo. V., Chapter 12), the Department of Lands, Forests and Mines was divided into the Department of Lands and Forests and the Department of Mines. The title, Bureau of Mines, was discontinued, and the new Department of Mines set up on the old basis modified to meet the needs of the situation. It was not thought necessary or desirable to make any break in the numbering of the Annual Reports, the present volume, although the first of the new Department, being the Twenty-ninth since the establishment of the Bureau in 1891.

I have the honour to be, Sir,

Your obedient servant,

Henry Mills,

*Minister of Mines.*

Department of Mines,
Toronto, 1920.

## INTRODUCTORY LETTER

*To the Honourable* H. Mills,
*Minister of Mines.*

Sir,—I have pleasure in submitting to you herewith, for presentation to His Honour the Lieutenant-Governor in Council, the annual report of the mining industry for 1919. The Bureau of Mines was by Act of the Legislature (the Department of Mines Act, 1920, 10-11 Geo. V, Chapter 12) severed from the Department of Lands, Forests and Mines, and constituted a separate Department, to be presided over by a Minister of Mines. The accompanying volume is the first report of the new Department. It has been thought advisable to preserve continuity in numbering these annual volumes, hence it is styled the Twenty-ninth Report, but of the "Department" instead of the "Bureau" of Mines.

The material comprised in the Report is more varied and larger in quantity than usual, and consequently is issued in six Parts. This arrangement has several advantages. It permits of the publication of articles completed at an early date without waiting for those received later; matter relating to cognate subjects may be grouped together under one cover; and economy is consulted by publishing editions of the several Parts varying in size with the interest of the subject and the probable demand by the public.

Part I includes the annual Statistical Review of the Mining Industry of the Province. It contains numerous tables of production, and draws attention to features of special interest or importance. The Review is largely the work of W. R. Rogers, the Department's Statistician and Topographer. There is also a chapter on Mining Accidents by T. F. Sutherland, Chief Inspector of Mines, and Assistant Inspectors A. H. Brown, Jas. Bartlett, J. G. McMillan and A. R. Webster, who report on the operating mines, quarries and metallurgical works. The second Report of the Joint Peat Committee, appointed by the governments of Canada and Ontario to investigate the practicability of producing a satisfactory fuel from peat, describes the experiments carried on at the Alfred bog with two machines of different type. This investigation is still in progress. In "A Geological Reconnaissance into Patricia," E. M. Burwash records the observations made by him last year, while exploring a tract of country extending from near Freda station on the Transcontinental railway northward into the district of Patricia. The prevailing formations were found to be of the glaciated granite and gneissic type, but areas of Keewatin rocks were also encountered. Ferruginous schists, iron pyrites and muscovite comprise the economic possibilities so far as these were disclosed. Windy lake, in the townships of Cascaden and Dowling, sits squarely on the line of contact between the norite and adjacent rocks on the northern or northwestern nickel range, and is in consequence of interest as the site of a possible deposit of nickel ore. The geology of the shores is described by C. W. Knight, and in connection with his work a magnetometric survey was made on the ice through the co-operation of the Federal Department of Mines. The results obtained did not indicate the presence of such a deposit, but negative evidence of this kind cannot be regarded as conclusive. Possibly diamond drilling either on the ice or from the shores, would be the best means of determining conditions underground. In the paper "Windy Lake and Other Nickel Areas," Mr. Knight deals also with several occurrences of nickel ore associated with serpentine, and J. G. Cross describes that found at Lake Shebandowan. The only working mine of this type is the Alexo in Dundonald township, from which a considerable quantity of good ore has already been taken. These deposits, while containing nickeliferous pyrrhotite closely resembling that of Sudbury, occur under quite different geological conditions, and suggest the possibility of important nickel resources outside of the well-established Sudbury field.

Part II of the Report embodies the results of an exploration in the valleys of the Abitibi and Mattagami rivers northward from the Transcontinental railway, carried out in conjunction with the Department of Mines, Ottawa. M. Y. Williams and J. Keele of that Department investigated respectively the possibilities of oil occurrences in the fossiliferous limestones of the area, and the deposits of clay and shale overlying the Paleozoic formations of the coastal region. Some of these clays are highly refractory, and may well prove of importance when transportation facilities are provided. J. G. Cross for this Department reported on the iron ore deposits, mainly of siderite, at Grand rapids on the Mattagami river. Interest in the natural resources of the region examined has been heightened by the project to extend the Timiskaming and Northern Ontario railway from Cochrane to Moose Factory, the probable route of which would follow the Abitibi river for a large part of the way.

The contents of Part III deal with the following areas in which gold has been found. Ben Nevis, West Shiningtree, Matachewan and Argonaut gold mine, also with the Gowganda silver area. The goldfields mentioned are of varying stages of development, West Shiningtree being of older standing than the others, followed by Matachewan and Ben Nevis in this order. The Argonaut gold mine was formerly known as La Mine d'Or Huronia. It is matter for satisfaction that the process of locating goldfields in northern Ontario goes on with much continuity. It takes a good deal of time and the expenditure of much money to prove the value of a goldfield, and as mines, unlike farms, cannot be worked in perpetuity but are limited in life by the size and value of the deposit, it is essential to the very existence of the industry that fresh discoveries and new developments should continue to be made. Ben Nevis and Argonaut gold mine are reported on by C. W. Knight, West Shiningtree by P. E. Hopkins, and Matachewan by A. G. Burrows. The last-named also reports on the Gowganda silver area.

Part IV deals wholly with the Kirkland lake gold area, the most productive field in Ontario except Porcupine. The report is the joint work of A. G. Burrows and P. E. Hopkins, and is regarded by the Department as one of the most important of its recent publications.

The natural gas resources of southwestern Ontario have proven of great value to the people who inhabit that peninsula, furnishing as they did in 1919 fuel equivalent to 578,120 tons of coal, much superior to that article in convenience and cleanliness. Owing to the declining supply, a strong demand has of late years been making itself felt that the industrial use of gas should be prohibited in order that the gas might be conserved for domestic purposes. In the Natural Gas Act, 1918, the Legislature adopted this policy. This Act was repealed at the following session and the Natural Gas Act, 1919, substituted. The latter continued the policy adopted in 1918, but dropped certain features of the first Act. regarding existing contracts and control of prices. There has been much controversy between producers and consumers both as to supply and price. the former contending that they could not continue to furnish gas at the old rates and remain in business. As in a number of cases these rates were fixed by agreements not yet expired, consumers naturally objected to pay the higher prices demanded. An investigation into the whole situation was ordered by the government and undertaken by E. S. Estlin, Natural Gas Commissioner. Part V contains Mr. Estlin's summary of this investigation, and also deals with the course of the natural gas industry in 1919.

In Part VI, Beatrice Helen Stewart, under the title, "The Stratigraphy and Paleontology of Toronto and Vicinity," describes the pelecypod fossils found in the Lorraine and Upper Ordovician formations in the neighbourhood of Toronto.

I have the honour to be, Sir,

Your obedient servant,

THOS. W. GIBSON,
*Deputy Minister of Mines.*

Department of Mines,
Toronto, 1920.

# STATISTICAL REVIEW

### of the

# MINING INDUSTRY OF ONTARIO FOR 1919

By

W. R. Rogers

There was a heavy falling-off in the mineral production of Ontario in 1919. The aggregate value of all the products, metallic and non-metallic, was $58,883,916, as compared with $80,308,972 in 1918. This represents a decrease of 26.7 per cent.

The obvious explanation is the stoppage of the great war. While the conflict was raging the need for nickel, copper, iron pyrites and other products urgently required for military purposes, together with the high level of prices, brought the output to the peak point in the history of the industry. With the cessation of strife, or rather with the signing of the armistice, the demand for such materials practically disappeared. They were not needed for purposes of destruction, and peaceful industries normally requiring them had not yet begun to operate.

This condition will probably be of short duration, yet the energies of the world which had been so long and so intensely organized for slaughter, could not at once be diverted into their wonted channels of production and manufacture. Moreover, in some of its aspects the old order has been changed, and to all appearance permanently. Labour insists upon less onerous conditions and a larger share in the fruits of production. Shorter hours may not in themselves lessen the output of toil, but if accompanied by the "ca' canny" spirit, they must inevitably do so. Lessened production at higher costs leads to higher prices for products, and to a narrower margin of profit. The rising tide of cost submerges low grade ore bodies, particularly in gold mines, where the fixed price prohibits an increased return to the mine-owner.

Nevertheless, on a survey of the whole situation, the position of the mining industry of the Province appears to be essentially sound, and a revival of demand which will accompany a full return to normal conditions, will restore the volume of output at least to the pre-war level, and as time passes probably to the old rate of increase year by year.

Following is a summary of the mineral production of Ontario in 1919. The table also shows the number of workmen employed in the several branches of the industry, and the wages paid them.

TABLE I.—SUMMARY OF MINERAL STATISTICS OF ONTARIO FOR 1919.

| Products | Quantity | Value $ | Employees | Wages $ |
|---|---|---|---|---|
| METALLIC. | | | | |
| Gold ........................ounces | 505,964 | 10,451,709 | 2,188 | 3,050,221 |
| Silver ........................ " | 11,363,252 | 12,904,312 | 2,121 | 2,876,660 |
| Copper in matte (a) .........short tons | 9,431 | 2,740,663 | 2,536 | 3,382,154 |
| Nickel in matte (a) ......... " | 15,581 | 7,990,403 | | |
| Iron ore, exported (b) ....... " | 5,953 | 48,341 | 559 | 650,242 |
| Iron, pig (c) ............... " | 46,769 | 1,200,793 | 835 | 1,349,145 |
| Lead, pig ........................lbs. | 1,529,987 | 94,507 | 83 | 62,601 |
| Copper, blister .................. " | 5,684,183 | 969,024 | | |
| Nickel, metallic .................. " | 10,202,308 | 3,592,984 | | |
| Nickel oxide ..................... " | 1,498,577 | 341,833 | (d) 468 | 757,369 |
| Platinum metals ...............ounces | 1,770 | 200,000 | | |
| Cobalt, metallic .................lbs. | 121,926 | 243,554 | | |
| Cobalt oxide ..................... " | 426,573 | 624,553 | | |
| Other cobalt compounds ........... " | 199,487 | 141,372 | (e) 464 | 670,407 |
| Nickel sulphate and carbonate ..... " | 353,267 | 46,711 | | |
| Total metallic .................. | ........... | 41,590,759 | 9,254 | 12,798,799 |
| NON-METALLIC. | | | | |
| Actinolite .......................tons | 160 | 1,176 | ........... | ........... |
| Arsenic, crude and white ..........lbs. | 5,668,170 | 485,360 | (e) | (e) |
| Clay products— | | | | |
| Brick, common ..................M | 141,255 | 1,966,711 | | |
| Brick, fancy and pressed ......... " | 31,738 | 539,908 | | |
| Tile, drain ...................... " | 13,009 | 354,700 | 1,904 | 1,405,132 |
| Tile, hollow building ...........tons | 17,435 | 184,900 | | |
| Tile, roofing .................... | ........... | 1,692 | | |
| Pottery ......................... | ........... | 119,551 | 45 | 42,939 |
| Sewer pipe ...................... | ........... | 609,100 | 218 | 219,665 |
| Cement, Portland ................bbls. | 2,022,575 | 3,659,720 | 647 | 722,029 |
| Feldspar .......................tons | 14,787 | 88,663 | 114 | 60,407 |
| Fluorspar ........................ " | 3,425 | 60,389 | 80 | 83,959 |
| Graphite, crude and refined ........ " | 1,340 | 99,841 | 124 | 93,467 |
| Gypsum, crushed, ground and calcined " | 59,899 | 278,111 | 102 | 118,298 |
| Iron pyrites ..................... " | 117,178 | 366,422 | 470 | 483,371 |
| Lime ..........................bush. | 3,911,572 | 1,268,290 | 363 | 366,686 |
| Mica ...........................tons | 567 | 56,199 | 61 | 42,660 |
| Mineral water ..............Imp. gals. | 276,833 | 19,290 | 17 | 10,228 |
| Natural gas ................M. cu. ft. | 11,085,819 | 2,583,324 | 506 | 444,678 |
| Peat ...........................tons | 500 | 1,750 | 35 | 14,166 |
| Petroleum, crude ............Imp gals. | 7,703,515 | 632,789 | (f) 1,580 | 2,045,072 |
| Phosphate (apatite) .............tons | 2 | 31 | ........... | ........... |
| Quartz (silica) .................. " | 59,658 | 179,070 | (g) 164 | 218,560 |
| Salt ............................. " | 148,112 | 1,395,368 | 296 | 319,463 |
| Sand and gravel ..............cu. yds. | 1,065,851 | 501,666 | 322 | 215,821 |
| Sand-lime brick ..................M | 27,661 | 367,815 | 176 | 140,889 |
| Stone, building, trap, granite, etc. ..... | ........... | 1,230,922 | 688 | 556,162 |
| Talc, crude and ground ...........tons | 17,571 | 240,399 | 87 | 76,384 |
| Total non-metallic .............. | ........... | 17,293,157 | 7,974 | 7,680,036 |
| Add metallic .................... | ........... | 41,590,759 | 9,254 | 12,798,799 |
| Grand total ..................... | ........... | 58,883,916 | 17,228 | 20,478,835 |

(a) Copper and nickel in the matte valued at 14 and 25 cents per pound respectively.
(b) Total shipments of iron ore, 195,919 tons valued at $688,452.
(c) Production from Ontario ore only. Total output of blast furnaces, 623,586 tons of pig iron, worth $16,010,537.
(d) Employees and wages for nickel-copper refining operations.
(e) Employees and wages for silver-cobalt refineries.
(f) Employees and wages for petroleum refineries.
(g) Includes employees and wages for ferro-silicon production.

Table II follows, showing the course of the mining industry during the five-year period 1915 to 1919, as indicated by the value of the total production.

TABLE II.—VALUE OF MINERAL PRODUCTION, 1915 TO 1919.

| Product. | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| METALLIC: | $ | $ | $ | $ | $ |
| Gold | 8,501,391 | 10,339,259 | 8,698,735 | 8,502,480 | 10,451,709 |
| Silver | 12,174,312 | 12,703,591 | 16,183,208 | 17,415,882 | 12,904,312 |
| Platinum metals | ........... | ........... | ........... | ........... | 200,000 |
| Cobalt (*a*) | 379,657 | 762,327 | 1,122,779 | 1,615,130 | 868,107 |
| Copper | 3,926,018 | 8,365,255 | 7,961,662 | 8,532,790 | 3,709,687 |
| Nickel (*b*) | 17,042,230 | 20,685,564 | 21,041,956 | 27,840,422 | 11,925,220 |
| Other Nickel and Cobalt compounds | 9,227 | 60,956 | 42,026 | 73,347 | 188,083 |
| Iron ore (exported) | 171,345 | 342,700 | 483,690 | 624,364 | 48,341 |
| Pig iron (*c*) | 1,891,400 | 1,646,010 | 1,016,699 | 1,364,736 | 1,200,793 |
| Lead (pig) | ........... | 70,863 | 172,601 | 149,841 | 94,507 |
| Molybdenite | 14,099 | 26,393 | 108,501 | 59,067 | .......... |
| Metallic production | 44,109,679 | 55,002,918 | 56,831,857 | 66,178,059 | 41,590,759 |
| NON-METALLIC: | | | | | |
| Actinolite | ........... | ........... | 1,320 | 2,508 | 1,176 |
| Arsenic | 148,379 | 200,103 | 608,483 | 566,332 | 485,360 |
| Asbestos | ........... | 100 | 2,150 | ........... | .......... |
| Barite | ........... | ........... | ........... | 900 | .......... |
| Brick, common and sand-lime | 763,591 | 509,559 | 800,983 | 756,962 | 2,334,526 |
| Brick, paving, fancy | 158,515 | 318,942 (paving, fancy and pressed) | 474,614 | 396,698 | 539,908 |
| " pressed | 217,350 | | | | |
| Cement, Portland | 2,534,537 | 2,242,433 | 2,934,271 | 1,910,839 | 3,659,720 |
| Corundum | 31,398 | 8,763 | 31,213 | 26,120 | .......... |
| Feldspar | 47,031 | 42,159 | 81,802 | 111,173 | 88,663 |
| Fluorspar | ........... | 10,146 | 66,474 | 153,190 | 60,389 |
| Graphite | 115,274 | 249,586 | 296,587 | 208,848 | 99,841 |
| Gypsum | 190,422 | 116,206 | 130,138 | 151,564 | 278,111 |
| Iron pyrites | 353,498 | 471,807 | 1,111,264 | 1,144,737 | 366,422 |
| Lime | 244,953 | 265,356 | 657,364 | 872,177 | 1,268,290 |
| Mica | 33,490 | 55,407 | 92,453 | 49,575 | 56,199 |
| Mineral Water | (*d*) | (*d*) | (*d*) | 133,808 | 19,290 |
| Natural gas | 2,622,838 | 2,404,499 | 3,220,123 | 2,498,769 | 2,583,324 |
| Peat fuel | ........... | ........... | ........... | ........... | 1,750 |
| Petroleum (crude) | 300,219 | 387,846 | 475,000 | 781,097 | 632,789 |
| Phosphate of lime (apatite) | ........... | ........... | ........... | ........... | 31 |
| Pottery | 49,387 | 87,025 | 94,501 | 88,275 | 119,551 |
| Quartz (silica) | 142,354 | 223,514 | 358,674 | 452,711 | 179,070 |
| Salt | 585,022 | 700,515 | 1,047,707 | 1,287,039 | 1,395,368 |
| Sand and gravel | 178,288 | 470,963 | 431,597 | 553,638 | 501,666 |
| Sewer pipe | 361,283 | 216,749 | 378,923 | 362,536 | 609,100 |
| Stone, building, crushed, etc. | 651,593 | 755,313 | 939,052 | 869,239 | 1,230,922 |
| Talc, crude and ground | 85,325 | 111,489 | 179,554 | 246,691 | 240,399 |
| Tile, drain | 321,253 | 275,471 | 546,040 | 309,899 | 354,700 |
| " building and roofing | (*e*) | 176,953 | 301,688 | 195,588 | 186,592 |
| Non-metallic production | 10,136,000 | 10,300,904 | 15,261,975 | 14,130,913 | 17,293,157 |
| Add metallic production | 44,109,679 | 55,002,918 | 56,831,857 | 66,178,059 | 41,590,759 |
| Total production | 54,245,679 | 65,303,822 | 72,093,832 | 80,308,972 | 58,883,916 |

(*a*) Cobalt oxide and metallic cobalt.
(*b*) Nickel in matte, oxide and metallic nickel.
(*c*) Product of Ontario ore only.
(*d*) Production figures not secured for these years.
(*e*) Included with fancy and paving brick.

In Table III is given the aggregate value of the metals and metallic products since the several substances began to be produced in Ontario down to the end of 1919. It should be pointed out that since 1914 the statistics of annual production credit pig iron only with the value of the pig iron product made from Ontario ore. This is but a small part of the total output, since the great bulk of the iron ore charged into the blast furnaces of the Province comes from the mines of Michigan and Minnesota. In 1919 only 7.5 per cent. of the ore smelted was of domestic origin. Conversely, part of the iron ore raised in Ontario is exported to the United States, in 1919 mainly in the form of briquettes produced from low-grade material. In the production tables credit is taken only for the ore exported, since to include the value of the ore converted into pig iron at home would involve a duplication of this item.

TABLE III.—VALUE OF TOTAL PRODUCTION OF METALS IN ONTARIO.

| Metal or Product | Production to 31st December, 1918 | Production, 1919 | Production to 31st December, 1919 |
|---|---|---|---|
| | $ | $ | $ |
| Gold | 50,864,863 | 10,451,709 | 61,316,572 |
| Silver | 185,027,590 | 12,904,312 | 197,931,902 |
| Platinum metals | 1,300,000 | 200,000 | 1,500,000 |
| Cobalt, including Cobalt oxide | 5,918,899 | 868,107 | 6,787,006 |
| Nickel, including Nickel oxide | 138,010,542 | 11,925,220 | 149,935,762 |
| Other Cobalt and Nickel compounds | 230,745 | 188,083 | 418,828 |
| Copper | 49,947,080 | 3,709,687 | 53,656,767 |
| Iron Ore | 9,301,935 | 48,341 | 9,350,276 |
| Pig Iron | 78,925,917 | 1,200,793 | 80,126,710 |
| Lead | 510,595 | 94,507 | 605,102 |
| Zinc Ore | 92,410 | ........ | 92,410 |
| Molybdenite | 209,735 | ........ | 209,735 |
| Total | 520,340,311 | 41,590,759 | 561,931,070 |

## Gold

Ontario has become an important producer of gold, 66 per cent. of the entire Canadian output for 1919 coming from this province. Owing to Ontario's contribution, 505,964 fine ounces worth $10,451,709, Canada ranks third among the six leading British Dominions producing gold, and was the only one to report an increased production for 1919. This is the largest output to date, the increase over that of 1916 being $112,450. Ontario's yield of gold now exceeds that of any other province of Canada or state of the American union, California alone excepted. The world output for 1919 was approximately 350 million dollars.

Production was hampered by a shortage of labour, in consequence of which neither the mines nor the mills could be worked to capacity. Fire destroyed the small mills of the Patricia and Miller Independence mines at Boston Creek. At Kirkland Lake the miners' strike, lasting from June 12th to October 15th, seriously interfered with production and development, and, as a direct result, completion of the Wright-Hargreaves 150-ton mill was delayed a year and the Tough-Oakes mine was not re-opened during 1919. During the strike period all work was suspended.

The average grade of ore milled remains nearly the same as in 1918, when the extraction per ton was $9.50 and $11.81 from the chief producing areas, namely Porcupine and Kirkland Lake, respectively. Details are set forth in the statement which follows:

TABLE IV.—GOLD PRODUCTION, 1919.

| Source | Ore milled Tons | Gold Production | | Silver Production | | Total Value, Gold and Silver | Extraction per ton milled |
|---|---|---|---|---|---|---|---|
| | | Fine ounces | Value | Fine ounces | Value | | |
| PORCUPINE: | | | $ c. | | $ c. | $ c. | $ c. |
| Davidson Consolidated | 3,831 | 1,208.26 | 26,999 92 | 80.4 | 88 89 | 27,088 81 | 7 07 |
| Dome Lake | 4,433 | 1,157.00 | 23,910 45 | ........ | .......... | 23,910 45 | 5 39 |
| Dome and Dome Extension | 187,580 | 61,893.04 | 1,279,341 77 | 9,420.5 | 10,958 42 | 1,290,300 19 | 6 87 |
| Hollinger Consolidated | 711,882 | 322,022.01 | 6,655,781 44 | 60,441.2 | 66,485 37 | 6,722,266 81 | 9 44 |
| McIntyre Porcupine | 185,018 | 95,038.44 | 1,955,769 97 | 20,461.5 | 22,243 89 | 1,978,013 86 | 10 69 |
| Total Porcupine | 1,092,744 | 481,318.75 | 9,941,803 55 | 90,403.6 | 99,776 57 | 10,041,580 12 | 9 19 |
| KIRKLAND LAKE: | | | | | | | |
| Kirkland Lake | 11,324 | 2,675.05 | 55,780 38 | 378.9 | 482 21 | 56,262 59 | 4 97 |
| Lake Shore | 11,081 | 12,695.72 | 262,421 80 | 932.5 | 952 50 | 263,354 30 | 23 77 |
| Teck-Hughes | 18,387 | 8,156.37 | 168,607 15 | 930.1 | 983 26 | 169,590 41 | 9 22 |
| Total Kirkland Lake | 40,792 | 23,527.14 | 486,809 33 | 2,241.5 | 2,397 97 | 489,207 30 | 11 99 |
| MISCELLANEOUS: | | | | | | | |
| Argonaut | 735 | 125.34 | 2,590 77 | 29.4 | 39 79 | 2,630 56 | 3 58 |
| Cobalt-Frontenac | .......... | 15.00 | 300 00 | ........ | .......... | 300 00 | ........ |
| Stone, W. E. | .......... | 10.21 | 210 98 | ........ | .......... | 210 98 | ........ |
| Nickel-Copper Refineries | .......... | 966.12 | 19,966 48 | ........ | .......... | 19,966 48 | ........ |
| Cobalt-Silver Refineries | .......... | 1.36 | 28 11 | ........ | .......... | 28 11 | ........ |
| Total Miscellaneous | 735 | 1,118.03 | 23,096 34 | 29.4 | 39 79 | 23,136 13 | ........ |
| Grand Total | 1,134,271 | 505,963.92 | 10,451,709 22 | 92,674.5 | 102,214 33 | 10,553,923 55 | 9.30 |

The list of producing gold mines is as follows:—

PRODUCING GOLD MINES, 1919.

| Name of Company. | Name of Mine. | Locality. | P.O. Address of Manager, etc. |
|---|---|---|---|
| Argonaut Gold, Limited .......... | Argonaut .......... | Gauthier tp. ... | Dane. |
| Cobalt Frontenac Mining Company, Limited .......................... | Golden Fleece....... | Eastern Ontario | Flinton. |
| Davidson Consolidated Gold Mines, Limited ........................ | Davidson .......... | Porcupine..... | South Porcupine. |
| Dome Lake Mining and Milling Company, Limited.................. | Dome Lake......... | Porcupine..... | South Porcupine. |
| Dome Mines Company, Limited .... | Dome and Dome Extension......... | Porcupine..... | South Porcupine. |
| Hollinger Consolidated Gold Mines, Limited ........................ | Hollinger........... | Porcupine..... | Timmins. |
| Kirkland Lake Gold Mining Company, Limited .................. | Kirkland Lake...... | Kirkland Lake. | Kirkland Lake. |
| Lake Shore Mines, Limited ........ | Lake Shore......... | Kirkland Lake. | Kirkland Lake. |
| McIntyre-Porcupine Mines, Limited. | McIntyre........... | Porcupine..... | Schumacher. |
| Stone, W. E. ..................... | A.L. 113 .......... | Mine Centre.... | Mine Centre. |
| Teck-Hughes Gold Mines, Limited .. | Teck-Hughes........ | Kirkland Lake. | Kirkland Lake. |

In the following table the total gold output of the Province is given. also that from Porcupine and Kirkland Lake beginning in 1910 and 1913 respectively:—

TABLE V.—TOTAL GOLD PRODUCTION OF ONTARIO.

| Year | Total Production | Porcupine | | Kirkland Lake | |
|---|---|---|---|---|---|
| | $ | $ | Percentage | $ | Percentage |
| 1892-1910........ | 2,509,492 | .............. | .............. | .............. | ............ |
| 1910........ | 68,498 | 35,539 | 51.8 | .............. | ............ |
| 1911........ | 42,637 | 15,437 | 36.2 | .............. | ............ |
| 1912........ | 2,114,086 | 1,730,628 | 81.8 | .............. | ............ |
| 1913........ | 4,558,518 | 4,294,113 | 94.1 | 65,260 | 1.2 |
| 1914........ | 5,529,767 | 5,190,794 | 93.8 | 114,154 | 2.0 |
| 1915........ | 8,501,391 | 7,536,275 | 88.6 | 551,069 | 6.5 |
| 1916........ | 10,339,259 | 9,397,536 | 90.8 | 702,761 | 6.8 |
| 1917........ | 8,698,735 | 8,229,744 | 94.5 | 404,346 | 4.6 |
| 1918........ | 8,502,480 | 1,767,907 | 91.4 | 632,007 | 7.4 |
| 1919........ | 10,451,709 | 9,941,804 | 95.1 | 486,809 | 4.7 |
| Total.... | 61,316,572 | 54,139,777 | 88.3 | 2,956,406 | 4.8 |

The period of productive gold mining in Ontario really began with the opening of the Porcupine mines in 1910. During the ten years since that time the gold mines have paid out in returns to shareholders a total of $15,545,238.20, details of which are given in Table VI below.

TABLE VI.—DIVIDENDS AND BONUSES PAID BY GOLD MINING COMPANIES TO DECEMBER 31, 1919.

| Name of Company. | Date of Incorporation. | Authorized Capital. | Capital Stock Issued. | Par value per share. | Amount of Dividends and Bonuses paid to end of 1918 | Amount of Dividends and Bonuses paid during 1919. | Rate per cent. | Total of Dividends and Bonuses paid to Dec. 31st, 1919. | Date when last Dividend or Bonus paid. |
|---|---|---|---|---|---|---|---|---|---|
| | | $ | $ | $ c. | $ | $ c. | | $ | |
| Dome Mines Company, Ltd. | Mar. 23, 1910 | 5,000,000 | 4,000,000 | 10 00 | 1,500,000 00 | ........... | ..... | 1,500,000 00 | May 7, 1917 |
| *Hollinger Consolidated Gold Mines, Ltd. | June 16, 1916 | 25,000,000 | 24,600,000 | 5 00 | 9,424,000 00 | 1,722,000 00 | 7 | 11,146,000 00 | Dec. 31, 1919 |
| Lake Shore Gold Mines, Ltd. | Feb. 25, 1914 | 2,000,000 | 2,000,000 | 1 00 | 100,000 00 | 100,000 00 | 5 | 200,000 00 | Oct. 25, 1919 |
| McIntyre-Porcupine Mines, Ltd. | Mar. 16, 1911 | 4,000,000 | 3,640,283 | 1 00 | 1,084,584.90 | 364,028 30 | 10 | 1,448,613 20 | Aug. 30, 1919 |
| Porcupine Crown Mines, Ltd. | May 26, 1913 | 2,000,000 | 2,000,000 | 1 00 | 840,000 00 | ........... | ..... | 840,000 00 | July 15, 1917 |
| Rea Consolidated Gold Mines | April 5, 1911 | 1,000,000 | 200,000 | 5 00 | 12,000 00 | ........... | ..... | 12,000 00 | ............ |
| Tough-Oakes Gold Mines, Ltd. | July 15, 1913 | 3,000,000 | 2,657,500 | 5 00 | 398,625 00 | ........... | ..... | 398,625 00 | Dec. 27, 1916 |
| Total | ........... | ........... | ........... | ..... | 13,359,209 90 | 2,186,028 30 | ..... | 15,545,238 20 | |

* Hollinger Consolidated Gold Mines, Limited, is a consolidation of the Acme Gold Mines, Limited, Millerton Gold Mines, Limited, and Hollinger Gold Mines, Limited. Dividends include $160,000 paid by Acme prior to amalgamation with Hollinger.

## Silver

A great impetus was given to silver mining at Cobalt and Gowganda by the high prices that ruled throughout the year, the average New York price being 111.122 cents per fine ounce. An adverse exchange situation as regards the United States really meant to silver shippers a premium over the New York price equivalent to the rate of exchange, the silver being paid for in U.S. funds. High prices, which permitted the mining of low-grade ore, stimulated also the opening of abandoned mines and stopes, and made profitable the re-treatment by flotation methods of tailing dumps having a silver content as low as four ounces to the ton. Despite these aids to production, the silver output continued to decline with the natural waning of the camp as the deposits are being worked out.

Among the noticeable features of the year may be mentioned the finding of high-grade ore on the Foster mine, under lease to C. L. Campbell and associates. The lease was sold to the Mining Corporation of Canada, who worked the mine, after the strike was settled, under the name of Central Operating Company. Towards the close of the year there was a decided revival of interest in the Gowganda area, following the results obtained by the Trethewey Company on mining claim R.S.C. 101, otherwise known as the Castle. In South Lorrain the Keeley mine has been re-opened and an 80-ton mill is under construction.

As regards metallurgical methods, the Nipissing Company has discarded amalgamation owing to the high price of mercury, and is now using cyanidation entirely in the high-grade mill. Recent improvements in the manufacture of cyanide by the American Cyanamid Company at Niagara Falls, Ont., have made it possible to produce a 37½ per cent. sodium cyanide equivalent to 50 per cent. potassium cyanide. The new product has been introduced at Cobalt.

Silver was discovered at Cobalt in 1903, and at Gowganda in 1907. The shipments from these camps, including South Lorrain and Casey in the former and Elk Lake in the latter, have been as follows:—

| | Average price, Cents per ounce. | Cobalt, Ounces silver. | Gowganda, Ounces silver. |
|---|---|---|---|
| 1904 | 57.2 | 206,875 | ........ |
| 1905 | 60.4 | 2,451,356 | ........ |
| 1906 | 66.8 | 5,401,766 | ........ |
| 1907 | 67.5 | 10,023,311 | ........ |
| 1908 | 52.9 | 19,437,875 | ........ |
| 1909 | 51.5 | 25,897,825 | ........ |
| 1910 | 53.5 | 30,163,658 | 481,523 |
| 1911 | 53.3 | 31,039,104 | 468,687 |
| 1912 | 60.8 | 29,693,883 | 549,976 |
| 1913 | 57.8 | 29,179,605 | 502,370 |
| 1914 | 54.8 | 24,763,541 | 399,300 |
| 1915 | 49.69 | 24,504,305 | 242,229 |
| 1916 | 65.661 | 19,554,420 | 360,670 |
| 1917 | 81.417 | 18,337,258 | 1,064,635 |
| 1918 | 96.772 | 17,023,496 | 638,198 |
| 1919 | 111.122 | 10,491,753 | 722,564 |
| Total to end of 1919 | | 298,170,031 | 5,430,152 |

Classified according to source, the output of silver in 1919 was derived as follows:—

| | Ounces. |
|---|---|
| Cobalt | 10,315,889 |
| Casey township | 171,278 |
| South Lorrain | 4,586 |
| Gowganda | 722,564 |
| Recovered from gold ores | 92,675 |
| Recovered from nickel-copper refining | 56,260 |
| Total | 11,363,252 |

The producers of silver are given in the following list:—

SILVER PRODUCERS IN 1919.

| Company or Owner. | Mine or Source. | P.O. Address of Manager, etc. |
|---|---|---|
| Adanac Silver Mines, Limited | Adanac | Haileybury. |
| Aladdin Cobalt Company, Limited | Chambers-Ferland | Cobalt. |
| Angus, D. H. | Nipissing Reduction Mill clean-up | Cobalt. |
| Associated Goldfields of Western Australia, Ltd. | Keeley | Almonte. |
| Beaver Consolidated Mines, Limited | Beaver | Cobalt. |
| Brewer, Price and Sullivan | Cobalt Silver Queen | Cobalt. |
| Buffalo Mines, Limited, The | Buffalo * | Cobalt. |
| Casey Cobalt Silver Mining Company, Limited. | Casey-Cobalt | New Liskeard. |
| Cobalt Provincial Mining Co., Limited | Provincial | Cobalt. |
| Coniagas Mines, Limited | Coniagas | Cobalt. |
| Crews-McFarlan Mining Co. | Crews-McFarlan | Gowganda. |
| Cross, J. G. | Silver Islet | Port Arthur. |
| Crown Reserve Mining Company, Limited | Crown Reserve | Cobalt. |
| Edwards & Wright, Ltd. | Green Meehan | North Cobalt. |
| Foster Lease (C. L. Campbell *et al.*) | Foster | Giroux Lake. |
| Foster Lease (Central Operating Co.) | Foster | Cobalt. |
| Hargrave Silver Mines, Limited | Hargrave | Cobalt. |
| Hudson Bay Mines, Limited | Hudson Bay | Cobalt. |
| Irwin, Geo. A. † | Cobalt Silver Queen | Cobalt. |
| Kerr Lake Mining Company, Limited | Kerr Lake | Cobalt. |
| Lansdowne, E. T. | Copper Cliff silver-cobalt plant clean-up | Toronto. |
| La Rose Mines, Limited | La Rose | Cobalt. |
| McKinley-Darragh-Savage Mines of Cobalt, Limited | McKinley-Darragh-Savage | Cobalt. |
| Mining Corporation of Canada, Limited, The | Cobalt Lake, Townsite-City | Cobalt. |
| Nipissing Mining Company, Limited | Nipissing | Cobalt. |
| O'Brien, M. J., Limited | O'Brien | Cobalt. |
| do | Miller Lake-O'Brien | Gowganda. |
| Penn-Canadian Mines, Limited | Penn-Canadian | Cobalt. |
| Peterson Lake Silver Cobalt Mining Co., Ltd. | Peterson Lake | Cobalt. |
| Pittsburg Lorrain Syndicate, Ltd. | H.R. 105, or Currie | Silver Centre. |
| Reliance Silver Mines, Ltd. | Reliance | Cobalt. |
| Reeve-Dobie Mines, Limited | Reeve-Dobie | Gowganda. |
| Reid, F. D. (Trustee) | | Cobalt. |
| Right of Way Mines, Ltd. | Right of Way | Cobalt. |
| Temiskaming Mining Company, Limited | Temiskaming | Cobalt. |
| Trethewey Silver-Cobalt Mine, Limited | Trethewey ‡ | Cobalt. |
| Waldman Lease (Mosher and McKay) | Waldman | Cobalt. |

* Sold to the Mining Corporation of Canada, Limited.
† Lease assigned to Brewer, Price and Sullivan, May 5th, 1920.
‡ Sold in January, 1920, to Coniagas Mines, Limited.

Mines shipping over a quarter million ounces of silver in 1919 are given in order:—

| | Ounces. |
|---|---|
| Nipissing | 3,731,892 |
| Mining Corporation | 1,088,064 |
| Coniagas | 918,063 |
| Kerr Lake | 802,243 |
| McKinley-Darragh-Savage | 760,787 |
| Miller Lake-O'Brien | 708,872 |
| O'Brien | 648,501 |
| Buffalo | 577,811 |
| La Rose | 290,227 |
| Crown Reserve | 265,853 |
| Beaver Consolidated | 263,388 |

In Table VII are shown the shipments of ore, concentrates and bullion from the mines of Cobalt, Gowganda and outlying silver areas since mining began in 1904. By "shipment" is meant consignment to outside points whether in Canada or the United States, but not movements within the camp, as for example, ore hauled or shipped by rail from a mine to a concentrating, sampling or reduction plant in Cobalt itself.

It will be noted that the quantity of ore shipped away from the camp has been reduced to very small proportions. Shipments of concentrates were about the average of the last three years, but the average silver contents were considerably lower. This is due to the predominance of concentrates produced by flotation methods.

TABLE VII.—PRODUCTION, SILVER MINES, 1904 TO 1919.

| Year. | No. of Producing Mines. | Shipments and Silver Contents. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Ore. | | | Concentrates and Residues. | | | Bullion. | Total. | |
| | | Tons. | Oz. | Av. per ton. Oz. | Tons. | Oz. | Av. per ton. Oz. | Oz. | Ounces. | Value. $ |
| 1904.... | 4 | 158 | 206,875 | 1,309 | ........ | ............ | ........ | ............ | 206,875 | 111,887 |
| 1905.... | 16 | 2,144 | 2,451,356 | 1,143 | ........ | ............ | ........ | ............ | 2,451,356 | 1,360,503 |
| 1906.... | 17 | 5,335 | 5,401,766 | 1,013 | ........ | ............ | ........ | ............ | 5,401,766 | 3,667,551 |
| 1907.... | 28 | 14,788 | 10,023,311 | 677 | ........ | ............ | ........ | ............ | 10,023,311 | 6,155,391 |
| 1908.... | 30 | 24,487 | 18,022,480 | 736 | 1,137 | 1,415,395 | 1,244 | ............ | 19,437,875 | 9,133,378 |
| 1909.... | 31 | 27,729 | 22,436,355 | 809 | 2,948 | 3,461,470 | 1,174 | ............ | 25,897 825 | 12,461,576 |
| 1910.... | 41 | 27,437 | 22,581,714 | 821 | 6,845 | 7,082,834 | 1,030 | 980,633 | 30,645,181 | 15,478,047 |
| 1911.... | 34 | 17,278 | 20,318,626 | 1,176 | 9,375 | 8,056,189 | 858 | 3,132,976 | 31,507,791 | 15,953,847 |
| 1912.... | 30 | 10,719 | 15,395,504 | 1,436 | 11,214 | 9,768,228 | 871 | 5,080,127 | 30,243,859 | 17,408,935 |
| 1913.... | 35 | 9,861 | 13,668,079 | 1,386 | 11,016 | 8,489,321 | 770 | 7,524,575 | 29,681,975 | 16,553,981 |
| 1914.... | 32 | 4,302 | 6,504,753 | 1,511 | 12,152 | 8,915,958 | 733 | 9,742,130 | 25,162,841 | 12,765,461 |
| 1915.... | 24 | 2,865 | 6,758,286 | 2,359 | 11,996 | 10,001,548 | 834 | 7,986,700 | 24,746,534 | 12,135,816 |
| 1916.... | 28 | 2,177 | 4,672,500 | 2,146 | 8,561 | 7,598,011 | 887 | 7,644,579 | 19,915,090 | 12,643,175 |
| 1917.... | 28 | 2,288 | 3,271,353 | 1,429 | 13,720 | 6,445,243 | 469 | 8,053,318 | 19,401,893 | 16,121,013 |
| 1918.... | 38 | 1,456 | 1,401,050 | 962 | 17,958 | 5,793,756 | 323 | 10,466,888 | 17,661,694 | 17,341,790 |
| 1919.... | 33 | 850 | 806,341 | 949 | 15,208 | 4,024,212 | 265 | ·6,383,761 | 11,214,317 | 12,738,994 |
| Total .. | ........ | 153,874 | 153,920,349 | 1,000 | 122,130 | 81,052,165 | 661 | 66,995,690 | 303,600,183 | 182,031,345 |

In addition to the silver content of the ores, concentrates, residues, etc., the producing mines in many cases are paid for the cobalt contained in them. Returns show that for 555,761 pounds of cobalt recovered and paid for, the producing companies received $163,960 from consignees in southern Ontario, England and the United States, or an average of 29.7 cents per lb. Only one mine reported payment for the copper content of concentrates shipped to the United States, and one company for arsenic contained in residues shipped to England.

The following reference to the price of silver is extracted from the Mining and Scientific Press of San Francisco, page 648, issue of May 10th, 1919:—

From April 23rd, 1918, to May 5th, 1919, the United States Governmnet paid $1 per ounce for all silver purchased by it, fixing a maximum of $1.01½ on August 15th, 1918. On May 5th, 1919, all restrictions on the metal were removed, resulting in fluctuations. During the restricted period, the British Government fixed the maximum price five times, the last time being on March 25th, 1919, on account of the low rate of sterling exchange, this resulting in daily fluctuations. The equivalent of dollar silver (1,000 fine) in Birtish currency is 46.65 pence per ounce (925 fine) calculated at the normal rate of exchange.

In Table 1 the heading "Other Cobalt Compounds" includes cobalt sulphate, cobalt hydroxide, cobaltous hydroxide and alloy, all produced by southern Ontario refineries, also the unseparated cobalt content of ores and residues for which payment was received by the mine owners. This latter item includes shipments by the Nipissing mine to the United States and England.

Table VIII is a statement of dividends and bonuses paid by silver mining companies since the beginning of operations at Cobalt in 1903. Privately-owned mines, such as the O'Brien, which pays a royalty to the Provincial Government, are not included in the list. It is significant that of the total value of minerals produced from Cobalt and outlying silver areas, namely, $192,392,352, up to the end of 1919, a total of $78,335,943 has been returned to shareholders in the shape of dividends or bonuses.

Table IX shows the quantity and value of all the constituents of the ores mined at Cobalt and outlying silver areas from the time the mines were opened. Previous to 1914 an estimate was made of the nickel, cobalt and arsenic contents, exact figures not being obtainable, since few or no assays were made for these minerals for the reason that the mining companies were not paid for them. Since that time only the actual recoveries of these subsidiary minerals have been included.

TABLE VIII.—DIVIDENDS AND BONUSES PAID BY SILVER MINING COMPANIES TO DECEMBER 31, 1919.

| Name of Company | Date of Incorporation | Authorized Capital | Capital Stock Issued | Par value per share | Amount of Dividends and Bonuses paid to end of 1918 | Amount of Dividends and Bonuses paid during 1919 | Rate per cent. | Total of Dividends and Bonuses paid to 31st Dec., 1919 | Date when last Dividend or Bonus was paid |
|---|---|---|---|---|---|---|---|---|---|
| | | $ | $ | $ c. | $ c. | $ c. | | $ c. | |
| Aladdin Cobalt Company, Limited | Aug. 23, 1912 | 500,000 | 500,000 | 5 00 | 75,000 00 | ............ | .... | 75,000 | Apl. 30, 1917 |
| Beaver Consolidated Mines, Ltd | Mar. 1, 1907 | 2,000,000 | 2,000,000 | 1 00 | 650,000 00 | ............ | .... | 650,000 00 | Apl. 8, 1916 |
| Buffalo Mines, Ltd., The (*a*) | April 27, 1906 | 500,000 | 500,000 | 50 | 2,787,000 00 | ............ | .... | 2,787,000 00 | May 28, 1914 |
| Casey Cobalt Silver Mining Company, Ltd | Dec. 19, 1906 | 100,000 | 100,000 | 1 00 | 203,249 33 | ............ | .... | 203,249 33 | Apl. 22, 1914 |
| Cobalt Central Mines Co., Ltd | Dec. 13, 1906 | 5,000,000 | 5,000,000 | 1 00 | 192,845 00 | ............ | .... | 192,845 00 | Aug. 25, 1909 |
| Cobalt Comet Mines, Ltd. (*b*) | April 16, 1913 | 1,000,000 | 1,000,000 | 1 00 | 230,000 00 | ............ | .... | 230,000 00 | Apl. 1, 1915 |
| Cobalt Silver Queen, Ltd | April 1, 1906 | 1,500,000 | 1,500,000 | 1 00 | 315,000 00 | ............ | .... | 315,000 00 | Dec. 31, 1908 |
| Coniagas Mines, Limited, The | Nov. 24, 1906 | 4,000,000 | 4,000,000 | 5 00 | 9,240,000 00 | 400,000 00 | 10 | 9,640,000 00 | Nov. 1, 1919 |
| Crown Reserve Mining Co., Ltd | Jan. 16, 1907 | 2,000,000 | 1,999,957 | 1 00 | 6,190,849 00 | ............ | .... | 6,190,849 00 | Dec. 28, 1916 |
| Foster Cobalt Mining Co., Ltd | Feb. 14, 1906 | 1,000,000 | 915,588 | 1 00 | 45,000 00 | ............ | .... | 45,000 00 | Jan. 1, 1907 |
| Hudson Bay Mines, Ltd | July 16, 1909 | 3,500,000 | 3,200,050 | 5 00 | 778,909 42 | ............ | .... | 778,909 42 | Aug. 31, 1913 |
| Kerr Lake Mining Company, Ltd | Aug. 9, 1905 | 40,000 | 40,000 | 100 00 | 8,448,000 00 | 337,000 00 | .... | 8,785,000 00 | July 3, 1919 |
| La Rose Mines, Ltd | May 31, 1908 | 1,500 000 | 1,500,000 | 1 00 | 6,300,546 84 | ............ | .... | 6,300,546 84 | Apl. 20, 1918 |
| McKinley-Darragh-Savage Mines of Cobalt, Ltd. | April 17, 1906 | 2,500,000 | 2,247,692 | 1 00 | 5,415,945 78 | 269,723 04 | 12 | 5,685,668 82 | Oct. 1, 1919 |
| Mining Corporation of Canada, Ltd. (*c*) | Nov. 23, 1916 | 8,300,250 | 8,300,250 | 5 00 | 4,254,830 47 | 622,518 75 | 7½ | 4,877,349 22 | Sept. 15, 1919 |
| City of Cobalt Mining Co., Ltd. (*d*) | Oct. 5, 1906<br>Jan. 7, 1909 | 500,000<br>1,500,000 | 1,500,000 | 1 00 | 145,000 00 | ............ | .... | 145,000 00 | Apl. 15, 1909 |
| Cobalt Lake Mining Co., Ltd. (*d*) | Dec. 22, 1906 | 3,000,000 | 3,000,000 | 1 00 | 465,000 00 | ............ | .... | 465,000 00 | May 29, 1914 |

TABLE VIII.—*Continued.*

| Name of Company | Date of Incorporation | Authorized Capital | Capital Stock Issued | Par value per share | Amount of Dividends and Bonuses paid to end of 1918 | Amount of Dividends and Bonuses paid during 1919 | Rate per cent. | Total of Dividends and Bonuses paid to 31st Dec., 1919 | Date when last Dividend or Bonus was paid |
|---|---|---|---|---|---|---|---|---|---|
| | | $ | $ | $ c. | $ c. | $ c. | | $ c. | |
| Cobalt Townsite Mining Co., Ltd. (*d*)…. | May, 8, 1906 | 100,000 | 45,011 | 1 00 | 1,042,259 61 | …………. | …. | 1,042,259 61 | Nov. 11, 1914 |
| Nipissing Mining Co., Ltd. (*e*)……………. | Dec. 16, 1904 | 250,000 | 250,000 | 100 00 | 19,438,297 25 | 1,845,000 00 | …. | 21,283,297 25 | Oct. 20, 1919 |
| Penn-Canadian Mines, Ltd. (*f*) …………. | April 24, 1912 | 1,500,000 | 1,349,705 | 1 00 | 175,461 65 | …………. | …. | 175,461 65 | Sept. 10, 1917 |
| Peterson Lake Silver-Cobalt Mining Co., Ltd. | April 11, 1906 | 3,000,000 | 2,469,802 | 1 00 | 462,350 35 | …………. | …. | 462,350 35 | Jan. 2, 1917 |
| Right of Way Mining Co., Ltd……………. | July 13, 1906 | 500,000 | 499,518 | 1 00 | 324,643 93 | …………. | …. | 324,643 93 | Oct. 1, 1909 |
| Right of Way Mines, Ltd………………. | Sept. 11, 1909 | 2,000,000 | 1,685,500 | 1 00 | 252,825 00 | …………. | …. | 252,825 00 | Mar. 17, 1917 |
| Seneca-Superior Silver Mines, Ltd………. | Sept. 29, 1911 | 500,000 | 478,884 | 1 00 | 1,579,817 20 | …………. | …. | 1,579,817 20 | Dec. 15, 1916 |
| Temiskaming Mining Co., Ltd…………. | Nov. 5, 1906 | 2,500,000 | 2,500,000 | 1 00 | 2,059,156 25 | …………. | …. | 2,059,156 25 | Jan. 18, 1918 |
| Temiskaming and Hudson Bay Mining Co., Ltd. | July 29, 1903 | 25,000 | 7,761 | 1 00 | 1,940,250 00 | …………. | …. | 1,940,250 00 | Nov. 10, 1914 |
| Trethewey Silver Cobalt Mines, Ltd…… | May 30, 1906<br>June 1, 1911 | 2,000,000 | 1,000,000 | 1 00 | 1,161,998 50 | 50,000 00 | 5 | 1,211,998 50 | Jan. 2, 1919 |
| Wettlaufer Lorrain Silver Mines, Ltd…….. | Nov. 30, 1908 | 1,500,000 | 1,416,590 | 1 00 | 637,465 50 | …………. | …. | 637,465 50 | Sept. 22, 1913 |
| Total………………………. | …………. | …………. | ………. | …… | 74,811,701 08 | 3,524,241 79 | …. | 78,335,942 87 | ………… |

(*a*) In 1917 the capital stock of the company was reduced from $1,000,000 to $750,000, in 1918 from $750,000 to $500,000, and on December 21, 1919, from $500,000 to $150,000, by returning to shareholders amounts equal to the reduction in capital, leaving 300,000 shares issued of 50 cents each.

(*b*) Cash assets amounting to $50,000 paid on April 27, 1917.

(*c*) Mining Corporation of Canada, Limited, owns and operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines.

(*d*) Now owned and operated by Mining Corporation of Canada, Limited.

(*e*) Includes $16,288,297.25 paid in dividends by the Nipissing Mines Co. (the holding company) to the end of 1916.

(*f*) Paid out of capital $40,491.15 on Sept. 10, 1917, and an equal amount on April 24, 1918.

TABLE IX.—TOTAL PRODUCTION, SILVER MINES, 1904 TO 1919.

| Year | Copper | | Lead | | Nickel | | Cobalt | | Arsenic | | Silver | | Total Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tons | Value | Tons | Value | Tons | Value | Tons | Value | Tons | Value | Ounces | Value | |
| | | $ | | $ | | $ | | $ | | $ | | $ | $ |
| 1904 | ........ | .......... | ........ | .......... | 14 | 3,467 | 16 | 19,960 | 72 | 903 | 206,875 | 111,887 | 136,217 |
| 1905 | ........ | .......... | ........ | .......... | 75 | 10,000 | 118 | 100,000 | 549 | 2,693 | 2,451,356 | 1,360,503 | 1,473,196 |
| 1906 | ........ | .......... | ........ | .......... | 160 | .......... | 321 | 80,704 | 1,440 | 15,858 | 5,401,766 | 3,667,551 | 3,764,115 |
| 1907 | ........ | .......... | ........ | .......... | 370 | 1,174 | 739 | 104,426 | 2,958 | 40,104 | 10,023,311 | 6,155,391 | 6,301,095 |
| 1908 | ........ | .......... | ........ | .......... | 612 | .......... | 1,224 | 111,118 | 3,672 | 40,373 | 19,437,875 | 9,133,378 | 9,284,869 |
| 1909 | ........ | .......... | ........ | .......... | 766 | .......... | 1,533 | 94,965 | 4,294 | 61,039 | 25,897,825 | 12,461,576 | 12,617,580 |
| 1910 | ........ | .......... | ........ | .......... | 504 | .......... | 1,098 | 54,699 | 4,897 | 70,709 | 30,645,181 | 15,478,047 | 15,603,455 |
| 1911 | ........ | .......... | ........ | .......... | 392 | .......... | 852 | 170,890 | 3,806 | 74,609 | 31,507,791 | 15,953,847 | 16,199,346 |
| 1912 | ........ | .......... | ........ | .......... | 429 | 14,220 | 934 | 314,381 | 4,166 | 80,546 | 30,243,859 | 17,408,935 | 17,818,082 |
| 1913 | ........ | .......... | ........ | .......... | 377 | 13,326 | 821 | 420,386 | 3,663 | 64,146 | 29,681,975 | 16,553,981 | 17,051,839 |
| 1914 | ........ | .......... | ........ | .......... | (b) 90 | 28,978 | (b) 351 | 590,406 | 2,030 | 116,624 | 25,162,841 | 12,765,461 | 13,501,469 |
| 1915 | ........ | .......... | ........ | .......... | (c) 35 | 28,353 | (d) 206 | 383,261 | 2,490 | 148,379 | 24,746,534 | 12,135,816 | 12,695,809 |
| 1916 | ........ | .......... | ........ | .......... | (c) 79 | 59,380 | (d) 400 | 805,014 | 2,160 | 200,103 | 19,915,090 | 12,643,175 | 13,707,672 |
| 1917 | (a) 53 | 28,840 | ........ | .......... | (c) 155 | 125,071 | (d) 337 | 1,138,190 | 2,592 | 608,483 | 19,401,893 | 16,121,013 | 18,021,597 |
| 1918 | (a) 72 | 35,712 | (a) 3 | 453 | (c) 186 | 156,893 | (d) 380 | 1,640,310 | 2,545 | 566,332 | 17,661,694 | 17,341,790 | 19,741,490 |
| 1919 | (a) 110 | 40,976 | (a) 12 | 1,296 | (c) 276 | 188,418 | (d) 298 | 1,019,479 | 2,834 | 485,360 | 11,214,317 | 12,738,994 | 14,474,523 |
| Total | 235 | 105,528 | 15 | 1,749 | 4,520 | 629,280 | 9,628 | 7,048,189 | 44,168 | 2,576,261 | 303,600,183 | 182,031,345 | 192,392,352 |

(a) Copper and lead are recovered from certain silver ores and concentrates shipped to United States refineries.
(b) Metallic contents of Nickel and Cobalt oxides respectively.
(c) Metals and metallic contents of all Nickel compounds.
(d) Metals and metallic contents of all Cobalt compounds.

*Treatment and Reduction Plants.*—Following is an epitome of the operation of plants at Cobalt which treat custom or purchased ores by way of sampling, concentration or reduction to bullion.

ORE SAMPLING, CONCENTRATION AND REDUCTION WORKS, 1919.

| Firm | Ore sampled | Ore treated | Concentrates produced | Conceentrates treated | Base Bullion, etc., treated | Silver Bullion produced |
|---|---|---|---|---|---|---|
| | tons | tons | tons | tons | lbs. | fine ounces |
| Cobalt Reduction Company | | 3,288 | .......... | 448 | 9,480 | 787,365 |
| Dominion Reduction Company | | 44,618 | 7,284 | 2,217 | ........ | 185,870 |
| Nipissing Mining Company, Ltd. | | 222 | .......... | ........ | 13,003 | 650,918 |
| Northern Customs Concentrators, Ltd. | | 33,531 | 903 | ........ | ........ | .......... |
| Temiskaming Testing Laboratories... | 554 | ........ | .......... | ........ | ........ | 41,982 |
| Total | 554 | 81,659 | 8,187 | 2,665 | 22,483 | 1,666,135 |

The last mentioned plant is operated by the T. & N. O. Ry. Commission and silver bullion recovered, averaging about 900 fine, is returned to the producers of the ore. The main operations consist of ore sampling. The Cobalt Reduction Company and Nipissing Mining Co. purchase ores, base bullion, etc. Employees engaged in these works numbered 316 and their wages amounted to $421,438.

*Refineries.*—In the southern part of Ontario there are four reduction works for the treatment of silver ore and concentrates from Cobalt. The Deloro company handles mainly the product of the O'Brien and Miller Lake O'Brien mines, the property of M. J. O'Brien, Limited, which also controls the refinery, while the Coniagas Reduction Company, Limited, refines for the most part the ores and concentrates shipped from the Coniagas mine. Metals Chemical, Limited, ran last year mainly on residues from the Nipissing Mining Company's high grade ore refinery at Cobalt. This company aims primarily at the production of the compounds of cobalt and nickel, and not at the recovery of silver. After operating for the first quarter of 1920, Metals Chemical, Limited, sold its plant to Ontario Smelters and Refiners, Limited. The latter is a newly organized company, which also owns the plant of the Standard Smelting and Refining Company. The operations at the plant of the last mentioned company have been small, cobalt and nickel oxides being the only products marketed in 1919.

REFINERS OF SILVER-COBALT ORES, 1919.

| Name of Company | Location of Works | P.O. Address |
|---|---|---|
| Deloro Smelting and Refining Co., Limited | Deloro | Deloro. |
| Coniagas Reduction Co., Limited | Thorold | St. Catharines. |
| Metals Chemical, Limited | Welland | Welland. |
| Standard Smelting and Refining Co., Limited | Chippawa | Niagara Falls. |

The operations of the refining companies during 1919 are summarized in the figures given below. Apart from the silver recovered, the by-products of the ores from Cobalt and outlying silver areas had a value of $1,596,744.

OPERATIONS OF SILVER-COBALT REFINERIES IN ONTARIO, 1919.

| Product | Quantity | Value |
|---|---|---|
| | | $ |
| Ore, treated ... tons | 881 | ... |
| Concentrates, treated ... " | 2,999 | ... |
| Residues, " ... " | 4,380 | ... |
| Silver recovered and marketed ... fine ounces | 4,390,539 | 5,070,102 |
| Arsenic, Crude and White, shipments ... lbs. | 5,274,884 | 483,604 |
| Cobalt Oxide, shipments ... " | 426,573 | 634,553 |
| Cobalt Hydroxide, Sulphate and Alloy, shipments ... " | 66,193 | 46,615 |
| Cobalt, Metallic, shipments ... " | 121,926 | 243,554 |
| Nickel Oxide, shipments ... " | 11,817 | 3,762 |
| Nickel Sulphate and Carbonate, shipments ... " | 353,267 | 46,711 |
| Nickel, Metallic, shipments ... " | 399,584 | 137,945 |
| Total value of Products Marketed ... | ... | 6,666,846 |

The number of workmen employed in the refineries was 464 and the wages paid them amounted to $670,407.

The following figures have been compiled from information furnished by refineries in the United States which treated products from Ontario silver mines:—

| | |
|---|---|
| Ore treated, tons ... | 311 |
| Concentrates treated, tons ... | 4,043 |
| Residues or slag treated, tons ... | 14 |
| Silver recovered, ounces ... | 1,413,934 |
| Gold recovered, ounces ... | 1.36 |
| Copper recovered, lbs. ... | 219,126 |
| Lead recovered, lbs. ... | 23,568 |

## Nickel and Copper

Following the close of the war in November, 1918, the output of the nickel-copper mines and smelters was greatly curtailed, owing to the sudden falling off in the demand for these metals, particularly nickel. Towards the close of 1919, however, market conditions had somewhat improved, and the smelters at the end of the year were again working on a scale approaching that of the pre-war period.

Ore raised in the year amounted to 614,955 tons as compared with 1,643,040 tons in 1918; and ore smelted to 754,567 tons, as compared with 1,559,892 tons. Bessemer matte produced was 42,735 tons as against 87,184 tons in 1918, and the nickel and copper contents were 22,035 tons and 12,099 tons respectively, as compared with 45,886 tons and 23,843 tons in 1918. Shipment was made of 11,099 tons of matte for refining purposes to Port Colborne, Ont.; 22,016 tons to Bayonne, N.J., and 3,191 tons to Clydach, Wales. The Port Colborne refinery of the International Nickel Company of Canada treated 10,911 tons of matte, recovering therefrom 4,901 tons of metallic nickel and 2,737 tons of blister copper, in addition to small quantities of gold, silver, platinum and palladium.

On January 17th, 1920, the new smelter of the British America Nickel Corporation at Nickelton was blown in, and on January 21st the first converter went into commission. Ore is being raised from the Murray mine in which diamond drill borings have disclosed over 16,000,000 tons of smelting ore. The inclined shaft is down 1,100 feet, and eight levels have been established, on five of which electric locomotives are used.

In the Nickelton smelter, which is situated one mile from the Murray mine, there are two blast furnaces and three Pierce-Smith basic-lined converters in operation. Another blast furnace and converter have been ordered. The most noteworthy features of operation are described in a letter dated June 24th, 1920, by W. A. Carlyle, Managing Director, as follows:

In the blower room are four turbo-blowers, each driven by steam turbines, 3,600 r.p.m., Rateau-Battu-Smoot design, made by the Dominion Bridge Co., Limited, Montreal. There are two blowers of 30,000 cu. ft. free air each at 36 oz. for blast furnaces and two of 36,000 cu. ft. each, 12 pound pressure, for supplying air to converters, the steam turbines for the latter being 2,200 h.p. The air stabilizers and governors first supplied were not successful, but new ones just installed, using monel metal in certain parts are operating well and this unique blower plant now promises to be most satisfactory. Each turbine has its surface condenser complete in every detail. A 300 k.w. motor-generator set supplies D.C. power to the locomotives, cranes and converters in the smelter building and a duplicate will soon be placed.

The ore consists of eruptive rock (norite), impregnated with pyrrhotite and some chalcopyrite, containing about 25 per cent. $SiO_2$, 35 per cent. Fe., and 18 per cent. S., etc., and the metallurgical process is to smelt this ore direct without roasting and to convert the low-grade matte containing 10 to 12 per cent. copper and nickel to the usual 80 per cent. matte, which is granulated and sent to the refinery. Converter slag, averaging about 16 per cent. $SiO_2$, is the only flux used in the blast furnace, which easily smelts 1,000 tons of ore and flux per day and has done 1,148, taking about 10 per cent. coke in the charge. At each end of each furnace is a 20′ by 30′ settler, having at one end two tapholes and two syphon exists for matte, the latter a new device, permitting most successfully the drawing off of matte from near the top of settler, thus avoiding break-aways.

In the converters low-grade matte is fluxed with fine ore and some blast furnace molten slag, gravel or sand being used for end fluxing when a completed charge of 60 to 110 tons of 80 per cent. matte is poured and granulated. The converter slag is partly poured into the settlers and partly into beds, where after being broken up by hand or explosives it is loaded by steam loco-cranes and sent to the smelter bins. There is no trouble in producing slag containing only 14 to 15.5 per cent. $SiO_2$, making a good iron flux for the blast furnace. The Garr gun is used for charging the fine ore or gravel. There are large dust flues and chambers, with a brick stack 300 feet high and 25 feet internal diameter.

The electrolytic refinery is situated on the Ottawa river, at Deschenes, Quebec, where cheap electric power is available. Mr. Carlyle's description follows:

The matte passes through two Wedge roasters with 8 hearths, thence to leaching department where part of the copper is leached out and sent to the copper electrolytic depositing house. The leached matte is then smelted with fluxes in a specially designed electric furnace using 24″ carbon electrodes, and nickel-copper anodes, weighing 200 pounds, are cast in moulds on a revolving table. This furnace has proved a signal success. These anodes go to the nickel house where the nickel is electrically plated out by the Hybinette process, the cathodes being then either cut up or remelted in a Rennerfelt electric furnace and poured into ingots or granulated to shot. The slimes containing platinum, palladium, gold, iridium, etc., will be refined in the precious metals department. The capacity of the present plant is 15,000,000 pounds nickel and 9,000,000 pounds copper per annum, but at comparatively small expenditure can be greatly increased.

A report for the half year ending June 30th, 1920, showed that 1,185 tons of Bessemer matte had been produced at the smelter. All this matte had been shipped to the refinery and was in process of treatment.

The production of ore during the year from the several mines was as follows:—

| | Tons. | Tons. |
|---|---|---|
| International Nickel Company of Canada:— | | |
| Creighton | 356,143 | |
| Crean Hill | 3,613 | |
| | | 359,756 |
| Mond Nickel Company:— | | |
| Levack | 58,383 | |
| Garson | 57,205 | |
| Worthington | 33,299 | |
| Bruce | 27,123 | |
| Victoria No. 1 | 26,934 | |
| Steinberg | 139 | |
| | | 203,083 |
| Alexo Mining Company:— | | |
| Alexo | | 2,216 |
| British America Nickel Corporation:— | | |
| Murray | | 49,900 |
| Total | | 614,955 |

The ore raised from the Alexo mine at Porquis Junction near Porcupine was shipped, as usual, to the Mond Nickel Company, and smelted at the latter's works, Coniston.

In Table X given below is indicated the course of the nickel industry during the last five years. That this metal takes on added importance during times of war is sufficiently shown by the fact that while in 1914 the quantity of ore smelted was 947,053 tons, it rose in 1918 to 1,559,892 tons, and fell to 754,567 tons in 1919.

TABLE X.—NICKEL-COPPER MINING AND SMELTING, 1915-1919.

| Schedule | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Ore raised.................tons. | 1,339,322 | 1,572,804 | 1,536,828 | 1,643,040 | 614,955 |
| Ore smelted............... " | 1,272,283 | 1,546,215 | 1,453,661 | 1,559,892 | 754,567 |
| Bessemer matte produced.. " | 67,703 | 80,010 | 78,897 | 87,184 | 42,735 |
| Nickel contents of matte ... " | 34,039 | 41,299 | 41,887 | 45,886 | 22,035 |
| Copper contents of matte... " | 19,608 | 22,430 | 21,197 | 23,843 | 12,099 |
| Value of Nickel in matte.... $ | 17,019,500 | 20,649,279 | 20,943,500 | 27,531,600 | 11,017,500 |
| Value of Copper in matte.... $ | 3,921,600 | 8,299,051 | 7,842,890 | 8,453,880 | 3,387,720 |
| Wages paid................. $ | 3,581,639 | 4,920,720 | 5,570,587 | 6,861,773 | 3,382,154 |
| Men employed.............. No. | 4,178 | 4,730 | 3,356 | 3,145 | 2,536 |

The following figures summarize the operations of the International Nickel Company of Canada's refinery at Port Colborne:—

TABLE XI.—NICKEL-COPPER REFINING, 1919.

| Schedule | | Quantity | Value |
|---|---|---|---|
| | | | $ |
| Matte refined in Ontario | tons | 10,911 | ............... |
| Metallic Nickel recovered | " | 4,901 | 3,455,039 |
| Blister Copper " | " | 2,737 | 938,141 |
| Gold " | ounces | 328.08 | 6,562 |
| Silver " | " | 20,570 | 23,864 |
| Platinum and Palladium | " | 87.26 | 4,981 |
| Total value of Products | | ............... | 4,428,587 |

## Platinum Metals

In addition to the platinum and palladium shown in Table XI to have been recovered by the International Nickel Company of Canada at the Port Colborne refinery, these metals and others of the platinum group, namely, rhodium, osmium, iridium and ruthenium were obtained at the Bayonne, N.J., works from the 19,528 tons of Bessemer matte treated there. In all, some 1,770 fine ounces were recovered, having an estimated value of $200,000. No definite figures are available in relation to the rare metal contents of the Mond Nickel Company's matte refined at Clydach. Formerly this company disposed of the residues from the matte refinery to the London firm, Johnson, Matthey and Company, who treated them for the recovery of platinum, etc., but the Mond Company has now installed a refining plant at Clydach, and will henceforth make its own recoveries.

The average price of platinum for the year was $114.61 per fine ounce. Palladium has been valued at $130 per ounce Troy; iridium at $300. The average value of iridium imported into the United States in 1918 was $114.18 per ounce, and for osmium it was $58.40 per ounce in 1917.

## Iron Ore, Pig Iron, Ferro-Alloys and Coke

*Iron Ore.*—The quantity marketed in 1919 fell a little short of the 1918 output, the figures being 195,915 and 198,882 short tons respectively. The entire shipments from the Magpie mine, 189,962 tons, went to the blast furnaces of the Algoma Steel Corporation, at Sault Ste. Marie. The output by four other producers of ore was shipped outside the Province, namely 5,953 tons valued at $48,341. This includes 5,484 tons of briquettes shipped to the United States by Moose Mountain, Limited. During the year 291,408 tons of ore were raised. In iron ore mining and beneficiation 559 men were employed whose wages amounted to $650,242.

Following is a list of iron mines from which shipments were made during the year:—

SHIPPERS OF IRON ORE, 1919.

| Company or Firm. | Mine. | Location. | Kind of Ore. | P.O. Address of Company. |
|---|---|---|---|---|
| Algoma Steel Corporation, Ltd. | Magpie | Algoma dist. | Siderite | Sault Ste. Marie. |
| Consolidated Iron & Steel Corporation | .................. | Furnace Falls, Leeds Co. | Hematite | Toronto, 24 King St. W. |
| Moose Mountain, Ltd. | Moose Mountain | Sudbury dist. | Magnetite | Sellwood. |
| Poe Mining Company | Ferguson | Palmerston tp. | Low-Phos. Magnetite | Clarendon Station. |

Regarding one by-product of iron furnaces, it has been demonstrated that blast furnace slag forms a suitable and standard aggregate for concrete in all classes of construction. It also makes a desirable railway ballast and is a good macadamizing material for roads.

Basic slag is utilized to a considerable extent as a fertilizer, being substituted for acid phosphate. Experiments over a period of 25 years at the Ohio agricultural experimental station have demonstrated that practically equivalent results in the case of most grains may be obtained from a 17 per cent. basic slag and 14 per cent. acid phosphate. Heretofore in Ontario blast furnace slag has not been used to any notable extent, while its disposal involves heavy expenditure in providing sites for dumps and also in labour costs for handling.

In the United States for the years 1917 and 1918 about eight million gross tons of iron ore per year were subjected to some form of beneficiation. Various processes and combinations were employed. For the year 1918 iron ores from 101 mines in 15 states were beneficiated. Reference was made in the last annual report of the Ontario Bureau of Mines to the necessity of beneficiation in some form for nearly all the iron ores produced in Ontario. At the Magpie mine siderite (iron carbonate) is roasted, calcined and nodulized before shipping to the blast furnace. At Moose Mountain magnetite is concentrated and briquetted. Unfortunately high-grade hematite is not plentiful in Ontario, while silicious magnetites, difficult to concentrate, are widespread. Experiments have been conducted as far back as 1906 at Sault Ste. Marie and elsewhere in the hope of finding a satisfactory method of treating these magnetites.

Jas. W. Moffat of Toronto has carried on investigations for several years and has patented processes which he claims are applicable to small deposits as well as to large bodies of ore. The method,[1] which is a discontinuous one, is a combination reduction and electric treatment, utilizing carbon monoxide gas in the reduction process and thereby lowering fuel costs. After crushing and concentration to a state of fine subdivision, the ore is charged to the reducing furnace where the sulphur is first eliminated and then carbon in the form of coke is added. Afterwards the reduced ore in the form of fines or " sponge " is melted down in the electric furnace. That electrical treatment is practical was demonstrated in Ontario during the war, when electric smelting of scrap steel was carried out on a large scale.

Prof. Alfred Stansfield of McGill University is conducting experiments along similar lines, namely the reduction of iron ores to a metallic powder in fuel-fired furnaces at very moderate temperatures, followed by further treatment in the electric furnace. He is being assisted financially in this work by a federal grant from the Honorary Advisory Council for Scientific and Industrial Research.

Recent experiments by other investigators indicate the possibility of using powdered non-coking coal as a blast furnace fuel, forecasting a revolutionary departure from traditional practice.

If a practical commercial process is evolved from these investigations it will mean much for Ontario, making available large tonnages of low-grade ores. Lower fuel costs and the utilization of hydro-electric energy from widely distributed water-powers combine to produce conditions that will admirably suit Ontario's peculiar situation as regards the development of her iron and steel industry.

*Pig Iron.*—Production for 1919 fell off considerably from the 1918 output, the figures for the two years being 623,586 short tons, worth $16,010,537 and 751,650 tons valued at $20,522,356 respectively. The output in 1917 was 67,647 tons

[1] Can. Mng. Journal, Oct. 1st, 1920, p. 796.

greater than the 1919 production, but its value was $1,809,158 less. The average prices for 1917, 1918 and 1919 were $20.54, $27.30 and $25.67 per short ton. During the year 1,299,348 tons of ore were charged to blast furnaces, of which only 97,514 tons or 7.5 per cent. were of Ontario origin, the remainder being imported from the United States.

The producing companies are shown in the list given below. Ten blast furnaces were in operation during the year. The four furnaces of the Algoma Steel Corporation were in blast for 285, 364, 171 and 141 days respectively. The Canadian Furnace Company had one furnace in blast for the full year. The furnaces of the Midland Iron and Steel Company, Standard Iron Company and Parry Sound Iron Company closed down on August 16th, October 15th and June 9th respectively, while the two furnaces of the Steel Company of Canada, Hamilton, were shut down for short periods, one for 17 and the other for 80 days.

The blast furnaces and steel mills now under construction by the Canadian Steel Corporation, Limited, at Ojibway, near Windsor, have not yet come into operation.

IRON BLAST FURNACES IN OPERATION, 1919.

| Name of Company. | Number of Furnaces. | Fuel used. | Location. |
|---|---|---|---|
| Algoma Steel Corporation, Limited ....... | 4 | Coke........... | Sault Ste. Marie. |
| Canadian Furnace Company, Limited ..... | 1 | Coke........... | Port Colborne. |
| Midland Iron and Steel Company, Limited. | 1 | Coke........... | Midland. |
| Parry Sound Iron Company, Limited .... | 1 | Coke........... | Parry Sound. |
| Standard Iron Company, Limited ........ | 1 | Coke, charcoal... | Deseronto. |
| Steel Company of Canada, Limited........ | 2 | Coke........... | Hamilton. |

Table XII gives particulars of the iron and steel-making industry of the Province for the last five years.

TABLE XII.—PRODUCTION IRON AND STEEL, 1915 TO 1919.

| Schedule. | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Ontario ore smelted...............tons | 293,305 | 215,366 | 94,318 | 99,852 | 97,514 |
| Foreign ore smelted .............. " | 623,094 | 1,056,810 | 1,221,881 | 1,400,085 | 1,201,834 |
| Limestone for flux................ " | 215,686 | 296,988 | 319,535 | 405,683 | 343,907 |
| Coke ............................ " | 486,022 | 708,273 | 723,657 | 869,729 | 736,872 |
| Charcoal........................ bush. | 1,314,957 | 1,843,209 | 1,288,390 | .......... | 177,795 |
| Pig iron produced.................tons | 493,400 | 699,202 | 691,233 | 751,650 | 623,586 |
| Value of pig iron produced .......... $ | 5,910,625 | 9,739,704 | 14,201,695 | 20,522,356 | 16,010,537 |
| Steel made.......................tons | 471,059 | 686,959 | 862,504 | 881,509 | 616,251 |
| Value of Steel made ............... $ | 7,618,272 | 12,847,309 | 22,179,982 | 28,792,361 | 17,913,263 |

As regards steel, it should be noted that the foregoing table includes only steel made by plants in which iron ore is reduced in the blast furnace and converted into steel, whether or not the process is a continuous one. No account is taken of what may be called secondary steel, namely, that made from scrap, turnings, etc., nor does the production of pig iron include that made from scrap.

*Ferro-Alloys.*—In addition to pig iron and steel the Algoma Steel Corporation produced 28,771 tons of spiegeleisen valued at $1,031,804.

Ferro-silicon and silico-manganese varying from 15 to 75 per cent. of silicon content were produced by Electro-Metals, Limited, at Welland. The raw products treated in the electric furnace include silica and steel turnings of domestic origin, and pyrite ore cinder from the United States. There is also a small output of ferro-silicon as a by-product by companies manufacturing artificial abrasives in the electric furnace from imported bauxite. Included in this list are the National Abrasive Company of Niagara Falls and the Norton Company at Chippawa. In all 14,967 tons of ferro-silicon valued at $749,380 were produced.

No record was obtained of the output of low-phosphorus pig iron in the electric furnace from scrap turnings, this being regarded as a secondary metal.

*Coke.*—Production of coke in Ontario is entirely from imported coal. In the United States by-product coke ovens are gradually replacing the old beehive ovens, a logical evolution affording greater economy, increased efficiency and wider application. By-product ovens possess notable superiority over the beehive type in all these particulars. During the year the Algoma Steel Corporation operated 110 Koppers and 50 Wilputte by-product ovens, while the Steel Company of Canada used 80 Wilputte ovens. From 1,015,706 tons of imported coal, valued at $5,182,249, the output of coke was as follows: blast furnace and foundry coke, 667,081 tons valued at $4,995,059, of which 108,947 tons worth $792,544 were marketed, the balance being used by the companies themselves. In connection with its coke plant, the Steel Company of Canada is installing a benzol plant capable of producing 100,000 gallons of motor fuel per month.

Coke oven by-products were produced as follows:

| Schedule | Quantity | Value |
|---|---|---|
| | | $ |
| Ammonium sulphate ........................ lbs. | 21,771,903 | 629,899 |
| Tar .................................... gals. | 7,566,402 | 338,263 |
| Gas ................................ M. cu. ft. | 6,881,785 | 479,155 |
| Domestic coke and braize ................. tons | 123,581 | 181,691 |
| Total ........................................ | | 1,629,008 |

The Semet Solvay Company has leased a property from the Toronto Harbour Commission for the installation of by-product coke ovens as soon as conditions warrant, construction costs at present being too high. British Foundation Ovens, Limited, also purposes the erection of retort ovens in the neighbourhood of Hamilton and Toronto. These enterprises require considerable capital, and it is not expected that construction will begin in 1920 as originally contemplated.

## Lead

With the exception of 54,074 pounds recovered from Ontario silver and gold ores refined in the United States, the entire output of lead came from the Kingdon mine at Galetta on the Ottawa river. For the first quarter of the year the mine and smelter were operated by the Jas. Robertson Estate. After re-organization and the formation of a new company called the Kingdon Mining, Smelting and Manufacturing Company, operations were continued during the last two months of the year. The lead smelter at Kingston operated on lead slag from Galetta up to June 1st, when it closed down. The entire output of pig lead by the Kingston Smelting Company, Limited, was returned to the Jas. Robertson Estate at Montreal with the exception of 36,993 pounds, which was marketed by the smelter.

Shipments of pig lead during the year, including recoveries in the United States from Ontario gold and silver ores, totalled 1,529,987 pounds, valued at $94,507. The average number of employees in mine and smelters was 83 and wages paid amounted to $62,601.

## Materials of Construction

An idea of the activity in the building trades during 1919 as compared with the nine years preceding may be had from the figures presented in February, 1920, issue of the *Labour Gazette*. Building permits for 15 Ontario cities in 1919 totalled $40,584,834, as compared with a maximum of $20,229,574 for any year during the war period. In 1912 and 1913, the best pre-war years, permits averaged nearly $50,000,000 per year. Taking into consideration the fact that cost of materials and labour in 1919 had increased between 50 and 100 per cent. as compared with pre-war prices, it is seen that building construction in 1919 would not represent more than a $25,000,000 outlay, or one-half that of 1912 or 1913 on a similar basis of prices. High cost of materials, doubtless, had much to do in retarding construction work. Builders feared that an early drop in prices might occur. Nevertheless, practically all materials in the several building trades, as well as the cost of labour, continued to rise in price.

## Clay Products

*Brick and Tile.*—For the first time since 1914 the output of clay products has reached a valuation approximating pre-war years. Labour and fuel scarcity had something to do in keeping down production, while builders refrained from large scale house construction owing to high costs and unsettled labour conditions. There is still a marked shortage of housing accommodation, owing to the inactivity in building operations during the war period. Common brick, which sold at an average price of $7.96 per M. in 1915 have risen to $13.92 per M. at the works. Details of the industry are shown in the tables which follow:—

TABLE XIII.—OUTPUT AND VALUE OF CLAY PRODUCTS, 1919.

| Product | Marketed | | Stock on hand Dec. 31, 1919 |
|---|---|---|---|
| | Quantity | Value $ | |
| Common Brick ........................M | 141,255 | 1,966,711 | 48,412 M. |
| Pressed Brick........................M | 29,994 | 532,464 | 3,322 M. |
| Tapestry or Rug Brick................M | 7,444 | 137,898 | 1,784 M. |
| Drain Tile ..........................M | 13,009 | 354,700 | ............... |
| Hollow Building and Roofing Tile.....tons | 17,435 | 184,900 | ............... |
| Pottery............................. | ................ | 119,551 | $15,061 |
| Sewer Pipe.......................... | ................ | 609,100 | $202,854 |

The following table shows the comparative value of the output of clay products since the outbreak of the war:—

TABLE XIV.—VALUE OF CLAY PRODUCTS, 1914-1919.

| Year | Brick | | Pottery | Drain Tile | Sewer Pipe | Total |
|---|---|---|---|---|---|---|
| | Common | Pressed, Fancy, Hollow Tile, etc. | | | | |
| | $ | $ | $ | $ | $ | $ |
| 1914........... | 2,336,207 | 894,384 | 25,720 | 277,530 | 571,756 | 4,105,597 |
| 1915........... | 763,591 | 375,865 | 49,387 | 321,253 | 361,283 | 1,871,379 |
| 1916........... | 509,559 | 495,895 | 87,025 | 275,471 | 216,749 | 1,584,699 |
| 1917........... | 713,824 | 776,302 | 94,501 | 546,040 | 379,923 | 2,509,590 |
| 1918........... | 665,454 | 592,286 | 88,275 | 309,899 | 362,536 | 2,018,450 |
| 1919........... | 1,966,711 | 726,500 | 119,551 | 354,700 | 609,100 | 3,776,562 |

Fuel for the firing of brick and tile kilns was both scarce and dear. Many plants did not operate for this reason. Owing to measures taken to confine the use of natural gas to domestic purposes there was a marked decrease in the consumption of that fuel.

FUEL CONSUMPTION, BRICK AND TILE PLANTS.

| Wood | | | Coal or Coke | | | Natural Gas | | |
|---|---|---|---|---|---|---|---|---|
| Cords | Value | | Tons | Value | | M. cu. ft. | Value | |
| | Total | per cord | | Total | per ton | | Total | per M. |
| | $ | $ c. | | $ | $ c. | | $ | $ c. |
| 30,180 | 208,789 | 6 92 | 95,189 | 590,348 | 6 20 | 44,847 | 9,869 | 0 22 |

The average period of operation for 119 brick and tile plants was 149 days in the year 1919. Many of the smaller plants operate in the summer months only. Employees numbered 1,904, and $1,405,132 was paid in wages.

Following is a list of the brick and tile operators who reported an output in 1919:

BRICK AND TILE PLANTS, 1919.

| Name. | Address. | Product. |
|---|---|---|
| Alvinston Brick & Tile Co., Ltd. | Alvinston | Tile and Hollow Blocks. |
| Armstrong Bros. | Fletcher | Tile. |
| Arnold, Willard | Virginia | Brick. |
| Baird & Son, H. C. | Parkhill | Brick, Tile and Blocks. |
| Bechtel, B. E. | Waterloo | Brick. |
| Bell & Son, R. | Paisley | Brick and Tile. |
| Bond & Bird | Woodstock, R.R. No. 5. | Common and Pressed Brick. |
| Booth Brick & Lumber Co., Ltd. | Islington, R.R. No. 1. | Common and Pressed Brick. |
| Brampton Pressed Brick Co. | Brampton | Pressed Brick. |
| Broadwell & Son, B. | Kingsville | Tile. |
| Brownscombe & Sons, H. | Cargill | Brick and Tile. |
| Buck, J. L. | Port Rowan | Brick, Tile and Blocks. |
| Bushell, Wm. | Toronto, 2 Gillespie Av. | Brick. |
| Butwell, Richard | Humber Bay | Brick. |
| Cabana, Jr., Oliver | Zurich | Brick and Tile. |
| Canadian Pressed Brick Co., Ltd. | Hamilton, 36 Sun Life Bldg. | Pressed Brick. |
| Canadian Wood Products, Ltd. | Toronto, 1,000 Gerrard St. E. | Brick. |
| Champion Brick & Tile Co. | Kingsville | Brick and Tile. |
| Clay Products Co. | Ruscomb | Brick. |
| Cooper, W. H. | Hamilton, 52 Gage Av. N. | Brick. |
| Crang, J. | Toronto, 202 Oakwood Av. | Brick. |
| Credit Forks Tile & Brick Co., Ltd. | Toronto, 88 St. David's St. | Brick. |
| Curtin, Francis | Lindsay | Brick. |
| Deller, Albert, & Co. | Vienna | Brick, Tile and Blocks. |
| Deller & Sons, Geo | Norwich, R.R. No. 2. | Brick, Tile and Hollow Blocks. |
| Deller, Wm. H. | Thorndale, R.R. No. 4. | Tile and Blocks. |
| Dochart Brick & Tile Works | Arnprior | Brick, Tile and Blocks. |
| Dolan, John | Watford, R.R. No. 2. | Tile. |
| Dominion Sewer Pipe & Clay Industries, Ltd. | Aldershot | Brick. |
| Don Valley Brick Works | Todmorden | Common, Pressed and Tapestry Brick. |
| Dougherty, Thos. | Henfryn | Brick and Tile. |
| Elliott, Charles | Bluevale | Brick and Tile. |
| Elliott, Wm. | Glenannan | Brick and Tile. |
| Elliott & Sons, Jas. | Sault Ste. Marie, 519 Wellington St. N. | Brick and Tile. |
| Fort William Brick & Tile Co. | Fort William | Brick. |
| Fox, Geo. J. | Dresden | Brick. |
| Frid Bros. | Hamilton | Brick. |
| Frost, Geo. H. | Toronto, 29 Cloverdale Road | Brick. |
| Gardiner, William | Blenheim | Brick and Tile. |
| Godfrey & Co., Thos. | Carleton Place | Brick. |
| Govenlock, J. M. | Seaforth, R.R. No. 1. | Brick and Tile. |
| Gowanlock, Jas. | West Fort William. | Brick. |

BRICK AND TILE PLANTS, 1919—*Continued.*

| Name. | Address. | Product. |
|---|---|---|
| Hallatt & Son, H. | Comber | Brick and Tile. |
| Halton Brick Co., Ltd. | Terra Cotta | Pressed Brick. |
| Hamilton Pressed Brick Co., Limited | Hamilton, Kensington Ave. S. | Pressed Brick. |
| Hill, Aaron | Essex | Tile. |
| Hill, A. W. | Coatsworth, R.R. No. 1 | Tile. |
| Hinde Bros. | Mount Dennis | Brick. |
| Hiscock & Sons | Cobourg | Brick. |
| Hitch, Mrs. Susan | Ridgetown | Brick and Tile. |
| Hohl, John | Wellesley, R.R. No. 1. | Brick and Tile. |
| Holland & Son, William | Ruscomb | Tile. |
| Howlett, Fred | Petrolia | Tile. |
| Huntsville Brick Co. | Huntsville | Brick. |
| Ideal Brick & Tile Co. | Brantford, Grey St. | Brick. |
| Interprovincial Brick Co. of Canada, Ltd., The | Toronto, 30 Toronto St. | Pressed Brick. |
| Jackson Bros. | Brantford | Brick. |
| Janes, D. A. | Mt. Brydges | Brick and Tile. |
| Jervis & Son, John | Dorchester Station | Brick and Tile. |
| Kaar, John | Brownsville | Brick and Tile. |
| Koebel, Joseph Z. | St. Clements | Brick and Tile. |
| Kruse Bros. | Seaforth, R.R. No. 3. | Tile. |
| Kuhn, Henry J. | Centralia, R.R. No. 2. | Tile. |
| Labey & Son, Geo. A. | Foxboro' | Tile. |
| Lethbridge Brick Co., Ltd. | Sault Ste. Marie | Brick. |
| Lindsay, Stephen | Wallaceburg, R.R. No. 2 | Tile. |
| Lowes, Gordon | Chatham, R.R. No. 3. | Brick and Tile. |
| Martin, David | Thamesville | Tile. |
| McCormick Bros. | Watford, R.R. No. 5. | Brick and Tile. |
| McCredie, W. | Belmont, R.R. No. 3. | Tile. |
| McLoughlin, Jno. | London, 1,044 William St. | Brick. |
| Merkleys, Ltd. | Billings Bridge | Brick. |
| Middleton, Chas. | Wyoming | Tile. |
| Milton Pressed Brick Co., Ltd. | Milton | Pressed and Tapestry Brick. |
| Miner, J. T. | Kingsville, R.R. No. 2. | Tile. |
| Napanee Brick & Tile Co. | Napanee | Brick and Tile. |
| National Fire Proofing Co. of Canada, Ltd. | Toronto, 601 Dominion Bank Bldg. | Brick, Tile and Blocks. |
| New, Edward | Hamilton, Dundas Rd. | Brick. |
| Norton, Alsey | Bolton | Tile. |
| Norton, T. W. | Toronto, Station D | Brick. |
| Odell & Sons, Wm. | Ingersoll | Brick, Tile and Blocks. |
| Ontario Paving Brick Co., Limited | West Toronto | Brick. |
| O'Reilly, T. E. | Ottawa, 320 Bay St. | Brick. |
| Ott Brick & Tile Mfg. Co., Limited, The | Kitchener | Brick and Tile. |
| Ottawa Brick Mfg. Co., Limited, The | Ottawa, 53 Queen St. | Brick. |
| Owen Sound Brick Co., Limited, The | Owen Sound | Brick. |
| Paxton & Bray | St. Catharines, Queenston St. | Brick. |
| Pears & Son, James | Toronto, Eglinton Av. W. | Brick. |

BRICK AND TILE PLANTS, 1919—*Continued.*

| Name. | Address. | Product. |
|---|---|---|
| Pembroke Brick Co., The | Pembroke | Brick. |
| Phillips & Son, Thos. | Lucknow, R.R. No. 2 | Tile. |
| Phinn, Geo. E. | London, St. James Pk. | Brick and Tile. |
| Phippen & Field | Toronto, Dawes Road. | Brick. |
| Port Credit Brick Co., Limited, The | Toronto, 307 McKinnon Bldg. | Common and Pressed Brick. |
| Price & Smith | Toronto, 490 Greenwood Av. | Brick. |
| Price, Ltd., Jno. | Toronto, 100 Greenwood Av. | Brick. |
| Provincial Brick & Tile Plant | Mimico | Brick, Blocks and Tile. |
| Richardson & Son, James | Kerwood | Brick and Tile. |
| Rollins, D. W. | Tweed | Brick. |
| Sadler, F. L. | Dublin | Brick and Tile. |
| Shale Brick Co. of Canada, Ltd., The | Cooksville | Brick. |
| Smith, Alex., & Son | Dutton, R.R. No. 2 | Brick and Tile. |
| Snelgrove, A. | Beaverton | Brick and Tile. |
| Sproat, Wm. M. | Seaforth, R.R. No. 4 | Brick and Tile. |
| Standard Brick Co., Ltd. | Toronto, 498 Greenwood Av. | Brick. |
| Stratford Brick, Tile & Lumber Co., The | Stratford, Monteith Ave | Brick and Tile. |
| Streetsville Brick Co., Ltd. | Streetsville | Brick. |
| Stroh, M. C. | Conestogo | Brick and Tile. |
| Sudbury Brick Co., Ltd. | Sudbury | Brick. |
| Superior Tile Co., Limited | Fort William | Common and Tapestry Brick. |
| Thompson Bros. | Essex | Brick and Tile. |
| Wagstaff & Co., A. H. | Toronto, 336 Greenwood Av. | Brick. |
| Waide, J. C. | London, 582 Grosvenor St. | Brick. |
| Waite, John E. | Forrester Falls | Brick and Tile. |
| Wallace & Son, R. | North Bay | Brick. |
| Warwick Brick Works | London, 647 Grosvenor St. | Brick. |
| Woodslee Brick & Tile Co. | S. Woodslee | Brick and Tile. |
| Wright, J. C. | Proton | Brick. |
| Wright & Sons, Geo. | Comber | Tile. |
| Yack, Norman A. | Walkerton | Brick and Tile. |

*Pottery.*—Ontario's pottery industry has developed but little during the past few years, and no goods are manufactured from native clays save flower pots and a small quantity of rough stoneware. The finer grades of pottery are imported from Europe and the United States. Bearing in mind that the large pottery and porcelain centres of New Jersey and Ohio are artificial developments—all china or ball clay being imported—there is no reason why a similar industry could not be established in Ontario. The ceramic laboratory under the direction of Joseph Keele, of the Mines Branch, Ottawa, has demonstrated what may be accomplished in the way of producing fine china and high grade pottery. The Technical Education Committee of the Canadian National Clay Products Association is formulating a plan whereby the necessary instruction may be provided in Toronto for those interested in the study of ceramics, in the hope that shortly the position of the pottery industry in Ontario may be improved.

The four potteries operating in 1919 worked an average of 286 days, employed 45 men and paid $42,939 in wages. Fuel costs were $13,620, and the total sales $119,551. Following is a list of operators:

POTTERY MANUFACTURERS, 1919.

| Name. | Address. |
|---|---|
| R. Campbell's Sons | Lock St. South, Hamilton. |
| J. Cranston Estate | 216 Dundurn St. South, Hamilton. |
| Davis & Son, John | 601 Merton St., Toronto. |
| Foster Pottery Company | Main St. West, Hamilton. |

*Porcelain and Refractory Linings.*—The Canadian Porcelain Company of Hamilton and Canadian General Electric Company of Peterborough produced porcelain goods valued at $430,000 in 1919, the raw materials required being approximately 600 tons each of china clay (kaolin) and English ball clay, and 500 tons each of feldspar and silica. Refractory linings were produced from imported clays by R. Campbell's Sons, Hamilton.

*Sewer Pipe.*—Sales of sewer pipe in 1919, including flue linings, tops and wall coping, totalled $609,100, as compared with $362,536 in 1918. The three plants operated for an average of 225 days and employed 218 men, whose wages amounted to $219,665. The stock in hand at the end of the year was valued at $202,854. During the year the Ontario Sewer Pipe Company was re-organized and is now called the Ontario Sewer Pipe and Clay Products, Ltd. The same remark applies to the Dominion Sewer Pipe and Clay Industries, Limited, successors to the Dominion Sewer Pipe Company. This Company has two plants, one at Swansea for sewer pipe manufacture, and the other, a brick plant, at Aldershot.

The following are the operating companies:

SEWER PIPE WORKS, 1919.

| Name of Company. | Location of Plant. | P.O. Address of Manager, etc. |
|---|---|---|
| Dominion Sewer Pipe Co., Ltd. | Swansea | Swansea. |
| Hamilton & Toronto Sewer Pipe Co., Ltd. | Hamilton | Hamilton. |
| Ontario Sewer Pipe Co., Ltd. | Mimico | Mimico. |

## Lime

Lime production in 1919 amounted to 3,911,572 bushels, valued at $1,268,290. Of this total 870,114 bushels were hydrated, the value being $307,342. Fuel scarcity and high cost reduced the output and increased the price of the commodity. Approximately 37,372 tons of coal worth $238,449 and 11,779 cords of wood worth

$63,695 were used in burning lime, the average cost being $6.40 per ton and $5.41 per cord respectively. The average time of operation for the year was 201 days and the industry employed 363 men whose wages totalled $366,686.

Below are given the names of producers and the location of plants operated in 1919:

LIME PRODUCERS, 1919.

| Name of Owner or Company. | Location of Kilns. | Head Office Address. |
|---|---|---|
| Alabastine Co., Paris, The (*) | Elora | Paris. |
| American Cyanamid Co. | Niagara Falls | Niagara Falls. |
| Bergin, Patrick | Napanee | Napanee. |
| Brunner Mond Canada, Limited | Anderdon tp. | Toronto, Bank of Commerce Bldg. |
| Cameron, W. M. | Carleton Place | Carleton Place. |
| Canada Cement Co., Limited | Thurlow tp. | Montreal, Herald Bldg. |
| Canada Lime Co. | Coboconk | Lindsay, R.R. No. 2. |
| Chalmers Lime Works | Owen Sound | Owen Sound. |
| Chestnut, W. D. | Nottawasaga tp. | Duntroon. |
| Christie, Henderson & Co., Limited (*) | Hespeler, Galt, Puslinch, Kelso | Toronto, 201 Crown Office Bldg. |
| Contractors' Supply Co., Limited (*) | Melville Junction | Toronto, 182 Van Horne St. |
| Delta Lime Co., Limited | Delta | Delta. |
| Dominion Sugar Co., Limited (*) | Chatham, Wallaceburg, Kitchener | Chatham. |
| Flieler, Edward | Clarendon | Fernleigh. |
| Gallagher Lime & Stone Co., Limited | Barton tp. | Hamilton. |
| Harvey, E., Limited | Rockwood | Guelph. |
| Higgerson, Geo. | Coldwater Jct. | Coldwater. |
| Jamieson, J. M. | Ross tp. | Forester Falls. |
| McKenzie Bros. | Kinloss tp. | Lucknow, R.R. No. 5. |
| Parks Bros. | Beverley tp. | Troy. |
| Robertson Co., D., Limited | Nassagaweya tp. | Toronto, 26 Queen St. E. |
| Smith, John S. | Inverhuron | Inverhuron. |
| Standard Chemical Co., Limited | Eganville | Toronto, 1104 Royal Bank Bldg. |
| Standard White Lime Co., Limited (*) | Beachville, Guelph, St. Marys | Guelph. |
| Toronto Brick Co., Limited | Coboconk | Toronto, 60 Victoria St. |
| Toronto Lime Co., Limited | Dolly Varden | Toronto, 26 Queen St. E. |
| Toronto Plaster Co., Limited, The (*) | Teeswater | Teeswater. |
| Weppler, Henry | North Durham tp. | Priceville, R.R. No. 2. |

* Producers of hydrated lime.

### Portland Cement

Sales of Portland cement in 1919 were 2,022,575 barrels, worth $3,659,720, or $1.81 per barrel, as compared with 1,226,244 barrels valued at $1,910,839, or $1.56 per barrel in 1918. The quantity marketed was practically the same as for 1917. Cement on hand December 31st, 1918, consisted of 473,184 barrels, and for December 31st, 1919, 279,048 barrels. The industry gave employment to 647 men, whose wages amounted to $722,029.

The tendency in manufacture is to use limestone in preference to marl. Only one operating plant in 1919 used marl, and it is the purpose of that company to substitute limestone. Of the six plants of the Canada Cement Company in Ontario only two were operated last year. The plants idle were No. 4 and No. 6 in Hastings county, Thurlow and Hungerford townships, respectively; No. 7 at Lakefield, and No. 9 at Shallow Lake, near Owen Sound.

During the year a potash recovery plant was under construction at the Port Colborne works of this company for the purpose of extracting or washing out flue-dust containing potash salts from gases passing through the kiln stacks. Volatilized potash in the gases is dissolved by passing through spray chambers. The resulting sludge is put through thickeners and filters, and the brine evaporated in condensers. The quantity of potash ($K_2O$) recoverable is about 1 ton per 1,000 tons of cement manufactured. In design the new plant contains many desirable features found in installations in the United States, and it is expected to be in operation by July, 1920. From the 12 potash recovery installations operated in the United States in 1918 there was a production of 1,549 short tons of potash ($K_2O$), valued at $603,617.

PORTLAND CEMENT PLANTS OPERATING IN 1919

| Company. | Location of Plant. | Head Office Address. |
|---|---|---|
| Canada Cement Company, Ltd. | | |
| Plant No. 5 | Thurlow tp., near Belleville. | Herald Bldg., Montreal, Que. |
| Plant No. 8 | Port Colborne. | |
| Hanover Portland Cement Co., Ltd., The | Hanover | Hanover. |
| National Portland Cement Co., Ltd., The | Durham | Durham. |
| St. Marys Cement Co., Limited | St. Marys | St. Marys. |

The following is an extract from "Limes and Cements," by E. A. Dancaster, London, 1920, in regard to a new waterproof cement which is now being manufactured at St. Marys for the Super Cement (America) Co., Ltd., of Mount Dennis, near Toronto.

A variety of Portland cement was introduced in England in 1915 under the name of "Super Cement," which was originally intended to be a waterproof Portland cement, that is to say, an ordinary Portland cement to which material was added in order to render it waterproof, thus obviating the disadvantage of having to entrust the mixing of the waterproofing compound to careless workmen. It was soon found, however, that the cement prepared in this manner not only produced a waterproof mortar, but the latter was also much stronger than ordinary Portland cement mortar, thus differing from the usual waterproofing materials, which tend to weaken the cement with which they are used. The increase in strength is specially marked in the case of cement and sand mortar, and the difference increases with time. The cement requires more water to produce a paste of "normal" consistency than does ordinary Portland cement, and the mortar is both denser and harder. It is too soon to say definitely in what manner this addition of the treated gypsum acts upon the cement, but it certainly is neither a mere water repellent nor a pore filler. The main effect appears to be to bring about a more complete hydration of the cement particles.

A chemical analysis of a shipment of this cement from England to Copenhagen in the winter of 1919 was as follows:

| | Per cent. |
|---|---|
| $SiO_2$ | 22.2 |
| $Al_2O_3$ | 5.5 |
| $Fe_2O_3$ | 2.3 |
| CaO | 62.3 |
| MgO | 1.3 |
| Loss by ignition | 3.2 |
| Modulus | 2.57 |

The manufacture of "super cement" involves the mixing of gypsum and a catalytic colloid with cement clinker in the ordinary process of Portland cement manufacture. "Super cement" concrete is claimed to be a dense, impervious mass, waterproof and oilproof, stronger than Portland cement, and therefore suitable for a great variety of uses. The hardening is slower than with Portland cement, which may be due, as pointed out by Prof. J. Stansfield of McGill University, to the colloidal material produced by hydration. Exhaustive tests were carried out in 1919 by the Canadian manufacturers and the product placed on the market in the spring of 1920.

*Cement Products.*—Portland cement, gravel and sand are used for the manufacture of various products, a record of which it has been considered advisable to secure. Reports have been obtained for cement drain tile, culvert tile and sewer pipe, cement brick, artificial stone and concrete blocks of various kinds. Of the latter, hollow building blocks, in some cases with granite face and usually 8 by 8 by 16 inches or 8 by 12 by 16 inches in size, are used for basement and wall construction. Cement heads, sills, chimney blocks or caps, and circular tile for cribbing wells are also used to some extent. In sections of the Province where clay brick and tile are not manufactured locally, cement substitutes are in particular demand.

Some prejudice against the use of cement drain tile has existed in the past owing to the fact that many poor tile have been made. Proper mixing and handling are important. Drain tile are made in one foot lengths, while culvert tile and sewer pipe are usually two and one-half feet in length. Many of the cement products plants are portable. The average number of days during which the plants were operated was 108. The industry employed 148 men, and the wages amounted to $90,653.

The record which follows does not include any construction of a monolithic nature:

OUTPUT OF CEMENT PRODUCTS, 1919.

| Product | Number | Value |
|---|---|---|
| | | $ |
| Cement brick | 742,900 | 10,631 |
| Cement blocks, sills, caps, etc. | 682,342 | 147,895 |
| Cement drain tile, culvert tile and sewer pipe | 1,988,386 | 142,072 |
| Total value | | 300,598 |

In 1916 the Ontario Bureau of Mines began the collection of statistics of cement products, while in the United States this work was not undertaken by the Geological Survey until 1917. The raw materials (sand, gravel and cement), from which cement products are made, have been included in the table of total mineral production of Ontario, and in consequence it has not been deemed advisable to include the valuation of cement products. The following table gives a summary covering the four years for which records are available:

CEMENT PRODUCTS STATISTICS, 1916-1919.

| Schedule. | | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Cement brick | $ | 10,684 (brick and blocks) | 1,420 | 1,290 | 10,631 |
| Cement blocks, sills, caps, etc. | $ | | 8,312 | 41,362 | 147,895 |
| Cement drain tile, culvert tile and sewer pipe | $ | 46,946 | 90,586 | 81,351 | 142,072 |
| Value of total output | $ | 57,630 | 100,318 | 124,003 | 300,598 |
| Average operation of plants | days | 109 | 105 | 122 | 108 |
| Employees | No. | 73 | 105 | 72 | 148 |
| Wages | $ | 15,513 | 28,641 | 25,901 | 90,653 |

The following list gives the names and addresses of manufacturers of cement products reporting an output during the year:

MANUFACTURERS OF CEMENT PRODUCTS, 1919.

| Name. | Address. | Product. |
|---|---|---|
| Andrews, S. J. | Clinton | Blocks and Tile. |
| Arthur, Municipality of | Kenilworth | Tile. |
| Bawden, Frederick W. | Exeter | Blocks. |
| Beam, P. | Port Colborne | Blocks. |
| Bowers, E. | Cottam | Blocks and Tile. |
| Boyd, H. | Osgoode | Blocks and Tile. |
| Brown, D. L. | Sudbury | Brick, Blocks and Tile. |
| Bungalow Brick Company, Limited | Toronto, 143 Royce Ave. | Brick. |
| Burkholder, Geo. | Whitevale | Brick and Tile. |
| Butler & Sons, J. E. | Vittoria | Brick and Blocks. |
| Campbell, Neil F. | West Lorne | Tile. |
| Canadian Concrete Products Co., Ltd. | Chicago, Ill., 521 People's Gas Bldg. | Blocks and Tile. |
| Clark, Alonzo | Thorold | Blocks. |
| Clark, W. H. | Gananoque, R.R. No. 3. | Tile. |
| Collins, John | Hastings | Tile. |
| Corlett, A. S. | Leamington | Brick. |
| Cowdry, W. | Mountain Grove | Blocks and Tile. |
| Crewe Bros. | Merlin | Blocks. |
| Deveney & Campbell | St. Marys | Blocks and Tile. |
| Dillon, John | Seeley Bay | Blocks and Tile. |
| Dolmage, Sydney | Seaforth | Tile. |
| Eldridge, Geo. | Sarnia | Blocks. |
| Elliott, J. A. | Dunsford, R.R. No. 1 | Blocks. |
| Essex Land Corporation, Ltd. | Leamington, R.R. No. 1. | Tile. |
| Faulkner, J. E. | Morewood | Tile. |
| Fletcher, J. H. | Fonthill | Blocks. |
| Fradenburg, John B. | Cayuga | Blocks. |
| Gillies, Alfred | Galt | Brick and Blocks. |
| Granite Concrete Block Co., Ltd. | Mt. Dennis | Blocks. |
| Hay & Son, John C. | Listowel | Tile. |
| Hetherington, Isaac | Sheppardton, R.R. No. 1 | Tile. |
| Hewitt & Son, A. B. | Princeton, R.R. No. 3 | Blocks and Tile. |
| Hope, J. M. | Chesley | Tile. |
| Iler Concrete Tile Co. | Arner | Tile. |
| Kinzel & Son, Jos. | Preston | Blocks and Tile. |
| Kolbe & Co., W. F. | Port Dover | Blocks and Tile. |
| Malcolm, John | Fergus | Blocks and Tile. |
| McLenaghan, W. A. | Essex | Blocks and Tile. |
| McQueen, Alex. | Arthur | Tile. |
| Oil Springs Tile & Cement Co. | Oil Springs | Tile. |

MANUFACTURERS OF CEMENT PRODUCTS, 1919.—*Continued.*

| Name. | Address. | Product. |
|---|---|---|
| Orde, Jno. A. | Guelph, R.R. No. 3 | Tile. |
| Osterhout, Peter | Windsor | Blocks and Tile. |
| Page, Geo. G. | Lucknow, R.R. No. 3 | Tile. |
| Palm, Jacob | Mildmay | Tile. |
| Pfaff, W. E. | Hensall | Blocks and Tile. |
| Prast, Frank | Hanover | Blocks and Tile. |
| Ridgeville Concrete Works | Ridgeville | Brick, Blocks and Tile. |
| Robinson, Edward | Mitchell, R.R. No. 3 | Tile. |
| Schram, A. J. | Camlachie | Tile. |
| Showell, P. W. | Owen Sound, R.R. No. 6. | Blocks and Tile. |
| Smith, Allan G. C. | Acton | Blocks and Tile. |
| Smithson, F. | Leamington | Blocks and Tile. |
| Taylor & Hall | Peterborough | Blocks and Tile. |
| Telford, Peter | Holland Centre | Blocks and Tile. |
| Watts, Alfred | Tillsonburg | Blocks. |
| Wharran, Lawson | Wheatley | Tile. |
| Williams, E. J. | Wheatley | Blocks and Tile. |

## Sand and Gravel

Sand and gravel suitable for building operations, including lime and cement mortars, concrete, road construction, etc., is widely distributed throughout the Province. The removal of these materials from the beds of the Great Lakes and other navigable waters is carried on under licenses issued by the Minister of Mines under the Public Lands Act. In addition to a license fee of $100 per annum per vessel, a royalty is collected on each yard of sand or gravel removed, the rate depending on location, distance from market, etc.

During 1919 the industry employed 322 men, whose wages amounted to $215,821. The average period during which operations were carried on was 169 days. There were 435,413 cubic yards of sand removed worth $283,766 and 630,438 cubic yards of gravel valued at $217,900, or a total of the two materials of 1,065,851 cubic yards worth $501,666. Material used for ballast on railways has not been included in the record.

Following is a list of sand and gravel operators who marketed 1,000 cubic yards or more during the year:

SAND AND GRAVEL OPERATORS, 1919.

| Name of Owner or Company. | Material. G=Gravel S=Sand. | Location of Deposit. | Address. |
|---|---|---|---|
| Armstrong Supply Co., Ltd., The | S. | 1143 York St., Hamilton. | 34 James St. N., Hamilton. |
| Barton Sand & Gravel Co., The | S. and G | Bartonville | Bartonville. |
| Baxter, Jas. | G. | Dereham tp., lot 17, con. X | Brownsville, R.R. No. 1. |
| Brantford, City of | S. and G. | Harold Ave. and St. Paul Ave. | Brantford. |
| Canadian Steel Corp'n, Ltd. | S. | Ojibway | Ojibway. |
| Chatham Sand & Gravel Co. | S. and G. | River Thames, E. of Chatham | Chatham. |
| Chatham, Wallaceburg & Lake Erie Ry. Co. | G. | Raleigh tp. | Chatham. |

SAND AND GRAVEL OPERATORS, 1919.—*Continued.*

| Name of Owner or Company. | Material. G=Gravel. S=Sand. | Location of Deposit. | Address. |
|---|---|---|---|
| Chick Contracting Co., Ltd.... | G. | St. Clair river ......... | Windsor. |
| Construction & Paving Co. of Ont., Ltd. ................ | S. and G. | Erie tp. .............. | Toronto, 708 Confederation Life Bldg. |
| Denyes, Horace ............ | G. | Ernestown tp., lots 15 and 16, con. IV...... | Odessa. |
| Dept. of Railways and Canals. | S. | Mouth Niagara river.... | Ottawa. |
| Empire Limestone Co. ....... | S. | Humberstone tp. ...... | Buffalo, N.Y., 19 Hudson St. |
| Fonthill Gravel Co., Ltd. ..... | S. | Pelham tp. ............ | Fonthill. |
| Forwell, Jos. H. ............ | S. and G. | Waterloo tp. .......... | Kitchener. |
| Foster, R. R. ................ | S. | Gloucester tp. ......... | Ottawa, 99 Irving Ave. |
| Godson Contracting Co., Ltd... | S. and G. | Brock tp., lot 12, con. IV. | Toronto, 113 Manning Chambers. |
| Hale, J. M. ................ | G. | Malahide tp., lot 16, con. V | Aylmer, Box 6. |
| Hamilton Sand & Gravel, Ltd... | S. and G. | Burlington Heights .... | Hamilton, 110 Queen St. N. |
| Home Smith & Co. .......... | S. and G. | West Toronto ......... | Lambton Mills. |
| Kilbourne & Son, Harvey .... | S. | Westminster tp., Wharncliffe Rd. ............ | London, 5 Cove Road. |
| Kingston Sand & Gravel Co... | S. | Kingston tp. .......... | Kingston, R.R. No. 5. |
| Larter, Chas. ................ | S. and G. | Waterloo tp., N. of Galt. | Galt, 76 Chalmers St. |
| Lyons Fuel & Supply Co. ..... | G. | Mile 34, A.C.R. ........ | Sault Ste. Marie, Ont. |
| Malloy, Wm. B. ............ | S. and G. | Ellice tp., lot 8, con. IV. | Sebringville, R.R. No. 1. |
| Maple Sand, Gravel & Brick Co. | S. and G. | Vaughan tp., lots 21-24. con. III............. | Toronto, 79 Spadina Ave. |
| Marine Contracting Co. ..... | G. | St. Clair R., Lake St. Clair | Port Huron, Mich. |
| Markus, Wm., Ltd. .......... | S. and G. | Stafford tp., lot 32, con. II | Pembroke. |
| McAuley, P. L. ............. | S. | Murray tp., lot 5, con. I.. | Trenton, R.R. No. 4. |
| McLean & Sons, A. B. ....... | G. | Lake Superior ......... | Sault Ste. Marie. |
| McPhail & Wright Construction Co. ..................... | S. | Korah tp. ............. | Sault Ste. Marie. |
| Michigan Builders' Supply Co. | G. | St. Clair river ......... | Detroit, Mich., 209 E. Hancock Ave. |
| Morrison, J. H. ............. | S. and G. | Elizabethtown tp., con. III ................. | Brockville. |
| National Sand & Material Co.. Ltd. ..................... | G. | Lake Erie ............ | Welland. |
| Niagara Sand Corporation ... | G. | Niagara River ........ | Buffalo, N.Y., 807 White Bldg. |
| Oneida Lime Co., Ltd. ....... | S. | N. Cayuga tp., lot 49... | Buffalo, N.Y., 406 Erie Co. Bank Bldg. |
| Ontario Gravel Freighting Co., Ltd. ..................... | G. | St. Clair river.......... | Windsor. |
| Paris Sand & Gravel Co. .... | S. and G. | Dumfries tp., lot 30, con. I .................. | Paris, R.R. No. 2. |
| Ponsford, A. E. ............ | S. and G. | Yarmouth tp., lot 1, con. VIII .............. | St. Thomas, 605 Talbot St. |
| Rocsand Company, Limited.... | G. | Erin village .......... | Hamilton, Canada Life Bldg. |
| Sand & Supplies, Ltd. ....... | S. and G. | Dumfries tp., lot 30, con. IX ................ | Toronto, 19 Melinda St. |
| Sarjeant Co., Ltd., The...... | S. and G | Barrie, James and Penetang Sts. ........... | Barrie. |
| Scott, J. G. ................ | G. | Barrie, Penetang and James Sts. .......... | Barrie. |
| Sleemon, Philip ............ | S. and G. | Hope tp., lot 9, con. II. | Port Hope, R.R. No. 1. |
| Superior Sand & Gravel Co. .. | G. | Point Edwards ........ | Detroit, Mich., 926 Dime Bank Bldg. |
| Taylor Gravel Pit .......... | G. | Aldborough tp., lot A, con. VII ........... | Rodney. |

SAND AND GRAVEL OPERATORS, 1919.—*Continued.*

| Name of Owner or Company. | Material. G=Gravel. S=Sand. | Location of Deposit. | Address. |
|---|---|---|---|
| United Fuel & Supply Co. .... | G. | St. Clair river ......... | Detroit, Mich., Free Press Bldg. |
| Verulam Tp. ................ | G. | Verulam tp., lot 8, con. IX, Harvey tp., lot VI. con. XIX ........... | Bobcaygeon. |
| Windsor, Essex & Lake Shore Ry. Co. .................. | G. | Mersea tp., W. of Leamington .............. | Kingsville. |
| Windsor Sand & Gravel Co., Ltd., The ............... | S. and G. | Two miles west of Leamington .............. | Walkerville. |
| Wood, John T. ............. | S. and G. | Osborne tp., lot 11, con. V | Exeter. |
| York Sand & Gravel Co., Ltd... | S. and G. | Gerrard St. E. and Victoria Park Ave....... | Toronto, 1327 Bloor St. W. |

Brief mention may be made here of an unusual situation which arose in connection with the operation of dredging plants for sand and gravel off Pelee island in Lake Erie. A good many years ago the owner of Fishing Point, the extreme southerly projection of Pelee island, obtained from the Crown the grant of a water lot on both sides of the point, for the professed purpose of enabling him to protect his land from the encroachment of dredges and "sand-suckers" from ports on the southern shore of the lake, which were accustomed to come over and load sand and gravel without leave or license. On obtaining the patent, the grantee at once authorized these operations for a monetary consideration, and the business of removing these materials has ever since been carried on, and has attained large dimensions. The sand bar, which was the subject of the grant, as well as a large part of Fishing Point has been carried away, and the actual site of the dredging operations, it is believed, has of late years had little relation to the boundaries of the original tract. Now, Pelee island is protected from the waves and storms of lake Erie by natural embankments thrown up by the waters, the interior of the island for a large part of its area being below the level of the lake. This land is very fertile and grows heavy crops of corn, tobacco and other products. The township municipality has at considerable expense installed and maintains a pumping plant with several stations, for the purpose of keeping these low lying lands free from water. Heavy erosion has been going on along the east and west shores of the island, threatening if continued, to destroy these protecting embankments, and the islanders are fully convinced that this erosion is due to the sand-sucking plants making excavations in the bed of the lake which their embankments are robbed to fill. Thus they see themselves faced with inundation and ruin. They brought an action against the sand operators, but the judge found they had failed to prove their case. Engineering experts differed in their opinions, some favouring the view of the islanders, some holding that the erosion was due to the natural set of the currents of the lake, aided at times by high winds. The case has been carried to the Court of Appeal, but no decision has yet been given. A somewhat similar case has occurred at Point Pelee, a sandy, low-lying peninsula projecting from the mainland north of Pelee island. Here also erosion of banks and dredging operations on a grant off the Point are contemporaneous. To ameliorate the situation the Ontario Legislature at the session of 1920 passed "The Beach Protection Amendment Act, 1920," which prohibited the removal of sand, gravel or stone from the bed or waters of lakes Erie, Ontario and Huron except under authority of a license from the Lieutenant-Governor in Council.

### Sand-Lime Brick

The chief reason for the use of brick of this class is its cheapness compared with brick made from clay or shale. It is made by compressing a mixture of sand and lime in moulds, and subjecting the resulting brick to a steam bath, while brick from clay or shale requires burning. Sand-lime brick are used chiefly as inside brick, and they will not stand rough handling as well as the clay product. They are improved by a few months' curing.

Fuel for burning brick made from shale or clay is now both scarce and dear. As an indirect result the output of sand-lime brick in 1919 was greatly in excess of the production for any war year. The fuel consumption for the 28,319 M. sand-lime brick produced in 1919 was 4,860 tons of coal, costing $32,875, or an average fuel cost of $1.16 per M. brick manufactured. Only 1,299 M. were reported on hand at the end of the year. Brick sold totalled 27,661 M. worth $367,815, or an average of $13.29 per thousand. In 1917 the output was 9,079 M. worth $9.60 per M., and in 1918 the quantity was 7,941 M. worth $11.52 per M. In 1917 and 1918 the average prices of sand-lime brick in the United States were $7.54 and $8.94 per M. respectively.

In 1919 the industry gave employment to 176 men whose wages totalled $140,889. The plants operated for an average of 179 days during the year. A list of operators follows:

SAND-LIME BRICK PRODUCERS, 1919.

| Name. | Location of Plant. | Address. |
|---|---|---|
| Silicate Brick Co. of Ottawa, Ltd. | 278 Echo Drive, Ottawa. | Ottawa. |
| The Canada Sand-Lime Pressed Brick Co., Ltd | Symes Rd, W. Toronto. | 28 Symes Rd., W. Toronto. |
| The Hepworth Silica Pressed Brick Co., Ltd. | Hepworth | Hepworth. |
| The Schultz Bros. Co., Ltd. | McMurray St., Brantford | 49 Albion St., Brantford. |
| Toronto Brick Co., Limited | Scarboro and Swansea. | 60 Victoria St., Toronto. |
| Willcox Lake Brick Co., Ltd. | Whitchurch tp. | Richmond Hill. |
| York Sandstone Brick Co., Ltd. | Gerrard St. and Victoria Ave., E. Toronto. | Toronto, 431 St. Clarens Ave. |

### Stone

The value of the production of the several varieties of stone noted in the table below exceeded that of any war year. Trap is again in demand for road metal, and for surface concrete where there is excessive wear. During the war period road construction was nearly at a standstill. In 1919 certain new work was begun, and an extensive programme of construction by the Provincial Highways Branch will be carried out in 1920.

Employment was afforded 663 men whose wages amounted to $542,518.

The tonnages of limestone, sandstone and trap marketed were 1,114,910, 3,117 and 62,275 respectively. Details for a five-year period are given in the following table:

TABLE XV.—VALUE OF STONE PRODUCTION, 1915—1919.

| Year | Limestone | Sandstone | Trap | Granite | Marble | Total |
|---|---|---|---|---|---|---|
| | $ | $ | $ | $ | $ | $ |
| 1915............ | 587,000 | 5,500 | 32,100 | 15,500 | 10,600 | 651,593 |
| 1916............ | 625,628 | 14,268 | 91,762 | 23,655 | ............ | 755,313 |
| 1917............ | 728,975 | 115,932 | 70,570 | 25,575 | ............ | 941,052 |
| 1918............ | 820,985 | 145 | 24,774 | 23,334 | ............ | 869,238 |
| 1919............ | 1,112,340 | 5,544 | 82,995 | 10,683 | 19,360 | 1,230,922 |

Below are given the names of quarry operators reporting a production for 1918, classified according to product:

STONE QUARRIES, 1919.

| Name of Owner, Firm or Company. | Location. | Kind of Stone. |
|---|---|---|
| Bancroft Marble Quarries................ | Dungannon tp. ........ | Marble. |
| Bergin, Patrick ........................ | Napanee .............. | Limestone. |
| Britnell & Co., Ltd. ..................... | Toronto ............... | do |
| Brown, Robert ......................... | Lyndhurst ............ | Granite. |
| Bruce Mines Trap Rock Co., Limited...... | Bruce Mines ........... | Trap. |
| Brunner, Mond Canada, Ltd. ............ | Amherstburg .......... | Limestone. |
| Canada Crushed Stone Corporation, Limited. | Dundas .............. | do |
| Contractors' Supply Co., Limited.......... | Toronto ............... | Crushed Limestone. |
| Cook, J. S., & Son ...................... | Wiarton ............... | Limestone. |
| Crushed Stone, Limited ................. | Kirkfield .............. | Crushed Limestone. |
| Farr, Mrs. L. G. ........................ | Haileybury ............ | Limestone. |
| Granite Crushed & Dimension, Ltd. ...... | Toronto ............. | Granite. |
| Gallagher Lime & Stone Co. .............. | Hamilton ............. | Limestone. |
| Gordon Granite Co., D. J. ............... | Gananoque ............ | Granite Blocks and Monuments. |
| Hagersville Crushed Stone Co., Limited.... | Hagersville ........... | Limestone. |
| Hamilton, Corporation of ................ | Hamilton ............. | do |
| Horne, Wm. ............................ | Ignace and Butler ..... | Granite. |
| Higginson, Geo., & Son .................. | Coldwater ............. | Limestone. |
| Longford Quarry Co., Limited ............ | Longford Mills ........ | Limestone and Riprap. |
| Markus, Wm., Ltd. ..................... | Pembroke ............. | Limestone. |
| Oliver-Rogers Stone Co., Limited, The..... | Owen Sound .......... | do |
| Ontario Rock Co., Ltd. .................. | Toronto ............. | Trap. |
| Ontario Stone Corporation, Limited ...... | Uhthoff ............... | Limestone. |
| Perkins, Geo. A. ........................ | Owen Sound .......... | do |
| Point Anne Quarries, Limited ............ | Point Anne ........... | do |
| Prescott, Corporation of ................ | Prescott .............. | do |
| Queenston Quarry Co., Limited .......... | St. David ............. | do |
| Quinlan & Robertson, Ltd. .............. | Crookston ............ | do |
| Reid, C. F. ............................. | Odessa ............... | do |
| Rideau Canal Supply Co., Limited ........ | Ottawa ............... | do |
| Robertson, D., & Company, Limited ....... | Milton ................ | Sandstone. |
| Robillard, H., & Son .................... | Ottawa ............... | Limestone. |
| Roddy & Monk .......................... | Kingston ............. | do |
| Rogers & Co., F......................... | Toronto .............. | Sandstone. |
| Standard White Lime Co., Limited ...... | Beachville, Guelph and St. Marys .......... | Limestone. |
| Walker Bros. ............................ | Thorold ............. | do |
| Wentworth Quarry Co., Limited.......... | Vinemount ............ | do |

### Actinolite

Mining for actinolite has not been carried on for some years past. Shipments in 1919 were made from the mill of the Actinolite Mining Company at Actinolite, a few miles north of Tweed in the County of Hastings. The total quantity shipped was 160 tons worth $1,176, or $11 per ton.

Grinding is accomplished in a manner that avoids as much as possible the breaking up of the fibre. The use of actinolite is in conjunction with coal tar for the manufacture of a roofing material. Operations began first in 1883, and the deposits in the townships of Elzevir and Kaladar have been worked at intervals since that date. The only company operating is the one above mentioned.

### Feldspar

Ontario feldspar in the crude form is marketed for the most part in the United States, chiefly to the pottery and porcelain firms of New Jersey and Ohio. Owing to the falling off in output of these works with the ending of the war, there was little demand for feldspar in the early part of the year; later the market improved. Total shipments for the year were 14,787 tons, worth $88,663. Another reason for the decreased output as compared with 1918, when 19,784 tons, worth $111,173, were marketed, was the fact that Feldspars, Limited, the largest shipper heretofore, did not operate their property, the Richardson mine, during the year. A comparison of average values for the past four years shows the price at the quarry to have been as follows: $3.25 per ton in 1916, $4.45 in 1917, $5.61 in 1918, and $5.34 in 1919. Workmen engaged in the industry numbered 114, and received wages amounting to $60,407.

For the first time in some years a shipment of ground feldspar was reported. The output of 1,000 tons of ground spar by The Feldspar Milling Company was all used in Canada, also 271 tons of crude spar, the balance going to the United States. Grinding of feldspar to 120 or 130-mesh is required for the pottery and porcelain trade, while 90-mesh is sufficiently fine for glass. A higher grade of spar is required for pottery and porcelain use than for glass manufacture.

Following is a list of shippers in 1919:

FELDSPAR PRODUCERS, 1919.

| Name. | Location of Deposit. | P.O. Address. |
|---|---|---|
| Canada Feldspar Corporation, Ltd. | Near Hybla | Toronto, 18 Madison Ave. |
| Donnen Feldspar Co., Limited | Markstay | Ottawa, P.O. Box 2. |
| Eureka Flint & Spar Co., The | Verona | Trenton, N.J. |
| Feldspar Quarries, Limited | Portland tp. | Toronto, 15 Manning Arcade Annex. |
| Feldspar Milling Co., Ltd. | Grinding plant at Tichborne | 33 Richmond St. W., Toronto. |
| International Feldspar Co., Ltd. | Lot 2, Con. III, Bedford tp. | 316 Moffat Blk., Detroit, Mich. |
| McConnell, Rinaldo | Lot 10, Con. IV, Sherbrooke tp.; Lot 3, Con. VII, Bathurst tp. | 1558 Yonge St., Toronto. |
| O'Brien and Fowler | Lot 6, Cons. II and III, March tp. | 17 Beech St., Ottawa. |
| Ontario Feldspar, Ltd. | S. Sherbrooke tp., Feldspar station, C.P. Ry. | 34 Toronto St., Toronto. |
| Verona Mining Co. | Hybla | 404 Harrison Bldg., Philadelphia, Pa. |

## Fluorspar

In common with practically all other war minerals the output of fluorspar. which is used chiefly as a flux in basic open-hearth steel furnaces, was much reduced in 1919. This mineral had not been mined in Ontario for a few years prior to 1916, when the production was valued at $10,146. In 1917 the output was worth $66.474. and in 1918 shipments had increased to 7,286 tons. worth $153,190. At times during 1918, owing to car shortage and freight congestion. the demand by steel-makers exceeded the supply. A similar situation existed in the United States. Prior to the war, the price for a number of years had averaged about $6.00 per short ton; this increased to $20.72 in 1918; and the production jumped from 116.545 tons in 1912, the maximum pre-war year, to 263.817 tons in 1918. Madoc in Hastings county is the centre of the fluorspar industry of Ontario. the deposits which have been worked being situated in the townships of Madoc and Huntingdon, as noted on the map which accompanied Volume XXVII. Report of the Bureau of Mines for 1918, page 137. The production in 1919 was 3,425 tons. worth $60,389. Eighty men were employed and wages amounted to $83.959.

Fluorspar has a number of miscellaneous uses: as flux in iron blast furnaces and iron foundries; in the manufacture of glass. enamelled and sanitary ware. and of hydrofluoric acid; as a bond for making emery wheels and carbon electrodes: and in processes used to extract potash from feldspar and to recover potash in the manufacture of Portland cement. Pure white unfractured crystals of optical fluorspar are in demand at high prices for optical purposes. Satisfactory samples have been secured at Madoc, but the supply is limited.

During the year shipments were made by the following operators:

FLUORSPAR PRODUCERS, 1919.

| Name. | Location. | Address. |
|---|---|---|
| Canadian Fluorite, Ltd. | Madoc | Madoc. |
| Canadian Industrial Minerals, Ltd. | Huntingdon and Madoc tps. | Toronto. 1511 Bank of Hamilton Bldg. |
| Cross & Wellington | Lot 11, Con. XIII. Huntingdon. | Madoc. |
| Wallbridge, Mrs. Jane | Lot 4, Con. I, Madoc | Madoc. |

## Graphite

The production of graphite was greatly curtailed in 1919 as compared with the war period. when there was a large demand for this mineral by the manufacturers of crucibles. Shipments in 1918 of both crude and refined graphite totalled 2,934 tons, worth $208,848. as compared with 1,340 tons. valued at $99.841 in 1919. Of this latter tonnage only 162 tons were crude ore. An average of 124 men was employed by the operating companies, and wages totalled $93,467.

As in previous years, the Black Donald mine at Whitefish lake in Renfrew county, 14 miles distant from Calabogie, was the chief shipper. Both flake and amorphous varieties are produced. The mine, however, was operated only 262 days and the mill 184 days. The Globe Graphite Company operated for the first 36 days of the year, and went into liquidation. In June the property was purchased by E. T. Eshelman. Syracuse Trust Co., Syracuse. N.Y.. and is now for sale. The mine and new 50-ton mill of National Graphite, Limited, was operated for only the first 65 days of the year. The new 200-ton mill of the Timmins company ran full time for the months of June, July and August. Only samples were shipped, although 13,676 tons of ore were mined. The company is endeavouring to find new uses and markets for its product.

A recently issued bulletin on "Solid Lubricants" by the Department of Scientific and Industrial Research of London, England, presents a good summary of information on this subject, from which the following notes are abstracted:

Of all solid lubricants natural graphite is the most important, the flake variety being used mostly for this purpose. Mica and talc, which are frequently found in association with graphite, have about the same specific gravity and are therefore difficult to remove. However, colloidal solid lubricants have been made from both of these minerals as well as from graphite. For heavy duty bearings, worm gears, steam cylinders and valves, chain drives, etc., the use of solid graphite lubricant is extending.

Chemically pure, amorphous graphite is produced artificially in electric furnaces by the International Acheson Graphite Company at Niagara Falls, Ontario. The product is of a soft, unctuous and non-coalescing nature. For lubricating purposes a colloidal solution of graphite in water in the form of a concentrated paste called "Aquadag" is produced by a kneading process. This paste is further mixed with mineral lubricating oil until the water is replaced by oil, to form a product called "Oildag." These solid lubricants, which contain about 98 per cent. pure carbon, may be diluted respectively with water or good quality neutral mineral oil without appreciable separation or "flocculation," owing to the finely divided condition of the graphite. Separation of the solid lubricant from the diffusing liquid by the action of acids or alkalis is the great drawback to which these colloidal solutions of graphite are susceptible.

Artificial graphite produced from anthracite coal or petroleum coke may be used for any purpose for which natural graphite is employed, except for the manufacture of large crucibles. The output[1] by the Acheson company of artificial graphite, which competes with the natural product, was 8,163,177 pounds in 1919 and 41,301,379 pounds for the five years, 1915-1919 inclusive.

The following is a list of active graphite operators during the year:

GRAPHITE OPERATORS, 1919.

| Company. | Location of Mine. | P.O. Address. |
|---|---|---|
| Black Donald Graphite Co., Limited | Brougham tp. | Calabogie. |
| National Graphite, Limited | Mumford, Cardiff tp. | Toronto, 1312 Royal Bank Bldg. |
| Globe Graphite Mining and Refining Co., Limited, The | Port Elmsley | Syracuse, N.Y., U.S.A., 701 Dillaye Bldg. |
| Timmins Graphite Mines, The | N. Burgess tp. | Stanleyville. |

### Gypsum

At the present time there is only one operating company in the Province, the Ontario Gypsum Company, Limited. A total of 67,884 tons was mined during 1919 in the townships of Seneca and Oneida. The calcining works are located at Caledonia and Lythmore. Crude crushed gypsum, 24,695 tons, and crude ground, 1,260 tons, were shipped to various Canadian points in addition to 6,562 tons of calcined gypsum. In the manufactured form 27,382 tons of calcined gypsum were used, the principal products being calcined and hardwall plaster. Calcined plaster is used by associated companies for the manufacture of fireproof gypsum blocks and plaster board, the former being used for fireproof interior walls and the latter

[1] Can. Mng. Journal, p. 577, July 16th, 1920.

as a substitute for wooden lath and lime plaster. Total shipments of various grades above mentioned was 59,889 tons worth $278,111.

The industry gave employment to 102 men in the mines and works whose wages amounted to $118,298 for the year.

### Iron Pyrites

During the years of war the production of pyrite ($FeS_2$) for the manufacture of sulphuric acid was greatly stimulated. The increased demand from the United States for pyrite in 1917 and 1918 was due to her entering the war and to the cutting off of trans-Atlantic supplies from Spain, owing to the lack of bottoms to carry the ore. At the close of 1918 large surplus stocks of acid were on the market, and in consequence the demand for pyrite in 1919 was light. The larger part of Ontario pyrite is shipped to the United States, although the Nichols Chemical Company at Sulphide and the Grasselli Chemical Company at Hamilton manufacture acid. During the latter part of the war there was also a large output of acid by the British Chemical Company at Trenton. Shipments of pyrite in 1918 totalled 270,966 tons, worth $1,144,737.

Of the total shipments of 117,178 tons in 1919, valued at $366,422, 85,628 tons were shipped to the United States and 31,550 tons to Ontario points. The sulphur content of the ore ran from 31.6 to 42.5 per cent. The industry employed 470 men, who received $483,371 in wages.

Crude native sulphur or brimstone is imported into Ontario, chiefly from Louisiana and Texas, for use in acid plants and also for the pulp and paper industry. The war stimulus to the production of elemental sulphur in the United States resulted in over half of the total sulphuric acid output in 1918 being produced from that source. In consequence, it may take two or three years for the United States market for Canadian pyrite to return to normal. The demand for acid comes chiefly from the fertilizer, chemical, drug, oil refining and galvanizing industries.

Following is a list of pyrite shippers in 1919:

IRON PYRITES SHIPPERS, 1919.

| Name of Owner, Firm or Company. | Location or Name of Mine. | P.O. Address of Manager, etc. |
|---|---|---|
| Algoma Steel Corporation, Limited | Helen | Sault Ste. Marie. |
| Canadian Sulphur Ore Company, Limited | Queensboro | Toronto, Crown Office Building. |
| Grasselli Chemical Co. | Caldwell | Flower Station. |
| Nichols Chemical Co., Limited, The | Goudreau | Goudreau. |
| | Sulphide | Sulphide. |
| | Vermilion lake | Northpines. |
| Rand Consolidated Mines, Limited | Goudreau | Buffalo, N.Y., 851 Ellicott Square. |
| Sheffield Molybdenite Mining Co. | Chisholm | Enterprise. |

### Mica

Most of the mica produced in this province comes from the counties of Lanark, Leeds and Frontenac in eastern Ontario. The greater part of the output is of the amber variety (phlogopite), although some white mica (muscovite) is worked, more particularly in the northern part of the province, in the districts of Nipissing, Muskoka and Parry Sound.

During 1919 in the township of Dickens, just south of Algonquin Provincial Park, a promising mica deposit was opened up by Thos. A. Low, of Renfrew. No shipments were made until 1920. While engaged in work on a mica prospect in Butt township, on the western side of Algonquin Park, Robert Elliott discovered radio-active pitchblende. This find occasioned a rush to the locality in the fall of 1919, and many claims were staked for radium. Reference to the prospect of the discovery being of economic importance is made elsewhere in this report.

The value of mica marketed in 1919 was $56,199 as compared with $49,595 in 1918. The quantity of all grades sold was 567 tons. This latter figure includes 231 tons of "rough-cobbed" worth $43,935, 288 tons of "scrap" valued at $1,157, and 95,753 pounds of "thumb-trimmed" mica, in sizes from 1 inch by 1 inch upwards, worth $11,107. The chief producers were Loughborough Mining Company, Limited, Kent Brothers and Estate of J. M. Stoness, Orser Mica Company, and George Green.

It is difficult to secure accurate figures as to men employed in the industry, for the reason that many farmers bring in small lots from time to time and sell to operators of splitting and trimming works. Leaving these out of consideration the industry employed 61 men whose wages amounted to $42,660 for the year.

The list of producers follows:

MICA PRODUCERS, 1919.

| Name of Owner or Producer. | Location or Name of Mine. | P.O. Address of Manager, etc. |
|---|---|---|
| Adams, J. H. | N. Burgess tp. | Perth. |
| Bennett, Herbert V. | | Perth. |
| Green, George | Bedford & Loughboro' tps. | Perth Road. |
| Grierson & Sons, John K. | N. Burgess tp. | Perth. |
| Kent Bros. and Estate J. M. Stoness | Bedford tp. | Kingston. |
| Loughborough Mining Co., Ltd. | Lacey mine, Loughboro' tp. | Sydenham. |
| McLaren, W. L. | North Burgess tp. | Perth. |
| Orser Mica Co., The | N. Burgess & Bedford tps. | Perth. |
| Smith, W. C. | Davis tp. | Ess Creek. |
| Sullivan and Fahey | South Crosby tp. | Elgin. |
| Tory Hill Marble & Mica Co. | Glamorgan tp. | Tory Hill. |
| Wilson, Richard | | Hartington. |

## Mineral Water

Although the quantity of mineral water shipped in 1919 was not much less than in 1918, the valuation declined appreciably. Shipments are now made chiefly in bulk (barrels or tanks) to bottling works in Montreal, Que. By reason of changing business conditions, employees in the industry and wages paid show a marked decline. Details for the two years are given below:

| Year | Sales | | Employees | Wages $ |
|---|---|---|---|---|
| | Imp. Gals. | Value $ | | |
| 1918 | 298,498 | 133,808 | 45 | 20,769 |
| 1919 | 276,833 | 19,290 | 17 | 10,228 |

One shipper remarks: "Since the coming of prohibition and the closing of the bars the mineral water trade has steadily declined." Natural spring waters, non-mineralized, are not included in the statement. Considerable business is done in disposing of such waters in bottles or glass jars.

As will be noted in the following list, the entire production in 1919 came from eastern Ontario.

SHIPPERS OF MINERAL WATERS, 1919.

| Operator. | Location of Wells or Springs. | Brand of Water. | P.O. Address of Manager, etc. |
|---|---|---|---|
| Allan's, Limited | Caledonia Springs | Caledonia Water | 86 Dorchester St. W., Montreal. |
| Belanger, Arthur | North Plantagenet, George Lake. | St. George | Papineauville, Que. |
| Borthwick, W. | Hawthorne, Gloucester tp. | Borthwick | 48 Fourth Ave., Ottawa. |
| Caledonia Springs Co., Ltd., The | Caledonia Springs and Bourget. | Magi, Duncan, Adanac. | 2716 St. Urbain St., Montreal. |
| Carlsbad, Limited, The | Carlsbad Springs | Magi, Carlsbad Lithia. | Carlsbad Springs. |
| Gurd & Co., Limited, Charles | Caledonia tp. | Gurd's Caledonia Water. | 76 Bleury St., Montreal. |
| Lyall, Trenholme & Macdonnell. | Caledonia Springs | Beaver Brand Caledonia Water. | Montreal West. |
| Sanitaris, Limited | Pakenham tp. | Sanitaris. | Arnprior. |

## Natural Gas

The statistics of production are given in Part V of this Report, which is wholly devoted to the subject of Natural Gas, and the problems to which the failing supply has given rise in that part of the province where it is the principal fuel, especially for domestic purposes.

## Peat

The only commercial production during 1919 was at the Alfred bog east of Ottawa, where the Peat Committee, appointed jointly by the Federal and Ontario Governments, carried on work. About 2,000 tons were produced, of which 500 tons worth $1,750 were marketed. The price was $3.50 per ton, f.o.b. cars. Experimental work was carried on for the greater part of the season, a full description being given (pages 142-156) under the heading "Second Report of Joint Peat Committee."

### Petroleum

During the field season of 1919 explorations were carried on in the northern part of the Province along the Moose and tributary rivers which empty into James bay. Paleozoic rocks occur there over a considerable area, and the possibilities of oil occurrence were investigated by Dr. M. Y. Williams of the Geological Survey of Canada. His report on this subject appears in Part II, Vol. XXIX. Ontario Bureau of Mines Report. Areas have been staked for oil near Grand rapids on the Mattagami river.

Ontario's production of crude petroleum so far has come entirely from the southwestern peninsula, and for some years past the output has been in the neighbourhood of 200,000 barrels per annum. In 1915 there was an increase in output for the first time in several years. The output for 1919 was 7.703.515 imperial gallons (220,100 barrels) as compared with 10,106,615 imperial gallons in 1918, a decrease of 27 per cent. The marked increase in 1918 was due to the new field in Mosa township. This field, however, does not promise to have long life, if the large decline in output reported for 1919 can be taken as conclusive evidence.

The supervisor of crude petroleum bounties at Petrolia, J. C. Waddell, remarks as follows:

> It is very satisfactory to note that the old Lambton county field has an increased production for the year of 5,000 barrels. Petrolia and Enniskillen show an increase of 4,600 barrels, and Oil Springs an increase of 500 barrels. This is an excellent record, and shows the stability of the Lambton county fields. The Petrolia field is now entering on its fifty-eighth year of production.

The production of the several fields during a period of five years was as follows:

CRUDE PETROLEUM PRODUCTION, BY FIELDS, 1915-1919.

| Field | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| | Bbls. | Bbls. | Bbls. | Bbls. | Bbls. |
| Lambton: Petrolia and Enniskillen | | | 74,267 | 65,467 | 70,087 |
| Oil Springs | | | 46,902 | 44,671 | 45,245 |
| Moore township | 161,368 | 142,208 | 6,282 | 6,367 | 4,029 |
| Sarnia " | | | 4,494 | 3,438 | 4,259 |
| Plympton " | | | 579 | 412 | 560 |
| Bothwell | 33,395 | 33,856 | 29,682 | 29,116 | 29,425 |
| Tilbury: Dover, West | 12,742 | 16,297 | 10,041 | 25,228 | 16,705 |
| Tilbury, East | | | | | 1,660 |
| Dutton | 5,401 | 2,852 | 2,941 | 1,875 | 1,272 |
| Onondaga township | 1,490 | 1,617 | 383 | 1,186 | 197 |
| Belle River | 46 | 46 | ........ | 447 | ........ |
| Mosa township | ........ | ........ | 20,999 | 108,988 | 45,860 |
| Thamesville | ........ | ........ | 6,420 | 1,565 | 801 |
| Total Production Bbls. | 214,442 | 196 876 | 202 990 | 288,760 | 220,100 |
| Value " $ | 300,219 | 387,846 | 475,000 | 781,097 | 632,789 |
| *Average Price per Bbl. | 1.40 | 1.98 | 2.34 | 2.70½ | 2.87½ |

* Producers of crude petroleum in Canada receive in addition a bounty under the "Petroleum Bounty Act" of 1½ cents per Imperial gallon or 52½ cents per barrel (35 gals.) from the Dominion Government. The price at the close of 1919 was $3.38 per barrel.

*Refineries*:—There were four petroleum refineries operating in the province in 1919 as per the following list:

PETROLEUM REFINERIES.

| Company. | Location of Refinery. | Head Office Address. |
|---|---|---|
| British American Oil Co., Ltd. | Toronto, Cherry St. | Toronto, Royal Bank Bldg. |
| Canadian Oil Companies, Limited | Petrolia | Petrolia. |
| Great Lakes Oil Refining Co., Ltd. | Wallaceburg | Toronto, 812 Excelsior Life Bldg. |
| Imperial Oil, Limited | Sarnia | Sarnia. |

OUTPUT OF PETROLEUM REFINERIES, 1915—1919.

| Schedule | * 1915 | * 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Crude petroleum product'n Imp. gals. | 7,505,478 | 6,890,681 | 7,104,700 | 10,106,615 | 7,703,515 |
| Value do $ | 300,219 | 387,846 | 475,000 | 781,097 | 632,789 |
| American Crude distilled..Imp. gals. | 76,435,884 | 84,143,603 | 122,436,923 | 137,065,788 | 141,157,309 |
| Value do $ | 2,858,907 | 4,932,598 | 9,236,033 | 12,612,882 | 12,486,174 |
| Canadian Crude distilled..Imp. gals. | 7,919,886 | 7,437,382 | 8,122,062 | 9,513,222 | 7,693,385 |
| Value do $ | 334,315 | 403,316 | 559,435 | 781,703 | 661,927 |
| Per cent. of total | 9.39 | 8.12 | 6.22 | 6.49 | 5.17 |
| Products: | | | | | |
| Illuminating oil........Imp. gals. | 26,261,575 | 25,405,296 | 40,195,774 | 36,211,715 | 34,800,233 |
| Value do $ | 1,942,549 | 1,999,261 | 3,457,817 | 4,239,816 | 5,073,647 |
| Lubricating oil ........Imp. gals. | 7,271,200 | 10,373,508 | 12,288,466 | 12,595,505 | 12,501,385 |
| Value do $ | 700,027 | 1,059,526 | 1,586,270 | 2,118,002 | 2,293,640 |
| Benzine,Naphtha,Gasoline,Imp.gals. | 19,118,334 | 24,344,319 | 34,611,056 | 39,156,447 | 44,625,590 |
| Value do $ | 2,412,625 | 5,077,314 | 8,292,828 | 10,244,328 | 11,677,077 |
| Gas and Fuel oil, Tar. ..Imp. gals. | 23,478,236 | 15,224,382 | 39,815,106 | 40,949,358 | 40,581,499 |
| Value do $ | 893,994 | 686,800 | 2,671,414 | 2,943,503 | 2,265,457 |
| Paraffin Wax and Candles.....lbs. | 9,826,635 | 8,834,945 | 12,649,553 | 13,650,128 | 10,903,202 |
| Value do $ | 319,929 | 631,560 | 908,996 | 1,148,726 | 1,044,798 |
| Employees ................Ave. No. | 723 | 1,161 | 1,289 | 1,312 | 1,580 |
| Wages paid ......................$ | 564,950 | 867,071 | 1,259,344 | 1,486,677 | 2,045,072 |

* The figures for the years 1915 and 1916 are for the Canadian Oil Companies, Ltd., and Imperial Oil, Ltd.

## Phosphate (Apatite)

The production of phosphate in Ontario has been very limited in the past few years, supplies from the southern States having supplanted the Canadian product from Ontario and Quebec which is now almost wholly recovered as a by-product in mica mining. The only reported shipment in 1919 was by W. S. McLaren of Perth to the Ontario Agricultural College at Guelph, where it was used in experiments with various fertilizers.

The following is a record of the phosphate shipments for a 5-year period:

| —— | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Tons .................... | 17 | 13 | 26 | nil | 2 |
| Value.................... $ | 102 | 174 | 256 | nil | 31 |

## Quartz (Silica)

Shipments of silica ($SiO_2$), commonly known as quartz or flint, were 59,658 tons worth $179,070 in 1919, the average valuation being $3.00 per ton as compared with $2.02 in 1917 and $2.12 per ton in 1918. In 1918 there were marketed 213,420 tons worth $452,711. In explanation of the large decrease in output it may be noted that some of the larger operators reported no production during 1919. Included in this category are Dominion Mines and Quarries, Limited; Electro-Metals, Limited; McPhail and Wright Construction Co., Limited, and Mond Nickel Company. The last mentioned secured sufficient quartz in 1919 for nickel-copper smelting from the siliceous ore of Bruce Mines. Electro-Metals, Limited, manufacturers of ferro-silicon at Welland, had a large stock of quartz on hand at the end of 1918, an accumulation on account of war contracts, and consequently it was not necessary to operate their Killarney quarry during the year.

The Algoma Steel Corporation used 2,569 tons of quartz, produced in 1918 from the McPhail & Wright quarry, in the manufacture for its own works of 577,785 silica brick worth $33,259. In Table I, Mineral Statistics for 1919, this value is not credited to 1919 production in view of the quartz having been included in the figures for 1918.

The main output of silica in Ontario is from quartzite and vein quartz. A small proportion is recovered from the working of pegmatite dikes for feldspar, the two minerals usually being in association. Sandstones in eastern Ontario furnish a fairly pure silica, particularly the white Potsdam sandstone. Flint or chert in the form of pebbles has been collected at various times, principally on the north shore of Lake Superior, for use in ball or tube mills.

The chief minor uses for quartz are in the manufacture of glass, pottery, paints, fillers, scouring powders, polishers, sand paper, abrasive soaps and abrasives generally, chemical apparatus, and foundry products.

Following is a list of quarry operators:

QUARTZ SHIPPERS, 1919.

| Name of Owner, Firm or Company. | Location. | P.O. Address of Manager, etc. |
|---|---|---|
| Eureka Flint and Spar Co................ | Verona ............... | Verona. |
| International Nickel Company of Canada, Limited .............................. | Dill tp. ............... | Copper Cliff. |
| Ontario Feldspar, Limited ............... | S. Sherbrooke tp. ...... | Toronto, 34 Toronto St. |

## Salt

The salt industry of Ontario is confined to the western peninsula of the province. No rock salt is quarries, the entire production being from wells which penetrate salt beds and from which salt in the form of brine is pumped. In 1919 there were 26 of these wells operated. Details of the industry, covering a five year period, are given in the following table. The quantities in short tons represent various grades of salt marketed, and the values as far as possible exclude the value of packages:

SALT STATISTICS, 1915—1919.

| Schedule | | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|---|
| Land | tons. | 992 | 1,050 | 2,093 | 2,041 | 1,720 |
| Coarse | " | 31,553 | 29,241 | 32,236 | 25,232 | 35,150 |
| Fine | " | 59,234 | 56,325 | 56,028 | 53,908 | 47,571 |
| Table and Dairy | " | 24,869 | 30,640 | 34,251 | 34,324 | 34,396 |
| Brine (salt equivalent) | " | .......... | 11,679 | 14,301 | 16,221 | 29,275 |
| Total sales | " | 116,648 | 128,935 | 138,909 | 131,726 | 148,112 |
| Value " | $ | 585,022 | 700,515 | 1,047,707 | 1,287,039 | 1,395,368 |
| Employees* | No. | 242 | 238 | 312 | 302 | 296 |
| Wages | $ | 183,558 | 208,673 | 234,925 | 275,842 | 319,463 |

* Employees of chemical works are not included.

The list of companies producing brine or salt in 1919 is as follows:

SALT COMPANIES, 1919.

| Name of Owner, Firm or Company. | Location of Wells or Works. | P.O. Address of Manager, etc. |
|---|---|---|
| Brunner, Mond Canada, Limited | Amherstburg* | Amherstburg. |
| Canadian Salt Company, Limited, The | Windsor; Sandwich* | Windsor. |
| Dominion Salt Company, Limited, The | Sarnia | Sarnia. |
| Elarton Salt Works Company, Limited | South of Egremont Road, Warwick tp.† | Hyde Park. |
| Exeter Salt Works Company, Limited | Exeter | Exeter. |
| Goderich Salt Co., Limited | Goderich | Goderich. |
| Ontario People's Salt and Soda Co., Limited | Kincardine | Kincardine. |
| Western Canada Flour Mills Co., Limited | Goderich | Goderich. |
| Western Salt Company, Limited | Courtwright | Courtwright. |
| Wingham Salt Works (Young Estate) | Wingham | Wingham. |

* Chemical works using salt brine as raw material.
† Plant not operated—only stock on hand marketed.

*Derivative Chemicals.*—In addition to the various grades of salt marketed, brine, equivalent to 29,275 tons of salt, was used in the chemical works of the Canadian Salt Company at Sandwich, and those of Brunner, Mond Canada, Limited at Amherstburg. The former manufactures caustic soda and bleaching powder, while the latter began last October to produce soda ash by the Solvay process. It is the first plant of the kind in Canada and has a capacity sufficient to meet all Canadian requirements. Soda ash is a very important chemical product, salt brine and pure limestone being utilized as the principal materials in its manufacture. It is an essential ingredient in the manufacture of soap, glass and many other commodities. In fact, its use is so general that the manufacture of soda ash is recognized as a "key" industry.

## Talc

The entire production of talc in Ontario comes from Madoc and Eldorado in Hastings county. The mineral, an acid metasilicate of magnesium, is otherwise known as steatite or soapstone, depending on the alteration of the schistose rock from which it is derived. Ontario talc being worked is of the massive variety. It lacks the fibrous quality of the deposits of New York state, but has the advantage of being generally freer of grit. Much of it is used for paper-making. The last annual Report [1] contained a full account of the great variety of uses to which the mineral is put—as talcum powder, in the rubber industry, etc. In addition talc has important ceramic uses as a glaze and also in the manufacture of pottery and porcelain, improving the translucency of the ware and promoting vitrification in the body.

A large part of the output, both crude and ground, is marketed in the United States. In 1918 of the total talc imported by that country, 96 per cent. came from Ontario. The United States is at present the chief talc producer among the countries of the world, and the great bulk of the output comes from the mountainous area near the Atlantic coast, New York state being the chief producer.

The progress of the industry in Ontario may be noted from the following table covering a five-year period:

TALC STATISTICS, 1915-1919.

| Schedule | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Crude talc shipped .................. tons | 1,720 | 3,665 | 2,398 | 1,044 | 1,644 |
| Ground talc shipped................ " | 9,285 | 8,145 | 13,678 | 16,421 | 15,927 |
| Total value shipments.............. $ | 85,325 | 111,489 | 179,554 | 246,691 | 240,399 |
| Employees, mine and mill........... No. | 40 | 60 | 56 | 43 | 87 |
| Wages paid ........................ $ | 23,790 | 32,434 | 49,734 | 41,936 | 76,384 |

After being idle since September 1, 1916, the talc property at Eldorado formerly operated by Eldorite, Limited, was re-opened in 1919. The business of mining and milling is now being carried on by the Eldorado Mining and Milling Co., Limited.

The following companies and firms were engaged in the mining and milling of talc during 1919:

TALC OPERATORS, 1919.

| Firm or Company. | Location of Mine or Works. | Address of Manager, etc. |
|---|---|---|
| Anglo-American Talc Corporation, Ltd..... | Huntingdon tp. ........ | Madoc. |
| Eldorado Mining and Milling Co., Ltd..... | Eldorado ............. | Eldorado. |
| *Henderson Mines, Limited .............. | Huntingdon tp. ........ | Madoc. |
| Geo. H. Gillespie and Company, Limited.... | Madoc (grinding mill).. | Madoc. |

* The Henderson mine was operated under lease by Henderson Mines, Limited, the product going to the Gillespie mill.

[1] Rep. Bur. Min., Vol. XXVIII, 1919, Part I, pp. 80-1.

## Mining Divisions

The mineral areas of the province are comprised in twelve Mining Divisions. The official in charge of a Mining Division is termed a Mining Recorder, and he administers the Crown lands within his division for the purposes of the Mining Act. He issues miner's licenses, receives and records applications for mining claims, settles disputes between licensees, and performs a variety of other duties laid down for him in the Act. There is an appeal from his decisions to the Mining Commissioner, who is clothed with judicial powers with respect to unpatented mining lands. Once the Crown title has issued, any subsequent controversy must be referred to the ordinary courts of law. This decentralized system has proven of much advantage, being local in administration, flexible in operation, and enabling speedy and inexpensive settlement of disputes concerning mining lands, which are bound to arise under any conceivable mining law.

At the end of the year the Recorders report to the Department regarding the work of their respective offices, and comment upon the state of the mining industry in their neighbourhood. Although there are twelve Mining Divisions, there are only nine Mining Recorders, a single Recorder being in three cases in charge of two Divisions, where the amount of business or local convenience indicates the advisability of such an arrangement. Where mining claims are staked in those parts of the Province not included in a Mining Division, the Department of Mines at Toronto acts as Recorder.

Following is a summary of the reports of the Mining Recorders for the year 1919:

*Sudbury.*—Little of special interest has transpired during the year, with the exception of the activity in West Shiningtree during the summer and up to about December. Development work, however, is going along satisfactorily and the prospectors and others seem to have plenty of faith for the future.

*Porcupine.*—Business in this division shows an increase over last year of about 40 per cent., due to the increased activity in prospecting and the termination of war extensions for performance of work. There was a scarcity of labour throughout the year, with the result that the mills of the producing mines were operated at less than three-quarters capacity. More labour has been available recently, and it is hoped that all of the mills will be running at full capacity within a short time. In spite of adverse labour conditions and increased mining costs, the position of the operating mines is better than ever. Almost without exception they have succeeded in largely increasing their ore reserves, and the outlook is very bright.

*Larder Lake.*—On the 15th of May, 1919, a sub-office was opened at Swastika for the convenience of prospectors in the south end of the division. Strikes and labour conditions generally very materially retarded development during the year. A notable feature was the activity in the vicinity of Larder Lake, the place where the first gold rush took place in this division, in the year 1906. Confidence seems to have been restored in that particular section, and reports are optimistic. It was in this section of the division that most of the new staking was done during the year. Indications would point to a revival of activity in the Lightning River area during the coming season.

*Sault Ste. Marie.*—Although the past year has not been very active, everything points towards a busy one in 1920.

*Port Arthur.*—A new discovery of gold about six miles north of Schreiber, and another of molybdenite near the Transcontinental railway, caused considerable activity in this Mining Division, but there has been no "boom." Prospects for increased business next spring are good.

*Kowkash.*—Very little interest has been taken by prospectors in the Kowkash Mining Division during 1919. No new discoveries have been reported. A few claims in good standing are about four or five miles south of Tashota station in the Nipigon Forest Reserve.

*Timiskaming.*—Most of the activity in the mining business appears to have been centered around Boston Creek, particularly in the townships of Eby and Catharine. There has also been considerable prospecting during the fall of 1919 in the Gillies Limit, and some silver discoveries have been reported from this section. With the opening of spring it is expected there will be great activity in prospecting through this Division, no doubt increased to some extent by the large number of prospectors who have returned from overseas and are looking forward to starting out again.

*Parry Sound.*—S. F. Walsh, of Detroit, Michigan, the owner of mining claims in Conger and Hardy townships, is completing arrangements to diamond drill them as soon as the season permits. Conger properties are copper claims, while Hardy properties are nickel and copper. In McConkey township the owners of mica mining claims are at present erecting camps in preparation to test these properties. Twenty-two mining claims have been located in Proudfoot township as radium claims in 1919, with commercial possibilities still to be proven.

*Gowganda.*—Business steadily increased in this Division during the year. A considerable number of mining companies have been installing machinery on their properties, and from the fact that several very rich discoveries of silver have been reported, it seems certain that Gowganda in a short time will be one of the leading silver camps of the Dominion.

*Montreal River.*—Business in this office during the year 1919 has been very good. Many new mining companies have been formed and considerable mining machinery installed on various properties. As several very rich discoveries of gold and silver have been made during the latter part of the year, this Division no doubt will receive much attention from the prospector and the mining companies during the coming year.

The business transacted at the offices of the various Recorders for the calendar year is summarized in the following table. These figures do not cover business of a like kind transacted at the Department in Toronto.

SUMMARY OF BUSINESS IN THE VARIOUS MINING DIVISIONS FOR THE CALENDAR YEAR 1919.

| Schedule | Sudbury | Porcupine | Larder Lake (Matheson and Swastika) | Sault Ste. Marie | Port Arthur | Kowkash | Timiskaming and Coleman | Parry Sound | Gowganda | Montreal River | Kenora | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. No. of letters received during the year.. | 1,657 | 2,313 | 4,633 | 555 | 2,576 | 437 | 1,427 | 813 | 858 | 2,271 | 1,067 | 18,607 |
| 2. " " written.................. | 1,267 | 2,481 | 4,612 | 448 | 2,331 | 358 | 1,211 | 639 | 766 | 2,076 | 1,169 | 17,358 |
| 3. " Miner's Licenses issued.......... | 378 | 112 | 477 | 105 | 148 | 5 | 349 | 147 | 18 | 84 | 31 | 1,854 |
| 4. " " " renewed........ | 256 | 250 | 287 | 119 | 230 | 27 | 893 | 19 | 54 | 84 | 43 | 2,262 |
| 5. " Mining applications recorded..... | 673 | 136 | 1,015 | 90 | 171 | 9 | 244 | 39 | 145 | 134 | 31 | 2,687 |
| 6. " " " cancelled.... | 408 | 153 | 280 | 26 | 40 | 31 | 167 | 9 | 55 | 238 | 74 | 1,481 |
| 7. " Agreements, Transfers, etc., recorded.................... | .......... | 189 | 410 | 41 | 82 | 21 | 329 | 4 | 80 | 131 | 18 | 1,305 |
| 8. Amount received for Miner's Licenses, Permits, Recording Fees, etc....... $ | 11,591 25 | 4,055 95 | 15,332 15 | 2,240 50 | 4,033 75 | 407 00 | 9,467 00 | 928 00 | 2,154 75 | 3,297 00 | 732 75 | 54,240 10 |
| 9. Amount received as Purchase Money or Rental ......................... $ | 3,074 44 | 6,742 22 | 13,787 84 | 598 25 | 3,282 58 | ...... | 3,910 30 | 402 00 | 415 39 | 888 45 | 743 25 | 33,844 72 |
| 10. No. of Claims of which surveyor's plans were filed during the year..... | 19 | 40 | 100 | 15 | 7 | ...... | 3 | ...... | 20 | 18 | 5 | 227 |
| 11. " disputes entered................ | 1 | ........ | 2 | 1 | ........ | ...... | 1 | ...... | 2 | 1 | ...... | 8 |
| 12. " disputed cases decided by Recorder | 1 | ........ | .......... | 1 | ........ | ...... | | ...... | | 1 | ...... | 3 |
| 13. " appeals to Mining Commissioner.. | 1 | ........ | 3 | ........ | ........ | ...... | ........ | ...... | 2 | ........ | ...... | 6 |
| 14. " extensions of time granted....... | 155 | 124 | 340 | 17 | 71 | 36 | 66 | ...... | 34 | 154 | 10 | 1,007 |
| 15. " Certificates of Record granted.... | 35 | 73 | 96 | 11 | 44 | 16 | 29 | 1 | 21 | 18 | 7 | 351 |
| 16. " Certificates of Performance of Work granted................ | 37 | 75 | 75 | 16 | 44 | 16 | 41 | ...... | 20 | 8 | 7 | 339 |
| 17. " claims for which papers were forwarded to the Department for issue of title................. | 32 | 79 | 151 | 3 | 36 | ...... | 39 | 3 | 19 | 11 | 7 | 380 |
| 18. " Forest Reserve Permits issued... | .......... | ........ | .......... | ........ | 6 | 1 | ........ | ...... | 2 | 59 | ...... | 68 |
| 19. " substitute Miner's Licenses issued | .......... | ........ | 1 | 1 | 4 | ...... | ........ | 1 | ........ | ........ | 1 | 8 |

For the fiscal year 1918-19 the remittances to the Department from the Recorders were as follows:

MONEYS REMITTED BY MINING RECORDERS FOR THE FISCAL YEAR ENDING OCTOBER 31, 1919.

| Mining Division | Name of Recorder | Address | Purchase Price | Permits | Miners' Licenses | Recording Fees, etc. | Total |
|---|---|---|---|---|---|---|---|
| | | | $ c. | $ c. | $ c. | $ c. | $ c. |
| Sudbury | Campbell, C. A. | Sudbury | 2,721 69 | 750 00 | 2,915 00 | 7,430 75 | 13,817 44 |
| Porcupine | Gauthier, G. H. | S. Porcupine | 7,228 95 | 110 00 | 1,707 25 | 2,429 45 | 11,475 65 |
| Larder Lake | Ginn, H. G. | Swastika | ........ | ........ | 35 00 | 327 25 | 362 25 |
| | Hough, J. A. | Matheson | 8,923 49 | ........ | 1,992 00 | 12,582 35 | 23,497 84 |
| Sault Ste. Marie | Miller, W. N. | Sault Ste. Marie | 658 25 | ........ | 1,083 00 | 1,263 25 | 3,004 50 |
| Port Arthur / Kowkash | Morgan, J. W. | Port Arthur | 3,637 12 | 20 00 | 2,063 25 | 2,081 25 | 7,801 62 |
| Timiskaming | McAulay, N. J. | Haileybury | 3,395 16 | 100 00 | 5,940 00 | 3,768 25 | 13,263 41 |
| Parry Sound | McQuire, H. F. | Parry Sound | 402 00 | ........ | 478 00 | 240 00 | 1,120 00 |
| Gowganda | Sheppard, H. E. | Elk Lake | 551 03 | 115 00 | 692 00 | 802 75 | 2,163 78 |
| Montreal River | Morgan, M. R. | | 648 36 | 456 25 | 366 00 | 2,066 75 | 3,537 36 |
| Kenora | Spry, W. L. | Kenora | 120 00 | ........ | 265 00 | 395 25 | 880 25 |
| Total | ........ | ........ | 28,289 05 | 1,611 25 | 17,636 50 | 33,387 30 | 80,924 10 |

## Mining Companies

During the year 1919 the mining and mineral companies incorporated under the laws of Ontario numbered 149, with a nominal capitalization of $223,600,000. The corresponding figures for 1918 were 59 companies capitalized at $49,809,000. Companies of extra-provincial incorporation licensed to do business in Ontario were 10, with authority to employ in the Province a total capital of $9,554,197. Nine companies surrendered their charters.

Following are the lists:

MINING COMPANIES INCORPORATED[1] IN 1919.

| Name of Company. | Head Office. | Date of Incorporation. | Capital. $ |
|---|---|---|---|
| Anglo-Canadian Metals, Limited | Toronto | Mar. 4 | 40,000 |
| Barry-Hollinger Gold Mines, Limited | " | May 20 | 2,000,000 |
| Bidgood Gold Mines, Limited | Haileybury | Mar. 26 | 2,000,000 |
| Bidwell Oil and Gas, Limited | Toronto | Dec. 17 | 1 000,000 |
| Boston-McCrea Gold Mines, Limited | " | Feb. 28 | 2,000,000 |
| British Matachewan Gold Mines, Limited | " | Aug. 28 | 3,000,000 |
| British Possessions Exploration Co., Ltd. | " | Mar. 19 | 40,000 |
| Camburn Silver Mines, Limited | Toronto | July 7 | 1 500,000 |
| Canada Petroleum & Refining Corporation, Ltd. | " | July 29 | 2 500,000 |
| Canadian-American Resources, Limited | " | Nov. 17 | 50,000,000 |
| Canadian Ceramics, Limited | " | May 13 | 40,000 |
| Canadian Electric Ore Smelters, Limited | " | Jan. 8 | 40,000 |
| Canadian Fireclay Products, Limited | " | Dec. 6 | 40,000 |
| Canadian Marble Quarries, Limited | " | Apr. 29 | 2,000,000 |

[1] Included in the list are certain companies which received permission to increase or decrease their capital. In such cases the new capitalization is given.

MINING COMPANIES INCORPORATED IN 1919.—*Continued.*

| Name of Company. | Head Office. | Date of Incorporation. | Capital. $ |
|---|---|---|---|
| Canadian Mexican Oil Company, Limited.. | Toronto ........ | Oct. 7...... | 1,000,000 |
| Canagoma Mining and Development Company, Ltd. ........................ | " ........ | May 13...... | 200,000 |
| Carveth Gold Mines, Limited ............ | " ........ | Nov. 13...... | 3,000,000 |
| Catharine Gold Mines, Limited .......... | Haileybury ...... | Apr. 22...... | 2,000,000 |
| Central Operating Company, Limited ..... | Toronto ........ | Nov. 7...... | 100,000 |
| Chatham Cement Tile and Block Company, Ltd. ................................ | Chatham ....... | July 14...... | 40,000 |
| Clark Metals, Limited .................. | Toronto ........ | Dec. 9...... | 100,000 |
| Clay Products Agency, Limited .......... | " ........ | Feb. 12...... | 100,000 |
| Clifton Porcupine Mines, Limited ........ | " ........ | Apr. 5...... | 2,000 000 |
| Colonial Oil Fields, Limited ............ | " ........ | Aug. 16...... | 50,000 |
| Colwell Sand and Gravel, Limited ........ | " ........ | Feb. 27...... | 300,000 |
| Concrete Pipe and Products Company, Ltd. | Hamilton ....... | June 21...... | 200,000 |
| Contact Bay Mines, Limited ............ | Increase of capital | Oct. 23...... | 350,000 |
| Crawford Skead Gold Mines, Limited ..... | Chatham......... | Dec. 5...... | 1,000,000 |
| Crookston Quarries, Limited ........... | Crookston........ | Oct. 2...... | 300 000 |
| Davidson Consolidated Gold Mines, Limited | Toronto.......... | July 15...... | 5,000 000 |
| Detroit Canadian Oil and Gas Co., Ltd. ... | Markdale........ | June 4...... | 60,000 |
| Dolomite Products Company, Limited ..... | Toronto.......... | Sept. 27...... | 100,000 |
| Dominion Sewer Pipe & Clay Industries, Ltd. ................................ | " ........ | Jan. 6...... | 1 000,000 |
| Dufferin Oil Company, Limited .......... | " ........ | Dec. 29...... | 1,000,000 |
| East Kent Oil Producing Company, Ltd... | " ........ | Feb. 15...... | 300,000 |
| Eastern Mining and Milling Company, Ltd. | Increase of capital | Mar. 19...... | 1,500,000 |
| Erie Investments, Limited .............. | Toronto ........ | Jan. 2...... | 40,000 |
| Erie Sand & Gravel Company, Limited .... | Windsor ........ | Mar. 11...... | 50,000 |
| Eureka Molybdenite Corporation ......... | Toronto ........ | Feb. 5...... | 1,000,000 |
| Farmers' Mining Company, Limited ...... | " ........ | Oct. 8...... | 50,000 |
| Feldspar Products Company, Limited .... | " ........ | Dec. 2...... | 1,000,000 |
| Ferro Alloys Iron & Coke Company, Ltd.. | " ........ | Feb. 13...... | 100,000 |
| General Examining and Developing Co., Ltd. | " ........ | Nov. 10...... | 1,000,000 |
| Glasscoat Sewerpipe & Conduits, Limited.. | " ........ | Dec. 11...... | 250,000 |
| Goldale Mines, Limited ................. | " ........ | Apr. 22...... | 3 000,000 |
| Gold Centre Mines, Limited ............. | " ........ | Oct. 1...... | 3,000,000 |
| Gold Nugget Products Company, Limited . | " ........ | July 28...... | 1,000,000 |
| Gould Allied Mines, Limited ........... | Ottawa ........ | Nov. 10...... | 2,000 000 |
| Granby-Kirkland Gold Mines, Limited .... | Toronto ........ | July 8...... | 2,000,000 |
| Greene-Kirkland Gold Mines, Limited .... | " ........ | Apr. 17...... | 3,000 000 |
| Gros Cap Mining and Exploration Co., Ltd. | Sault Ste. Marie. | Oct. 8...... | 100,000 |
| Hargrave Consolidated Mines, Limited .... | Toronto ........ | Dec. 29...... | 2,500,000 |
| Herrick Gold Mines, Limited ........... | " ........ | Apr. 22...... | 2,000,000 |
| Hiesha Mines of Porcupine, Limited ...... | " ........ | July 25...... | 40,000 |
| Hudson-Porcupine Gold Mines, Limited... | " ........ | Nov. 20...... | 1,500,000 |
| Hughes-McElroy Gold Mines, Limited .... | " ........ | Dec. 31...... | 2,500,000 |
| Iroquois Sand and Gravel Company, Ltd.. | " ........ | June 16...... | 300,000 |
| Ivanhoe-Boston Gold Mines, Limited ...... | Haileybury ..... | Oct. 15...... | 2,000,000 |
| Jack Munro Mining Company, Limited.... | Toronto ........ | Dec. 11...... | 2,000,000 |
| Kalgoorlie-Kirkland Gold Mines, Limited.. | " ........ | Dec. 4...... | 2,000,000 |
| Kennedy Boston Gold Mines, Limited .... | Haileybury ..... | Mar. 21...... | 2,000,000 |
| Keystone Gold Mines, Limited ........... | Toronto ........ | Apr. 30...... | 2,000,000 |
| Kirkland-Hudson Bay Gold Mines, Limited | " ........ | Jan. 7...... | 2,000,000 |
| Lake Matachewan Gold Mining Company, Ltd. ................................ | " ........ | May 20...... | 2,000,000 |
| Lakeview Gold Mines, Limited .......... | " ........ | Mar. 11...... | 1,500,000 |
| La Santa Lucia Gold Mines, Limited ..... | " ........ | Nov. 22...... | 1,000,000 |
| Liberty Oil Refining Company, Limited ... | " ........ | Aug. 28...... | 1,000,000 |
| McLaurin Development Company, Limited. | " ........ | Nov. 21...... | 50 000 |
| Maple Leaf Oil and Gas Company, Limited | Wellandport .... | Dec. 2...... | 320 000 |

MINING COMPANIES INCORPORATED IN 1919.—*Continued.*

| Name of Company. | Head Office. | Date of Incorporation. | Capital. $ |
|---|---|---|---|
| March Gold, Limited | Toronto | Dec. 9 | 1,500,000 |
| Marigold Mining Company, Limited | " | Mar. 1 | 3,000,000 |
| Matachewan-Rand Gold Mines, Limited | " | Jan. 27 | 3,000,000 |
| Merriton Clay Products Company, Limited | " | Aug. 27 | 50,000 |
| Miller-Adair Mines, Limited | " | June 13 | 2,000,000 |
| Mohawk Petroleum Company, Limited | Petrolia | Apr. 29 | 150,000 |
| Murray-Mogridge Mines, Limited | Toronto | Aug. 13 | 4,000,000 |
| New Porcupine Imperial Mines, Limited | " | Feb. 21 | 3,000,000 |
| Nipissing Extension Mines, Limited | " | July 4 | 3,000,000 |
| North Cliff Mines, Limited | " | July 29 | 100,000 |
| Northern Oilfields, Limited | " | Sept. 22 | 1,000,000 |
| Northern Ontario's Great Mines Developing Co., Limited | Hamilton | Oct. 7 | 2,000,000 |
| Nubrik Products, Limited | Toronto | May 17 | 100,000 |
| Oil and Gas Producers, Limited | " | Dec. 22 | 300,000 |
| Okawaw-Kenda Gold Mines, Limited | " | Oct. 15 | 1,000,000 |
| Ontario Barium Company, Limited | " | Mar. 20 | 1,000,000 |
| Ontario Cement, Limited | Brantford | Dec. 8 | 600,000 |
| Ontario Exploration Syndicate, Limited | Toronto | Sept. 10 | 40,000 |
| Ontario Feldspar, Limited | " | Aug. 18 | 100,000 |
| Ontario Sewer Pipe and Clay Products, Ltd. | " | Feb. 14 | 300,000 |
| Oxford Cobalt Silver Mines, Limited | Woodstock | Mar. 27 | 1,000,000 |
| Palmer-Paine Mines, Limited | Toronto | Mar. 14 | 4,000,000 |
| Peace River Petroleums, Limited | " | Oct. 24 | 5,000,000 |
| Petrol Oil and Gas Company, Limited | " | Apr. 22 | 500,000 |
| Pittsburgh and Northern Ontario Exploration and Development Co., Limited | " | July 7 | 100,000 |
| Porcupine Paymaster Mines, Limited | " | Nov. 19 | 2,000,000 |
| Premier Gold Mining and Exploration Company, Limited | New Liskeard | Nov. 3 | 2,000,000 |
| Premier Oil and Gas Producing Co., Ltd. | Toronto | Oct. 25 | 250,000 |
| Prince Edward County Oil Company, Ltd. | Wellington | July 18 | 60,000 |
| R. W. F. Mines, Limited | Toronto | Oct. 22 | 1,000,000 |
| St. Marys Cement Company, Limited | St. Marys | Nov. 13 | 3,000,000 |
| Silver Bullion Mines, Limited | Toronto | Dec. 4 | 1,500,000 |
| Singleton Porcupine Mines, Limited | " | Nov. 21 | 40,000 |
| Skead Gold Mines, Limited | " | Oct. 9 | 5,000,000 |
| Sun Oil Company, Limited | " | June 2 | 500,000 |
| Symmes-Young Silver Mines, Limited | " | June 28 | 2,000,000 |
| The Abrasive Company of Canada, Limited | Hamilton | Sept. 15 | 250,000 |
| The Adelaide Oil Company, Limited | Kerwood | Aug. 28 | 40,000 |
| The Brown Feldspar Potash, Limited | Toronto | July 8 | 500 000 |
| The Buffalo Mines, Limited | Decrease of capital | Dec. 2 | 150,000 |
| The Canboro Gas and Oil Company, Ltd. | Selkirk | June 26 | 100,000 |
| The Cowain Fluorite Mining Co., Ltd. | Peterborough | Jan. 14 | 100,000 |
| The Federal Mining Company, Limited | Port Arthur | Nov. 10 | 40,000 |
| The F. H. Stover Drilling Co., Limited | Chatham | Aug. 27 | 40,000 |
| The Frontenac Graphite Mining Co., Ltd. | Toronto | Jan. 16 | 40 000 |
| The Frontier Oil and Gas, Limited | Fort Erie | Oct. 9 | 300,000 |
| The Golden Summit Mining Company, Ltd. | Toronto | Oct. 16 | 2,500,000 |
| The Honer-Kirkland Gold Mines, Limited | Haileybury | Jan. 24 | 2,000,000 |
| The Inland Oil and Gas Company, Limited | Toronto | Oct. 24 | 1 000,000 |
| The International Fluorite Mining Co., Ltd. | Peterborough | May 2 | 500,000 |
| The International Pyrite Co., Ltd. | Toronto | Oct. 29 | 1,000,000 |
| The Iowa Canadian Mines Company, Ltd. | Dryden | Nov. 4 | 40,000 |
| The Jewel Gold & Copper Mining Co., Ltd. | Sudbury | Mar. 11 | 300,000 |
| The Macassa Gold Mines, Limited | Toronto | June 10 | 2,000,000 |
| The Miller Lake Enterprize, Limited | Gowganda | Sept. 4 | 1,000 000 |
| The Nichols Gold Mining Company, Ltd. | Toronto | Oct. 6 | 2,000,000 |

MINING COMPANIES INCORPORATED IN 1919.—*Continued.*

| Name of Company. | Head Office. | Date of Incorporation. | Capital. $ |
|---|---|---|---|
| The Prospectors' Development Co., Ltd. .. | Haileybury ..... | May 26...... | 2,000,000 |
| The R. A. P. Gold Mining Co. of Boston Creek, Ltd. ........................ | Toronto ........ | Aug. 16...... | 2,000,000 |
| The Red-Line Prospectors, Limited......... | " ........ | Dec. 12...... | 100,000 |
| The Saint Antonio Mining and Exploration Company, Limited .................. | Sault Ste. Marie. | Mar. 7...... | 1,000,000 |
| The Sheffield Molybdenite Mining Co., Ltd. | Ottawa ........ | Jan. 24...... | 1,000,000 |
| The Silver Diadem Mines, Limited ....... | Toronto ........ | Aug. 19...... | 2,000,000 |
| The Summit Sand and Gravel Co., Ltd. ... | " ........ | Mar. 24...... | 40,000 |
| The Swedish-Canadian Mines, Limited .... | " ........ | Dec. 31...... | 3,000,000 |
| The Toronto Sewer Pipe Company, Limited | " ........ | May 8...... | 100,000 |
| The Wachman Mining and Milling Co., Ltd. | Dryden ......... | Nov. 3...... | 500,000 |
| The World Mining & Reduction Co., Ltd.. | Toronto ........ | Oct. 2...... | 1,000,000 |
| Toronto Brick, Limited ................. | " ........ | Jan. 17...... | 400,000 |
| Toronto Cement Products Company, Ltd... | " ........ | July 14...... | 20,000 |
| Toronto Cement Products, Limited ....... | " ........ | Dec. 13...... | 40,000 |
| Toronto-Glencoe Oil Company, Limited ... | " ........ | Jan. 14...... | 1,000,000 |
| Triangle Silver Mines, Limited .......... | Cornwall ........ | June 13...... | 2,000 000 |
| Union Petroleum Company, Limited ...... | Toronto ........ | Oct. 8...... | 40,000 |
| Victory Silver Mining Company, Limited.. | St. Catharines ... | Apr. 10...... | 500,000 |
| West Tree Mines, Limited ............... | Toronto ........ | Apr. 29...... | 3,000,000 |
| White Rock Mining Company, Limited .... | Sudbury ........ | Nov. 17...... | 1,000,000 |
| Willastone Mines, Limited .............. | Toronto ........ | Feb. 28...... | 2,500,000 |
| Wood-Kirkland Gold Mines, Limited ...... | " ........ | Dec. 24...... | 2,000,000 |

MINING COMPANIES LICENSED IN 1919.

| Name of Company. | Head Office for Ontario. | Date of License. | Capital for use in Ontario. |
|---|---|---|---|
| Baldwins Canadian Steel Corporation ..... | Toronto ........ | Dec. 10...... | $2,300,000 |
| British Molybdenite, Limited ............ | " ........ | Feb. 7...... | 75,000 |
| Brunner Mond Canada, Limited .......... | | Feb. 7...... | 5,000 000 |
| Canada Iron Foundries, Limited [1] ......... | Hamilton ....... | Dec. 19...... | 1,000,000 |
| Manning Abrasive Company, Inc. ........ | Toronto ........ | Apr. 11...... | 10,000 |
| Meteor Development Company ........... | Haileybury ..... | July 2...... | 100,000 |
| Pittsburgh Corporation .................. | " ........ | Feb. 13...... | 20,000 |
| The Canada Company .................... | Toronto ........ | Sept. 12...... | 909,197 |
| The Tilbury Oil & Refining Company ..... | Petrolia ........ | Feb. 11...... | 100,000 |
| West Kirkland Gold Mines, Limited ...... | Toronto ........ | Oct. 11...... | 40,000 |

[1]Incorporated March 16th, 1915.

MINING COMPANY CHARTERS SURRENDERED IN 1919.

| Name of Company. | Date of Dissolution. |
|---|---|
| Adelaide Mining Company, Limited | Apr. 22 |
| Alloy Steel Works, Limited | Feb. 17 |
| National Petroleum Co. of Petrolia, Limited | Oct. 27 |
| Ontario Exploration Syndicate, Limited | Nov. 10 |
| Porcupine Krist-Thompson Mines, Limited | Nov. 3 |
| Sudbury Nickel, Limited | Apr. 22 |
| The Asbestos Manufacturing Company, Limited | July 7 |
| Thunder Mining Company, Limited | Sept. 29 |
| United Fuel Supply Company, Limited | Jan. 17 |

## Mining Revenue

The mining revenue of Ontario comes from three sources: (1) the sales or rentals of Crown lands; (2) fees for miners' licenses, recording of claims, etc.; (3) taxation under the Mining Tax Act. The taxation provided by the Tax Act is of three kinds, (*a*) an acreage tax of 5 cents per acre on lands sold or leased for mining purposes, where situated in territory without local organization, (*b*) a tax of 2 cents per thousand cubic feet on natural gas with a rebate of 90 per cent. of the amount when the gas is used in Canada, (*c*) a tax of 3 per cent. on the net profits of mining companies, save nickel mining companies, where the tax is a graduated one starting at 5 per cent. There are also the receipts derived from licenses authorizing the removal of sand and gravel from the beds of the great lakes and connecting rivers under the authority of the Public Lands Act. These revenues are collected by the Department of Mines.

The revenue for the fiscal year ending October 31, 1919, amounted to $762,492.65, the items being as follows:

| | |
|---|---|
| Sales of mining land | $28,510 54 |
| Mining leases | 14,270 78 |
| Sand and gravel royalties | 25,218 16 |
| Sand and gravel rentals | 3,479 47 |
| Miners' licenses, etc. | 63,962 90 |
| Mining Tax Act | 624,951 20 |
| Natural Gas Act, 1919 | 1,370 00 |
| Provincial Assay Office | 729 60 |
| Total | $762,492 65 |

The number of parcels of land sold and leased under the Mining Act was 283, comprising an area of 10,602.28 acres. There were 62 mining leases issued in the Forest Reserves, covering in all 2,137.21 acres, the first year's rental being $1,562.99. The number of parcels disposed of was 345, containing 12,737.49 acres, and the receipts amounted to $29,913.

MINING LANDS SOLD AND LEASED FROM NOVEMBER 1ST, 1918, TO OCTOBER 31ST, 1919.

| District | Sales | | | Leases | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Acres | Amount | No. | Acres | Amount | No. | Acres | Amount |
| | | | $ c. | | | $ c. | | | $ c. |
| Timiskaming | 203 | 7,146 99 | 18,982 50 | 36 | 1,289 62 | 715 40 | 239 | 8,436 61 | 19,697 90 |
| Thunder Bay | 39 | 1,537 65 | 3,773 50 | .... | ........ | ........ | 39 | 1,537 65 | 3,773 50 |
| Algoma | 13 | 623 70 | 1,657 75 | .... | ........ | ........ | 13 | 623 70 | 1,657 75 |
| Sudbury | 13 | 573 26 | 1,845 19 | 19 | 750 75 | 750 75 | 32 | 1,324 01 | 2,595 94 |
| Nipissing | 4 | 250 00 | 685 00 | 5 | 48 19 | 48 19 | 9 | 298 19 | 733 19 |
| Kenora | 1 | 40 00 | 120 00 | .... | ........ | ........ | 1 | 40 00 | 120 00 |
| Rainy River | 6 | 244 68 | 734 07 | 2 | 48 65 | 48 65 | 8 | 293 33 | 782 72 |
| Elsewhere | 4 | 184 00 | 552 00 | .... | ........ | ........ | 4 | 184 00 | 552 00 |
| Total | 283 | 10,600 28 | 28,350 01 | 62 | 2,137 21 | 1,562 99 | 345 | 12,737 49 | 29,913 00 |

Royalties and license fees in connection with sand and gravel licenses produced $28,697.63. The dredging operations are carried on at the mouth of the Niagara river and in the river itself, at some points in lake Erie, also in the St. Clair river, and in lake Superior. The largest quantities removed were from the St. Clair river, where an excellent grade of gravel is obtained, composed mainly of fragments of trap, granite, etc., from the older rock formations on the shores of lake Huron and Georgian bay.

Miners' licenses and recording fees produced $63,962.90. The price of a miner's license is $5, and the right is conferred upon the holder to stake out three mining claims in any and every Mining Division during the license year. All licenses expire on the 31st day of March following the date of issue. The fee [1] for recording a mining claim is $10.

The Mining Tax Act produced a revenue of $626,321.20, as follows:

| | |
|---|---|
| Acreage tax | $33,126.34 |
| Natural gas tax | 38,797.71 |
| Profit tax | 553,027.15 |
| | $624,951.20 |

Details of profit tax paid by the mining companies are as follows:

| | | |
|---|---|---|
| Gold: | | |
| Hollinger Consolidated | $49,005 37 | |
| Lake Shore Mines | 3,885 30 | |
| McIntyre Porcupine | 6,367 11 | |
| | | $59,257 78 |
| Silver: | | |
| Aladdin Cobalt Co. | $1,035 95 | |
| Beaver Consolidated | 2,163 66 | |
| Buffalo | 3,375 13 | |
| Casey Cobalt | 699 92 | |

[1] Reduced to $5.00 by the Mining Amendment Act, 1920, where the claim is staked out by a licensee on his own license.

| | | |
|---|---|---|
| Coniagas | 5,473 85 | |
| Hudson Bay Mining Co. | 988 15 | |
| Kerr Lake Mining Co. | 44,942 80 | |
| McKinley-Darragh | 1,481 47 | |
| Miller Lake O'Brien | 15,036 87 | |
| Nipissing Mining Co. | 67,483 84 | |
| Penn-Canadian Mines | 84 92 | |
| Timiskaming | 526 02 | |
| | | 143,292 58 |
| Nickel-Copper: | | |
| Alexo Mining Co. | $1,054 02 | |
| International Nickel Co. | 300,923 51 | |
| Mond Nickel Co. | 44,543 78 | |
| | | 346,521 31 |
| Miscellaneous: | | |
| Canadian Industrial Minerals (Fluorspar) | $119 61 | |
| Henderson Mines (Talc) | 4 47 | |
| Kingston Smelting Co. (Lead) | 45 50 | |
| Nichols Chemical Co. (Pyrite) | 3,785 90 | |
| | | 3,955 48 |
| Grand total | | $553,027 15 |

The Natural Gas Act, 1919, provides for the issuing of licenses to persons or companies engaged in boring or prospecting for natural gas, or in its production, transmission and distribution. Fees charged for such licenses amounted to the sum of $1,370.

## Provincial Assay Office

The Provincial Assayer, W. K. McNeill, reports as follows for the year 1919:

The Assay Office has been in operation without interruption for the entire year and the usual variety of work has been accomplished with the assistance of T. E. Rothwell, Chemist and Assayer, and T. A. Leat, laboratory assistant.

The work during the year may be classified as follows:

*Gold, Silver and Platinum:* 823 samples. These samples came from all parts of the Province; also a number from Manitoba and British Columbia.

*Cobalt and Nickel:*—28 samples. Twenty-four of these are pyrrhotite or nickel.

*Copper:*—28 samples. Twenty-eight samples were tested and reports issued.

*Clay and Clay Shale:*—Three samples were analyzed and reports as to their suitability for economic purposes issued.

*Iron Ores:*—25 samples. These were analyzed also for titanium, phosphorus and silica.

*Limestone and Dolomite:*—5 samples. Five samples were tested and reports issued thereon.

*Fluorspar:*—6 samples. Six samples were analyzed for the purity and on these the silica was also determined.

*Lead Ore:*—4 samples. Four samples submitted for their lead content. These were also assayed for silver.

*Potash:*—7 samples. These mere mainly from feldspars.

*Barite:*—9 samples. These were analyzed for the barite content and in some cases tests were made for barium carbonate.

*Rock Analyses:*—36 specimens. Thirty-six complete rock analyses were made. These were submitted by the geologists of the Ontario Bureau of Mines.

*Identifications:*—88 samples. Eighty-eight samples were sent in for identification, or for opinions of their commercial value. None of these required chemical analysis. These do not include the number which were brought directly to the Laboratory; of these no record is kept.

*Radium:*—36 samples. Thirty-six samples were submitted for radium and in several cases they showed radio-activity. These came from Butt township, district of Nipissing. A large number were tested for persons who came directly to the laboratory and, if not radio-active, no records were kept.

*Miscellaneous:*—61 samples. Sixty-one samples of other minerals were tested. These included tests for tin, sulphur, sulphates, manganese, uranium, arsenic, etc.

Following is the schedule of charges for work at the Provincial Assay Office and Chemical Laboratory:

Tariff of Fees for Analyses and Assays.

*1. Assays:*

| | |
|---|---|
| Gold | $1 50 |
| Silver | 1 50 |
| Gold and Silver in one sample | 2 50 |
| Platinum Minerals | 5 00 |
| Gold and Platinum Minerals in one sample | 7 00 |
| Separation of Platinum Minerals | Prices on application. |

*2. Iron Ores:*

| | |
|---|---|
| Iron (metallic) | $1 50 |
| Silica | 1 50 |
| Iron and insoluble residue | 2 50 |
| Ferrous Oxide | 2 00 |
| Phosphorous | 3 00 |
| Sulphur | 2 50 |
| Iron, Sulphur, Phosphorus and insoluble | 8 00 |
| Manganese | 3 00 |
| Titanium | 4 00 |
| Complete analysis | Price on application. |

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

Determination of:

| | |
|---|---|
| Insolubles | $1 50 |
| Silica | 1 50 |
| Ferric Iron | 3 00 |
| Ferrous Iron | 2 00 |
| Alumina | 3 00 |
| Lime | 2 00 |
| Magnesia | 2 50 |
| Potash | 5 00 |
| Soda | 5 00 |
| Alkalies (on one sample) | 6 00 |
| Water (combined) | 2 00 |
| Moisture | 1 00 |
| Carbon Dioxide | 2 00 |
| Sulphur | 2 50 |
| Phosphorus Anhydrite | 3 00 |

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

Determination of:

Silica, Iron Oxide, Alumina, Lime, Magnesia, Sulphur, and Volatile matter.......Prices on application.

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

Determination of:

| | |
|---|---|
| Moisture | $1 00 |
| Volatile Combustible | 1 50 |
| Fixed Carbon | 1 50 |
| Ash | 1 50 |
| Sulphur | 2 50 |
| Phosphorus | 3 00 |
| Calorific value (B.T.U.) | 5 00 |
| Ultimate analysis | Price on application. |

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

*7. Ores and Minerals:*

Determination of:

| | |
|---|---|
| Alumina | $3 00 |
| Antimony | 4 00 |
| Arsenic | 4 00 |
| Bismuth | 4 00 |

| | |
|---|---|
| Cadmium | $4 00 |
| Chromium | 5 00 |
| Cobalt | 5 00 |
| Nickel | 5 00 |
| Cobalt and Nickel on same sample | 6 00 |
| Copper | 2 00 |
| Fluorite | 4 00 |
| Lead | 3 00 |
| Molybdenum | 4 00 |
| Manganese | 3 00 |
| Tin | 4 00 |
| Zinc | 3 00 |

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

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

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

11. *Test for Radio-Activity*..........................................Free.

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

The pulp of each sample is retained for future reference.

DIRECTIONS.

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

Crushed samples representing large quantities or samples less than five pounds weight may be sent by mail as third class matter. The name and address of sender should be written plainly on each parcel. Instructions, with money in payment of fees, should be contained in a separate letter. Samples may be sent by express, charges prepaid.

Sample bags addressed to this Laboratory for sending ore pulp by mail may be obtained free on application; also canvas bags for shipping.

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

Samples should be addressed as follows:

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

# MINING ACCIDENTS IN ONTARIO IN 1919

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, A. H. Brown, Cobalt; James Bartlett, Sudbury; J. G. McMillan, Cobalt; A. R. Webster, Toronto

During the year 1919 at the mines, metallurgical works, quarries, clay and gravel pits regulated by the Mining Act of Ontario there were 34 fatal accidents, causing the death of 39 men, as compared with 32 deaths in 1918. Of these accidents, 19 occurred underground and resulted in 21 deaths. Six men were killed above ground at the mines, 10 at the metallurgical works and two at the quarries and clay pits.

Twenty-two companies had fatal accidents during the year.

**Table of Fatalities**

| | 1915 | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|---|
| Mines, underground | 17 | 30 | 19 | 11 | 21 |
| Mines, surface | 4 | 7 | 7 | 4 | 6 |
| Metallurgical Works | 1 | 8 | 6 | 12 | 10 |
| Quarries | 0 | 6 | 4 | 5 | 2 |
| Totals | 22 | 51 | 36 | 32 | 39 |

By months, the fatalities occurred as follows:

| | 1919 |
|---|---|
| January | 4 |
| February | 8 |
| March | 2 |
| April | 1 |
| May | 6 |
| June | 3 |
| July | 2 |
| August | 1 |
| September | 4 |
| October | 1 |
| November | 3 |
| December | 4 |
| Totals | 39 |

The fatalities were divided amongst the several districts as follows:

| | |
|---|---|
| Cobalt | 7 |
| Porcupine | 5 |
| Sudbury | 9 |
| Sault Ste. Marie | 3 |
| Michipicoten | 3 |
| Southeastern Ontario | 5 |
| Southwestern Ontario | 5 |
| Northeastern Ontario | 2 |
| Total | 39 |

Classifying the fatalities according to the industry gives the following:

| | |
|---|---|
| Nickel mines, smelters and refineries | 11 |
| Iron mines and blast furnaces | 8 |
| Silver mines, mills and refineries | 7 |
| Gold mines | 7 |
| Lead mines | 2 |
| Pyrites mines | 1 |
| Fluorite mines | 1 |
| Limestone quarries | 1 |
| Clay pits | 1 |
| Total | 39 |

### Analysis of Fatalities at Mines

| | 1915 Per cent. | 1916 Per cent. | 1917 Per cent. | 1918 Per cent. | 1919 Per cent. |
|---|---|---|---|---|---|
| Falls of ground ............ | 4.8 | 24.3 | 15.4 | 20.0 | 22.2 |
| Shaft accidents ............. | 23.8 | 27.0 | 15.4 | 0.0 | 29.6 |
| Explosives ................ | 33.3 | 21.6 | 15.4 | 40.0 | 7.4 |
| Miscellaneous underground... | 23.8 | 8.1 | 26.9 | 26.6 | 18.5 |
| Surface .................. | 14.3 | 18.9 | 26.9 | 13.3 | 22.2 |

### Table of Fatal Accidents in Mines, Metallurgical Works and Quarries, 1901 to 1919

| —— | Persons killed at metallurgical works and mines. | Persons employed at metallurgical works and producing mines. | Persons employed at non-producing mines (estimated). | Total persons employed. | Fatal accidents per 1000 employed. |
|---|---|---|---|---|---|
| 1901........ | 13 | 4,135 | 550 | 4,685 | 2.77 |
| 1902........ | 10 | 4,426 | 450 | 4,876 | 2.05 |
| 1903........ | 7 | 3,499 | 400 | 3,899 | 1.79 |
| 1904........ | 7 | 3,475 | 400 | 3,875 | 1.80 |
| 1905........ | 9 | 4,415 | 500 | 4,915 | 1.83 |
| 1906........ | 11 | 5,017 | 750 | 5,767 | 1.90 |
| 1907........ | 22 | 6,305 | 1,140 | 7,445 | 2.93 |
| 1908........ | 47 | 7,435 | 1,750 | 9,185 | 5.11 |
| 1909........ | 49 | 8,505 | 2,000 | 10,505 | 4.66 |
| 1910........ | 48 | 10,862 | 2,000 | 12,862 | 3.73 |
| 1911........ | 49 | 12,543 | 2,000 | 14,543 | 3.37 |
| 1912........ | 43 | 13,108 | 2,000 | 15,108 | 2.84 |
| 1913........ | 64 | 14,293 | 2,000 | 16,293 | 3.93 |
| 1914........ | 58 | 14,361 | 1,500 | 15,861 | 3.60 |
| 1915........ | 22 | 13,114 | 1,500 | 14,614 | 1.51 |
| 1916........ | 51 | 14,624 | 2,000 | 16,624 | 3.07 |
| 1917........ | 36 | 16,791 | 1,000 | 17,791 | 2.02 |
| 1918........ | 32 | 14,726 | 500 | 15,226 | 2.10 |
| 1919........ | 39 | 11,926 | 1,000 | 12,926 | 3.00 |

The occupation and nationality of the men killed are set out in the following table:

| Occupation. | English Speaking | Austrian | Russian | Italian | Finn | Ukrainian | Bulgarian | Swede | Chinaman | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Miner........... | 2 | 1 | 2 | ...... | 2 | 1 | ........ | ........ | ........ | 8 |
| Labourer........ | 2 | 2 | ...... | 2 | ...... | ...... | ........ | ........ | 1 | 7 |
| Trammer........ | 2 | 2 | 1 | ...... | 1 | 1 | ........ | ........ | ........ | 7 |
| Foreman......... | 5 | ...... | ...... | 1 | ...... | ...... | ........ | ........ | ........ | 6 |
| Blaster.......... | ...... | 1 | ...... | ...... | ...... | ...... | 1 | ........ | ........ | 2 |
| Stovetender...... | 2 | ...... | ...... | ...... | ...... | ...... | ........ | ........ | ........ | 2 |
| Hoistman........ | 1 | ...... | ...... | ...... | ...... | ...... | ........ | ........ | ........ | 1 |
| Blacksmith...... | 1 | ...... | ...... | ...... | ...... | ...... | ........ | ........ | ........ | 1 |
| Repair man...... | ...... | ...... | 1 | ...... | ...... | ...... | ........ | ........ | ........ | 1 |
| Cage tender...... | 1 | ...... | ...... | ...... | ...... | ...... | ........ | ........ | ........ | 1 |
| Scaler........... | 1 | ...... | ...... | ...... | ...... | ...... | ........ | ........ | ........ | 1 |
| Teamster........ | ...... | ...... | ...... | ...... | ...... | ...... | ........ | 1 | ........ | 1 |
| Electrician....... | 1 | ...... | ...... | ...... | ...... | ...... | ........ | ........ | ........ | 1 |
| Totals..... | 18 | 6 | 4 | 3 | 3 | 2 | 1 | 1 | 1 | 39 |

The ages of the men killed were as follows:

| Age | 17-20 | 21-25 | 26-30 | 31-35 | 36-40 | 41-45 | 46-50 | 51-55 | 56-60 | Total. |
|---|---|---|---|---|---|---|---|---|---|---|
| No. killed. | 1 | 9 | 6 | 4 | 2 | 10 | 3 | 1 | 3 | 39 |

### Cause and Place of Fatalities in Mines

| | |
|---|---|
| **Below Ground:** | |
| Falls of ground | 6 |
| **Explosive Accidents:** | |
| Walked into blast | 1 |
| Picked into explosive | 1 |
| **Shaft Accidents:** | |
| Cage accidents | 3 |
| Material falling down shaft | 2 |
| Struck by cage or skip | 2 |
| Falling crosshead | 1 |
| **Miscellaneous Underground:** | |
| Rock falling from chute | 1 |
| Rock falling from raise | 1 |
| Buried in stope | 1 |
| Falling from bench | 1 |
| Crushed by locomotive | 1 |
| **Above Ground:** | |
| Failure of air receiver | 2 |
| Fell into stope | 1 |
| Fell from cyanide tank | 1 |
| Suffocated in chute | 1 |
| Team ran away | 1 |
| **Metallurgical Plants:** | |
| Premature explosion | 2 |
| Falls | 2 |
| Burned by hot blast | 2 |
| Explosion of blast furnace | 1 |
| Buried in ore bin | 1 |
| Crushed in elevator | 1 |
| Found dead | 1 |
| **Quarries and Clay Pits:** | |
| Buried in ore bin | 1 |
| Fall of clay | 1 |

### Prosecutions

Before Magistrate Greenwood at Port Colborne, on February 25th, Robert Wright was charged with an infraction of sub-section 98, section 164, Part IX, of the Mining Act of Ontario. A fine of $15.00 and costs was imposed.

On April 29th, before Mr. Chas. Macnab, Magistrate of the County of Carleton, at Ottawa, Mr. A. G. Munich, manager of the Kingdon lead mine at Galetta, was fined $100 and costs for allowing a cage to be used for the raising and lowering of men which was not equipped with safety devices as required by the Mining Act of Ontario.

The White Reserve Mining Company, Limited, were fined $100 and costs by Police Magistrate S. Atkinson, at Haileybury, on August 4th, 1919, for permitting men to be hoisted on a cage whose sides were not enclosed and which was not equipped with doors as required by the Mining Act of Ontario.

Table of Fatal Accidents in

| No. | Date 1919 | Name of Mine. | Name of Owner. | Name of Deceased. | Occupation of Deceased. |
|---|---|---|---|---|---|
| 1 | Feb. 11. | Magpie | Algoma Steel Corp. | E. J. Bissonette | Labourer |
| 2 | May 30. | do | do do | Fabio Lerese | Trammer boss. |
| 3 | June 8. | Murray | British America Nickel Corp. | Andrew Morrissey | Trammer |
| | | | | Jos. Kolyn | do |
| 4 | Mar. 1. | Noyes | Canadian Industrial Minerals | Jos. Milks | Hoistman |
| 5 | Feb. 2. | Casey-Cobalt | Casey-Cobalt Silver Mining Co. | Oskar Huhtala | Machine-runner |
| 6 | Dec. 10. | Rognon | Contact Bay Mines | Jas. Barclay | do do |
| | | | | Wm. Sheardown | Blacksmith |
| 7 | May 15. | Dome | Dome Mines Co. | Peter John | Blaster |
| 8 | July 7. | Foster | Foster lease | F. A. MacDonald. | Foreman |
| 9 | Nov. 13. | Hollinger | Hollinger Consolidated Gold Mines | J. Bilous | Machine-runner |
| 10 | Sept. 13. | Hudson Bay | Hudson Bay Mines | N. Olanski | Trammer |
| 11 | Jan. 3. | Crean Hill | International Nickel Co. of Canada | W. Teremczuk | Machine-runner |
| 12 | Feb. 11. | Creighton | do do | J. Hyrhor | Blaster |
| 13 | Feb. 26. | do | do do | P. Peraniuk | Machine-runner |
| 14 | May 16. | do | do do | E. Creitzman | Shaft repair man |
| 15 | Oct. 1. | Kingdon | Kingdon Mining, Smelting and Mfg. Co. | J. Marjinski | Machine-runner |
| 16 | Nov. 19. | do | do do | C. Grant | Cage-tender |
| 17 | Jan. 11. | McIntyre | McIntyre Porcupine Mines | J. Cloutier | Trammer |
| 18 | Feb. 5. | do | do do | J. Kavanagh | Machine-runner |
| 19 | Aug. 10. | do | do do | A. La Roque | Scaler |
| 20 | Feb. 8. | Worthington | Mond Nickel Co. | Walde Siren | Trammer |
| | | | | J. Mananen | Machine-runner |
| 21 | Sept. 3. | Goudreau | Nichols Chemical Co. | J. Swanson | Teamster |
| 22 | Dec. 13. | Nipissing | Nipissing Mining Co. | G. Berchanio | Labourer |
| 23 | June 18. | Penn-Canadian | Penn-Canadian Mines | P. Kaskosky | Trammer |
| 24 | July 12. | White Reserve | White Reserve Mines | P. Stibon | do |

Table of Fatal Accidents at

| No. | Date 1919 | Name of Works. | Name of Owner. | Name of Deceased. | Occupation of Deceased. |
|---|---|---|---|---|---|
| 25 | Jan. 20. | Blast furnace | Algoma Steel Corp. | R. Cameron | Stove-tender |
| 26 | Sept. 15. | do | do do | J. Oremovisk | Labourer |
| | | do | do do | K. Zaruyk | do |
| 27 | Mar. 15. | do | Coniagas Reduction Co. | F. Gentilere | do |
| 28 | Feb. 16. | Refinery | International Nickel Co. of Canada | G. M. Guillon | Electrician's helper |
| 29 | May 16. | Smelter | do do | F. W. Knight | Shift-boss |
| 30 | Dec. 31. | Refinery | do do | C. Mark | Labourer |
| 31 | Feb. 18. | Blast furnace | Midland Iron & Steel Co. | J. Hicks | Stove tender |
| 32 | May 22. | do | Steel Company of Canada. | M. Skingley | Foreman |
| | | do | do do | W. Rae | Labourer |

Table of Fatal Accidents

| | | | | | |
|---|---|---|---|---|---|
| 33 | Nov. 29. | Quarry | Canada Cement Co. | J. Graham | Foreman |
| 34 | Apl. 12. | Clay pit | Sun Brick Co. | J. Crouter | Labourer |

**or about the Mines, 1919.**

| Nationality of Deceased. | Age. | Married or single | Below ground | Above ground | Cause of Accident. |
|---|---|---|---|---|---|
| English-speaking... | 22 | S | ...... | 1 | Suffocated in chute leading from conveyor belt. |
| Italian............ | 31 | M | 1 | ...... | Caught by run of ore from chute. |
| English-speaking.. | 24 | S | 1 | ...... | Struck by timber falling down shaft. |
| Russian.......... | 28 | S | 1 | ...... | Same accident as above. |
| English-speaking... | 21 | S | 1 | ...... | Caught while trying to board moving cage. |
| Finn.............. | 35 | S | 1 | ...... | Struck by falling crosshead. |
| English-speaking.. | 44 | S | ...... | 1 | Head of air receiver blew out. |
| English-speaking.. | 45 | M | ...... | 1 | Same accident as above. |
| Bulgarian......... | 23 | S | 1 | ...... | Crushed by electric locomotive. |
| English-speaking... | 38 | M | 1 | ...... | Walked into blast. |
| Ukrainian......... | 25 | S | 1 | ...... | Caught in run of ore in chute. |
| Austrian.......... | 43 | M | ...... | 1 | Fell into open stope. |
| Austrian .......... | 43 | M | 1 | ...... | Fell from bench in open stope. |
| Austrian.......... | 23 | S | 1 | ...... | Caught by fall of rock in stope. |
| Russian........... | 31 | S | 1 | ...... | Struck by rock falling from raise. |
| Russian........... | 49 | M | 1 | ...... | Caught by skip in shaft. |
| Russian........... | 25 | S | 1 | ...... | Caught in shaft by cage. |
| English-speaking... | 30 | S | 1 | ...... | Caught between cage and shaft timbers. |
| English-speaking... | 38 | M | 1 | ...... | Caught by fall of rock. |
| English-speaking... | 28 | M | 1 | ...... | Caught by fall of rock. |
| English-speaking... | 48 | M | 1 | ...... | Caught by fall of rock. |
| Finn.............. | 29 | M | 1 | ...... | Caught by fall of rock. |
| Finn.............. | 29 | S | 1 | ...... | Same accident as above. |
| Swede............. | 56 | S | ...... | 1 | Team ran away. |
| Italian............ | 42 | M | ...... | 1 | Fell from top of cyanide tank. |
| Austrian........... | 45 | M | 1 | ...... | Explosive in broken ore. |
| Ukrainian......... | 23 | S | 1 | ...... | Fell from cage while gassed. |

**Metallurgical Works, 1919.**

| Nationality of Deceased. | Age. | Married or Single | Cause of Accident. |
|---|---|---|---|
| English-speaking... | 45 | S | Furnace wrecked by explosion. |
| Austrian.......... | 31 | S | Door on hot blast connection flew open. |
| Austrian.......... | 24 | S | Same accident as above. |
| Italian............ | 27 | S | Crushed by freight elevator. |
| English-speaking... | 19 | S | Fell from hook of crane. |
| English-speaking... | 41 | M | Buried in ore bin. |
| Chinaman......... | 44 | M | Fell from ladder. |
| English-speaking... | 44 | S | Found dead. |
| English-speaking... | 59 | M | Premature explosion while blasting in furnace. |
| English-speaking... | 57 | M | Same accident as above. |

**at Quarries and Clay Pits, 1919.**

| | | | |
|---|---|---|---|
| English-speaking... | 54 | M | Buried in ore bin. |
| English-speaking... | 46 | M | Struck by fall of clay. |

# MINES OF ONTARIO

**Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, J. G. McMillan, Cobalt; James Bartlett, Sudbury; A. R. Webster, Toronto**

## 1.—NORTHWESTERN ONTARIO

### Gold

*Contact Bay Mines, Limited.*—Contact Bay Mines, Limited, was incorporated in July, 1918, with a capitalization of $200,000, and owns or controls thirteen mining claims south of Dryden, near Wabigoon lake. The company has done work on three of these claims: the Rognon, the Redeemer and a third claim which has been named the Bonanza.

The Rognon mine is on claim K 635 (survey number A.S. 14), on the west side of Contact bay, Wabigoon lake. It is in the unsurveyed area south of Van Horne township and is six miles due south of Dryden village. During part of 1917 and of 1918 Rognon Gold Mines, Limited, who at the time controlled the property, sank a shaft and did a small amount of lateral work. Contact Bay Mines, Limited, some of the officers of which were connected with the old company, then acquired the claim and has since carried on work intermittently.

When the mine was visited on December 15th, 1919, preparations were being made to start drifting under contract. The total underground work done up to that time consisted of: a two-compartment shaft inclined at 80 degrees and 106 feet in depth; a level at 50 feet with 65 feet of drifting to the west of the shaft; a level at 100 feet with 70 feet of drifting to the east and 122 feet to the west.

The machinery consists of a M. Beatty & Sons locomotive-type boiler, a 10 by 10 by 12-inch Canadian Ingersoll-Rand compressor, a Jenckes 5-inch by 5-inch hoisting engine, and one Nissen stamp with amalgamating plates.

Eight men were employed under mine foreman John Reany, of Dryden.

The Redeemer mine is about two and a half miles northeast of the Rognon and comprises the southeast and southwest quarters of the south half of lot 7, concession I, township of Van Horne.

These claims were originally owned by A. B. Hermann, of Chicago, and Gus Larson, of Dryden. In 1902 the Redeemer Mining and Milling Company of Windsor, Ont., began work under option, and in 1904 a mill was built notwithstanding the fact that no ore had been blocked out. Little, if any, work was done after 1906.

The Contact Bay Mines, Limited, carried on underground development and prospecting from July, 1918, to August, 1919, and it is expected that the work will be continued in 1920. The shaft is 235 feet deep and levels have been opened at 100 and 200 feet. On the first level the east drift is 56 feet long and the west 177 feet; on the second level there is a drift extending to the east for 50 feet, and from this a cross-cut has been driven north for 400 feet to intersect another vein.

The manager, Mr. H. S. Badger, states in the course of a report to the stockholders:—

The vein on the first level is from 8 to 12 feet wide and averages $4.00 per ton. On the second level for 90 feet from the shaft it is 7½ feet wide and averages $6.00 per ton; from this point for about 78 feet it averages $16.00 per ton. At the face of the west drift the vein is three feet wide.

When the mines of this district were last inspected (December, 1919) the Redeemer mine workings were filled with water, all the employees of the company being at work on the Rognon and Bonanza claims.

The Bonanza claim, which is also owned by this company, is on the northeast quarter of the south half of lot 7, concession I, township of Van Horne, and adjoins the Redeemer mine on the North. On December 16, 1919, a two-compartment vertical shaft had been sunk to a depth of 15 feet, and a log power house and a blacksmith shop completed. An Ingersoll-Rand 8-inch by 8-inch air compressor, which may be driven by either gasolene or kerosene, was being set up. There were thirteen men working under superintendent E. S. Henlye.

The officers of Contact Bay Mines, Limited, are: president, J. N. Beckley, 326 Cutler Building, Rochester, N.Y.; secretary, J. R. L. Starr, 120 Bay Street, Toronto. Harry S. Badger, Dryden, Ont., is manager.

*Iowa Canadian Mining Company.*—The Iowa Canadian Mining Company were preparing to start work on some claims south of Dryden in December, but details regarding the company and its holdings were not obtained. Nathan Wachman, Dryden, Ont., is manager.

*Wachman.*—The Wachman Mining and Milling Company, Limited, capitalization $500,000, was formed in 1919 to work some gold claims in the unsurveyed territory a short distance south of Van Horne township. These claims lie west of the Rognon mine and are six miles due south of Dryden village.

The property was visited on December 16, 1919, when the only mining being done was in a shaft on claim K 646, where two men were engaged in sinking by hand on a narrow quartz vein. A depth of 16 feet had been reached. A cook house, a sleeping camp and a stable had been built. At the time of inspection eight men were employed.

Robert Wachman of Chicago is president of the company and is now making his headquarters in Dryden.

## Pyrite

*Nickel Lake.*—The Nickel Lake Mining Company, Limited, has an authorized capital of $1,000,000 and was formed to work some pyrite claims on Nickel lake in the township of Watten, about 20 miles east of Fort Frances. The holdings of the company include mining claims P. 577, 578, 579 and 580, and some land under the waters of Nickel lake.

Work was carried on from August, 1918, until the spring of 1919. Camps were built, a vertical shaft sunk to a depth of 75 feet, and 35 feet of cross-cutting done.

W. A. Preston, of Mine Centre, Ontario, who is manager, states that the work done disclosed a large body of pyrite paralleled by a body of pyrrhotite carrying nickel, copper and a little gold. It is the intention of the company to do diamond-drilling in 1920.

The directors of the company include: G. A. Elliott, K.C., Winnipeg; Senator Lendrum McMeans, Winnipeg; Senator Wm. H. Sharpe, Manitou, Man.; and W. J. Tupper, K.C., Winnipeg.

*Northpines.*—To avoid confusion the name of the pyrite mine at Northpines, Ont., has been changed from Northern Pyrites mine to Northpines mine. This mine, which is owned by The Nichols Chemical Company of 25 Broad Street, New York, was at one time known as the Michie mine, and later as the Vermilion Pyrite mine.

As the pyrite market was unfavourable in 1919 owing to the large reserve stocks of pyrite on hand at the termination of the war, the mine was closed at the end of April and was not reopened until October 1. Shipments for the year totalled 42,476 tons and development work done consisted of 92 feet of drifting and 242 feet of raising. An addition is being built to the power house to provide space for another compressor, and a new machine shop has been started to replace the old one which was destroyed by fire. While the mine was being worked the force averaged 180 men of whom 120 were employed underground.

Robert H. Cromwell is manager of the mining and metallurgical department of the Nichols Chemical Company and J. P. Flynn, Jr., is the resident superintendent.

## II.—SUDBURY, NORTH SHORE AND MICHIPICOTEN

### Gold

*Foley.*—The Swedish-Canadian Mines, Limited, has been incorporated with an authorized capital of $3,000,000 to work the Foley gold mine and other claims near Mine Centre, Ont., in the Lower Seine gold area. In the spring of 1920 the company intends to pump out the Foley mine which was actively worked from 1894 to 1900 and was at that time considered the most promising property in the area.

J. A. Johnson, Mine Centre, is manager.

*Kirk Gold.*—Kirk Gold Mines Company Limited, was incorporated in 1916 and has an authorized capital of $2,000,000 divided into $1.00 shares. The directors are: president, George A. Bull, Brampton, Ont.; vice-president, John Black, Toronto; G. A. Gillespie, M.P.P., Peterborough, Ont.; R. B. Burkell, Toronto; C. L. Messecar, Brantford, Ont. The secretary-treasurer is Ziba Gallagher, of 18 Toronto street, Toronto.

The holdings of the company consist of two parcels of land: claims L 3685 and L. 3686 in the township of Lebel, Kirkland Lake area, and the southeast 40 acres of broken lot 11 in concession V, Aberdeen township, north of the village of Bruce Mines.

The Aberdeen township property is the one on which the company did most work in 1919. It is reached by driving about twenty miles north from Bruce Mines and is on the southeast shore of Bass lake. Here in the southeast quarter of the south half is a quartz vein well exposed in the face of a cliff which rises to a height of some 250 feet above the lake. This vein is in diabase, varies from two to eight feet in width and carries a little chalcopyrite. At a point some 50 feet above the foot of the cliff a shaft is being sunk on the vein, and when inspected in January, 1920, it was 65 feet deep. The dip of the vein seems to be at 55 degrees to the south. At the 50-foot level 20 feet of drifting had been done to the east. Frame buildings have been completed to serve as office, cook house and sleeping camp, and part of an old sawmill building has been repaired and converted into a power house. The machinery provided consists of a locomotive-type boiler, 4 feet by 13 feet 5 inches, a two drill Ingersoll-Rand compressor, and a 5-inch by 5-inch Jenckes hoisting engine. Twenty-one men were employed at the time of inspection. The manager is John Black, who is also vice-president of the company; the superintendent is Merton Bean. Leeburn, Ont., is the nearest post-office.

*Manxman.*—In the autumn of 1919 the Grace Mining Company, Limited, capitalized at $1,000,000, began work on the Manxman or Norwalk mine in the Michipicoten district. This company also controls the Grace gold mine in the same district.

The officers are: president, Wm. A. Burmeister, 1509 Cornelia Avenue, Chicago, Ill.; vice-president, Henry Schefe, Appelton, Wis.; secretary, G. M. Bruss, Chicago, Ill.; superintendent, J. M. Stewart, Michipicoten River, Ont.

*Saint Antonio.*—The Saint Antonio Mining and Exploration Company, Limited, controls 1,760 acres of land in the township of Deroche, near Bellevue, on the Algoma Central railway. The tract of land touches the railway at mileage 20½.

The president of the company reports that three discoveries have been made on the property—a calcite vein carrying galena, a deposit of magnetite and another of mispickel. He also stated that camps had been built and some diamond-drilling done.

The officers of the company are: president, Walter W. Smith; first vice-president, George K. Booth; second vice-president, Nicholas Moutsatson; third vice-president, William Christie; secretary, L. M. Adatte; treasurer, Joseph Brissette; all of Sault Ste. Marie, Michigan. The company is capitalized at $1,000,000 divided into shares of $10 par value. The head office is at 807 Queen St., Sault Ste. Marie, Ont.

## Iron

*Leitch.*—The Leitch iron claims east of Lake Nipigon and about six miles north of Beardmore station on the Canadian National railway are being diamond-drilled by Smith and Travers, of Sudbury. The drilling was still in progress at the end of the year and the results had not been made public. C. H. Hitchcock, of Sudbury, is supervising the work.

*Magpie.*—The Magpie siderite mine of the Algoma Steel Corporation was in operation all year; 187,179 (short) tons of roasted ore were produced and 189,962 tons shipped to the blast furnaces at Sault Ste. Marie, Ont.

The four-compartment vertical shaft, which was sunk another lift, is now 581 feet deep. The fifth level station was cut at 551 feet and a cross-cut is being driven to the ore body.

A. Hasselbring, who has been in the employ of the Corporation for many years, resigned in September and was succeeded by George R. McLaren as superintendent.

*Helen.*—No work was done at the Helen siderite deposit in 1919, but 2,286 tons of pyrite were shipped from the stock-pile formed while the old Helen hematite mine was running.

*Moose Mountain, Limited.*—Moose Mountain, Limited, owns and operates a magnetite mine, concentrating mill and agglomerating plant at Sellwood, Ont. In 1919, 89,631 tons of ore were treated, and 38,099 tons of product obtained. 4,895 tons of briquettes were shipped and the remainder was still stock-piled at the plant at the end of the year. The ore is being obtained from above the adit.

The mill machinery was increased by the addition of a fifth 6-ft. Hardinge mill and a sixth duplex Dorr classifier.

The company, which has a capitalization of $4,000,000 divided into 400,000 shares, has the following directorate: president, Charles E. Herrman, Scarsdale, N.Y.; James C. Hutchins and John J. Mitchell, of Chicago; Wm. Mackenzie and Donald D. Mann, of Toronto; Charles H. Smith, John B. Dennis, Augustine L. Humes, David Dows and John F. Harris, of New York. The secretary and treasurer is Albert Moreau, 17 Battery Place, New York, and the head office is at Sellwood, Ont.

The resident officers are: general manager, A. J. Anderson; assistant general manager, A. R. Globe; mine superintendent, J. G. Barron; mill superintendent, R. Sturgeon; master mechanic, C. A. Stohl.

About 150 men are employed.

## Nickel and Copper

### British America Nickel Corporation

The British America Nickel Corporation, Limited, has an authorized capital of $20,000,000, divided into shares of $100 par value. The officers of the company are: president, J. H. Dunn, New York; vice-president and managing director, W. A. Carlyle, Ottawa; treasurer, S. M. Brown, Ottawa. The Canadian head office is in the Jackson building, Ottawa.

*Nickelton Smelter.*—The construction work at Nickelton smelter was almost completed at the end of 1919. The smelter building contains two blast furnaces and three converters served by two Dominion Bridge Company 40-ton cranes.

On January 17, 1920, a trial run of one furnace and one converter was begun.

The officers at the smelter are: manager of smelter, E. J. Carlyle; assistant manager of smelter, J. H. Gillis; smelter superintendent, Oliver E. Jager; chief chemist, Frank Lathe; electrical engineer, Reginald Harding; safety engineer, G. A. Crane; master mechanic, James Harvey.

*Murray Mine.*—Development work was continued at the Murray mine during the year and the condition of the mine is now such that a large tonnage can be supplied when required. The shaft or slope is now 1,075 feet long at an angle of 36 degrees. Levels have been opened at 150, 300, 400, 500, 600, 700, 800, 900 and 1,000 feet. On the 800, 900 and 1,000-foot levels stations have been cut and a little drifting done to the southwest; on all the upper levels drifts extend both northeast and southwest from the shaft. At the end of the year there were em-

Murray Mine, British America Nickel Corporation.


British America Nickel Corporation smelter at Nickelton.

ployed at the mine, exclusive of those on construction work, 360 men, of whom 235 were working in the mine.

The rockhouse machinery was put in operation on January 16th, 1920.

E. Hibbert is manager of mines, and H. L. Roscoe superintendent of the Murray.

### International Nickel Company of Canada

The International Nickel Company of Canada, Limited, curtailed the output of their mines and smelter in January, 1919, but at the close of the year were operating at approximately pre-war capacity. Important innovations were made during the year, in the establishment of a pension fund, scholarships and group insurance.

The officers of the company are: president, A. D. Miles, Toronto; and the following residing in Copper Cliff: vice-president and general manager, J. L. Agnew: general superintendent, J. C. Nichols; assistant general superintendent, E. H. Jones; superintendent of mines, E. T. Corkill; superintendent of smelter, Wm. Kent; assistant smelter superintendent, D. MacCaskill; metallurgist, J. W. Rawlins; master mechanic of mines, D. Butchart; master mechanic of smelter, G. R. Craig; electrical superintendent, J. B. McCarthy; safety engineer, E. A. Collins; transportation superintendent, G. A. Sprecher.

Ore bridge for loading roasting heaps at O'Donnell, International Nickel Company of Canada, Ltd.

*Pensions.*—Employees who have become incapacitated after twenty years of continuous service with the company or its subsidiaries will be pensioned. Pensioners are paid monthly from the general funds at a figure based on the average full-time earnings for the last year worked. After 20 years' service, the pension is 50 per cent. of the average earnings, after 30 years' service 62½ per cent., and so forth in proportion to the number of years in the employ of the company.

Employees are not required to contribute to the pension fund, and pensions are granted at the discretion of the executive of the company. Pensions are not granted for the reason that an employee has completed 20 years' continuous service, or reached any stated age; but after 20 years' continuous service, old age, sickness, injury or incapacity from any other cause may be considered sufficient reason for granting a pension.

*Scholarships.*—The scholarship scheme provides for a course in applied science at McGill, Queen's or Toronto University for a certain number of the sons of employees, or of apprentices under 21 years of age. Three scholarships have been awarded, and in September 1919, when the first award was made, the Sudbury High School Staff conducted a competitive examination and the three candidates ranking highest at this examination were considered the winners. Details of the scheme and a set of regulations are being prepared.

*Group Insurance.*—As the law of Canada now permits group insurance to be written, the directorate of the company put the following plan in force from November 1, 1919:

Each employee who has completed one year of continuous service with the company is insured for $500. This insurance is increased to $800 at the end of two years' service; $1,200 at the end of three years' service; $1,600 at the end of four years' service; and the maximum of $2,000 at the end of five years' continuous service. Past service is to be counted.

These amounts are payable in the event of death or total disability to the beneficiary named by the employee. The initial payment is 20 per cent.; the remainder is paid in 24 semi-monthly instalments.

This insurance does not take the place of the payments made by the Workmen's Compensation Board and is cancelled as soon as a workman leaves the company's employ. A man is considered to have left who has been absent for two weeks without permission from his superintendent. When an employee obtains leave of absence he must notify the timekeeper to avoid having his insurance cancelled after two weeks' absence.

The policies were given to the employees in February, 1920.

The total number of employees of the company in the Sudbury district in 1919 averaged 1,730, of whom 442 were employed underground.

*Copper Cliff Smelter.*—In January the International Nickel Company had five furnaces in blast at the Copper Cliff smelter. At the end of the month production was reduced and for the remainder of the year three, and part of the time four, furnaces were operated.

*Crean Hill.*—The Crean Hill mine was closed down in January, 1919, and has not since been reopened. The shipments for the year amounted to 3,613 tons.

*Creighton.*—After the month of January the Creighton was the only mine of the International Nickel Company in operation, and it was worked on a greatly reduced scale. The shipments for 1919 amounted to 356,144 tons, the smallest output since 1911. The total production of the Creighton from July, 1901, when it was started, to the end of 1919, is 7,874,780 tons.

The main shaft (No. 3) is completed to 1,590 feet vertical depth, and 1,941 feet measured on the slope of 55 degrees. The 23rd level is being opened 180 feet vertically below the 20th. About 400 men were employed during the year.

The mine officers are: superintendent, George A. Morrison; assistant superintendent, W. J. Rolfe; mine foremen, Charles Collins and K. C. Browne.

*Dill Quarry.*—The quartz quarry of the International Nickel Company in Dill township on the Canadian National railway was worked for eight months in 1919. From this quarry 58,889 tons of quartz were shipped to Copper Cliff smelter for flux. William Roach was superintendent and had 40 men employed.

### Mond Nickel Company

The Mond Nickel Company, Limited, has an authorized capital of £3,400,000, divided into: 500,000 7 per cent. cumulative preference shares of £1 each; 2,000,000 7 per cent. non-cumulative preference shares of £1 each; and 900,000 ordinary shares of £1 each. There is also outstanding £375,000 of 5 per cent. first mortgage debenture stock and £500,000 of 6 per cent. redeemable debenture stock. The head office of the company is at 39 Victoria Street, London, S.W., England. Robert Mond is president and David Owen Evans, secretary.

The Canadian offices are at Coniston, Ont., and the officers living there are: manager, C. V. Corless; superintendent of mines, Oliver Hall; superintendent of reduction works, J. F. Robertson; chief engineer, W. L. Dethloff; electrical superintendent, W. H. Soule.

Owing to the large stock of nickel in England at the time of the armistice the output of the company's mines and smelter was greatly curtailed in 1919, but all the mines were kept running.

*Coniston Smelter.*—At Coniston smelter two furnaces were in blast until April 8, 1919, and from that date until the end of the year one was in operation.

A turbo-blower, made by the Rateau-Battu-Smoot Company, New York, was put in use in October to supply air to the blast furnaces. This blower is in two units which have a total capacity of 65,000 cubic feet of air at atmospheric pressure and temperature to 42 ounces gauge with a speed of 3,560 r.p.m. It is driven by a 950 h.p. Ridgway induction motor.

J. F. Robertson is superintendent of all reduction works, E. T. Austin of the smelter, and K. S. Clarke of the sintering and flotation plants.

*Bruce Mines.*—From the Bruce copper mines the Mond Nickel Company mined and shipped 27,123 tons of siliceous copper ore to Coniston in 1919.

Stoping was done at No. 4 shaft on the fifth or 427-ft. level and at "old No. 2" shaft some of the pillars were removed. In January, 1920, the Taylor shaft, which had been shut down since 1918, was pumped out and when inspected at the end of the month a drift on the 160-ft. level was being extended to the east and was then 900 feet from the shaft.

A. D. Carmichael is superintendent. The force numbers from 55 to 65 men.

*Garson.*—In 1919 stoping was continued at the Garson mine of the Mond Nickel Company above the second, third, fourth and sixth levels. Shipments for the year totalled 55,836 short tons, the greater part of the output being obtained from the block of ore between the fourth and sixth levels. On the eighth and tenth levels (800 and 1,000 feet respectively) some development was done to the east of the shaft, but no sinking was undertaken during the year. From 90 to 95 men were employed.

Captain A. L. Sharpe has returned from military service and resumed his former position of superintendent.

*Victoria.*—The ore shipped from the Victoria mine at Mond in 1919 amounted to 26,934 tons; this was obtained from various stopes between the fourth and eighteenth levels. Eighty men were employed, of whom 50 worked underground. W. J. Mumford, Mond, Ont., is superintendent.

On the eighteenth or 3,000-ft. level the cross-cut from the shaft entered the west ore-body at 1,008 feet. Preparation is being made to sink a winze in the ore below this level.

*Levack.*—As at the other mines of the Mond Nickel Company work was continued at the Levack mine, but on a reduced scale, from 70 to 90 men being employed. There were 58,383 tons of ore shipped in the course of the year.

Above the first level the ore has been worked out and on the seventh level development work is being done. As in the previous year most of the ore mined in 1919 came from between the first and fifth levels. At one point in the stope above the fifth level the horizontal distance between the walls is 580 feet.

Frank J. Eager, Levack, Ont., is superintendent.

*Worthington.*—In 1919 the Mond Nickel Company shipped 33,299 tons of ore from the Worthington mine to Coniston. Most of this was obtained from stopes above the third, fourth and fifth levels. Some diamond-drilling was done from the sixth, or 1,000-ft., level.

A 1,750-ft. Rand air compressor was moved from the Frood Extension mine to the Worthington power-house.

In September a fall of ground, amounting to some 10,000 tons, occurred. This came from the back of a stope between the third and fourth levels and carried away part of the third level floor. At the same time the pillar of ore at the west end of and adjacent to the shaft developed cracks from the 340-ft. point (vertical depth) to the 525-ft. Between these points additional timber has been placed to secure the ground on the west and south sides of the shaft, and no further trouble has been experienced. All the workmen had been withdrawn from the mine before the fall occurred.

From 70 to 100 men were employed under superintendent John G. Harris.

## Pyrite

### Nichols Chemical Company

*Goudreau Mines.*—The pyrite crushing plant of the Nichols Chemical Company at Goudreau, Ont., was closed in October, 1918, and was not started again until August 28, 1919.

In this plant the pyrite is first fed to a No. 12 Gates gyratory crusher from which a 42-inch belt conveyor leads to two No. 6 McCully gyratories; thence two 30-inch conveyors carry the crushed material to a 16-foot trommel with 1⅛-inch circular openings. The aim is to keep the product as near 2½ inches in size as possible. Waste rock is removed by handpicking from the 42-inch and 30-inch conveyors.

*"C" Deposit.*—The stripping of "C" deposit which was stopped on December 19, 1918, was not resumed until August 5, 1919. The pyrite shipped during 1919 was obtained from the open-pit on this deposit. When last inspected, in September, 1919, there were 150 men employed in and about this mine.

*Bear Deposit.*—No work was done on the "Bear" claim in 1919 other than grading part of the narrow-gauge railway which leads from the crushing plant to this claim and eastward to the Morrison No. 3 shaft.

The power-house on the "Bear" claim contains: two Jenckes return tubular boilers of 110 horsepower each; an Ames engine; a direct-current generator, 16 amperes, speed 1,200; an alternating-current generator, 25 kilowatts, speed 1,200; a Canadian Ingersoll-Rand compressor, steam 13 and 22 by 18 inches, and air 12 and 20 by 18 inches.

*Morrison No. 3.*—On the Morrison No. 3 group of claims, which is the most easterly of the deposits being worked by the Nichols Chemical Company in the Goudreau area, a three-compartment shaft or slope has been sunk on claim A. C. 40 for 230 feet at an angle of 47 degrees. Levels have been opened at 100 and 210 feet. When the last inspection was made, on September 7th, 1919, on the 100-foot level a cross-cut was being driven to the north from the shaft and on the 210-foot level 80 feet of cross-cutting and 450 feet of drifting to the southeast had been completed.

The machinery on this claim consists of: an 80 horsepower locomotive-type boiler; an Ingersoll-Rand compressor, steam 13 and 22 by 18 inches, and air 12 and 20 by 18 inches; a Bacon-Copeland hoisting engine, 9 inches by 15 inches; a Jenckes 6-inches by 8-inches hoisting engine for moving the mine pumps; a No. 4 Sheldon blower, driven by a 5-horsepower engine, for the mine ventilation. Since the "Bear" claim powerhouse was built, the power for this mine has been obtained from that source.

The resident officers of the company are: superintendent, D. J. Rees; mine captain, Arthur Schenck; mill foreman, J. H. Lineberry.

In January, 1920, the company stopped all work on their properties in this area.

### Rand Consolidated

Rand Consolidated Mines, Limited, continued to work under lease the pyrite deposit called Morrison No. 4, near Goudreau station on the Algoma Central and Hudson Bay railway. Some pyrite was shipped in the spring, but not much work was done in the quarry during the greater part of 1919 pending the completion of a crushing plant.

When last inspected on September 6, 1919, 60 men were employed. The following machinery was then being set up: two Leonard and Sons 125 horsepower return tubular boilers; a Leonard Corliss engine, 16 inches by 36 inches; three T. L. Smith Company Symons crushers, a No. 7½ and 2 No. 5's; and two trommels.

In December when the above-mentioned machinery had been set up and the building partly completed all work was stopped at the Morrison No. 4 and preparations were made to develop the Morrison No. 2 property by means of an adit. The Morrison No. 2 is a mile and a quarter south of Goudreau station and west of the track; on it both pyrite and siderite have been found associated with iron formation. The adit will be started about 1,200 feet west of mileage 175.75 on the Algoma Central.

The officers of the company are: president. Starr Jackson, Buffalo, N.Y.; secretary and treasurer, A. H. Jackson, Buffalo, N.Y.; general manager, A. W. Jackson, Buffalo, N.Y.; superintendent, A. E. Flynn, Goudreau, Ont. The head office is at 851 Ellicott Square, Buffalo, N.Y.

## III.—DISTRICT OF TIMISKAMING

### Gold

#### Boston Creek and Munro

*Baldwin.*—Work on this property in lot 2, concession VI, Eby township, was suspended at the time of the Kirkland Lake strike, and mining operations have not yet been resumed. The work in 1919, prior to the strike, consisted of 175 feet of drifting on the 200-ft. level.

J. P. Charlebois was manager, employing 20 men.

*Boston-McCrea.*—The Boston-McCrea Gold Mines, Limited, prospected its claim, the north half of lot 2 in the sixth concession of Pacaud township, during the summer months. Underground work consisted of a shaft 60 feet in depth and 30 feet of a cross-cut. The working force consisted of 15 men under superintendent W. R. Adams.

The officers of the company are: Geo. W. Morris, president; E. Wettlaufer, vice-president; Wm. Allan, treasurer; James Day, secretary, Toronto.

*Bourkes Mines, Limited.*—This company with a capitalization of $2,500,000 in shares of $1 par value, owns 158 acres in Benoit township near Bourkes Station at mileage 184 on the Timiskaming and Northern Ontario railway. The officers of the company are: Chas. Millar, president; Chas. Gentles, vice-president; A. W. Hunter, secretary-treasurer, 55 Yonge St., Toronto. David Sloan is manager and a force of 30 men is employed.

The following machinery was purchased during the year: two 100-h.p. return tubular boilers, one Allis-Chalmers compound two-stage air compressor of 1,200 cu.-ft. capacity and a 10 by 12-inch Rand hoist.

The shaft was continued from a depth of 100 feet to 400 feet and levels opened at 300 and 400 feet. The exploration and development work on the 400-ft. level amounted to 255 feet and on the 300-ft. level to 140 feet. On the 200-ft. and 100-ft. levels some drifting was done, increasing the lateral workings on these levels to about 788 feet on the 100-ft. level and 440 feet on the 200-ft. level.

*Burton-Munro.*—Work on this property in the north half of lot 11, in the first concession of Munro township was resumed in the spring of 1919 and continued during the summer.

*Kennedy-Boston.*—The Kennedy-Boston Gold Mines, Limited, operated its claim, in the south half of lot 11, in the sixth concession of Catharine township. Duncan Campbell was superintendent and 10 men were employed.

A shaft was sunk to a depth of 50 feet.

*Miller-Independence.*—The mine of the Miller-Independence Mines, Limited, is situated in the south half of lot 1, in the sixth concession of Pacaud township, Geo. J. Miller is president and general manager.

The plant consists of two 60-h.p. and one 80-h.p. boilers, a 6-drill air compressor, and an 8 by 10-in. hoist.

Development work during the year consisted in sinking the A shaft from a depth of 175 feet to 427 feet; 50 feet of drifting from D shaft was also done. The A shaft is being continued to a depth of 500 feet, where a cross-cut is to be driven some 300 feet to cut a vein encountered in D shaft. A force of 35 men was employed.

*Murray-Mogridge.*—Operations at this property were conducted on a limited scale during 1919, the underground work amounting to 34 feet of cross-cutting, 26 feet of drifting and 10 feet of sinking. The cross-cutting and sinking was done on the 200-ft. level.

Considerable work of a prospecting nature was done during the year.

The company owns 10 claims in lots four and five in the fifth and sixth concessions in the township of Maisonville, four miles from Bourkes station on the Temiskaming and Northern Ontario railway.

G. G. Thomas is manager and John McCallum is mine superintendent.

*Peerless.*—The Peerless Gold Mines, Limited, own the following claims in McElroy township: L 5384, 5326, 5266, 5265, 7422, 5264, 5267 and 5268. The authorized capital consists of 1,500,000 shares of $1.00 par value. At the end of 1919 the shaft was 132 feet deep and 152 feet of drifting and 57 feet of cross-cutting had been done. No ore had been shipped up to that time, but 260 bags were stored at the mine. A winter road has been cut to the Boston-McCrea mine, 2½ miles distant.

The buildings and machinery of the Dane Copper Company at Dane were purchased and moved during the winter of 1919. This necessitated the cutting of a winter road, 3 miles in length, from the Larder lake road to the mine.

The machinery includes: a 6-drill Sullivan compressor; 3 boilers, two 60-h.p. and one 50-h.p., and two 8 x 10-inch hoists.

The head office of the Company is at Room 102, Southam Building, Montreal; A. D. McPhee, Boston Creek, is superintendent.

## Kirkland Lake

*Canadian-Kirkland.*—The Canadian-Kirkland Gold Mining Company, Limited, which owns claims 6768, 6687, 6729, and 6730, in the Township of Teck, gave the Porcupine Crown Mines, Limited, an option to purchase a controlling interest in May, 1919. The latter company started work at once with S. Beanland in charge of a force of 24 men.

At the end of the year No. 2 shaft had been sunk from a depth of 42 feet to 150 feet and a cross-cut had been driven south 24 feet on the 100-ft. level.

The machinery includes a 100-h.p. boiler, a straight-line air compressor and a 6 by 8-inch hoist.

*Kirkland-Combined.*—The Kirkland-Combined Mines, Limited, started a shaft on its property north of the Sylvanite mine on December 12, using compressed air from the Sylvanite plant. This shaft had reached a depth of 200 feet by the end of February, 1920, and it was then the intention to cross-cut south to the vein. A. W. Grierson is superintendent and 19 men are employed.

*Kirkland Lake.*—The Kirkland Lake Gold Mining Company, Limited, which is controlled by the Beaver Consolidated Mines, Limited, worked during part of the year. The new 150-ton mill was gradually being brought up to capacity production when the strike was called on June 12. Work was resumed on October 24.

The mine is developed from two shafts: the main shaft 500 feet deep and No. 2 shaft 700 feet deep. At the end of February, 1920, the stope on the 400-ft. level was 300 feet long and contained 4,042 tons of broken ore, and the stope on the 500-ft. level was 260 feet long and contained 1,915 tons of broken ore. Stoping on the 600-ft. level and drifting on the 700-ft. have been begun.

Wm. Sixt is superintendent; an average of 75 men is employed.

*Lake Shore.*—The Lake Shore Mines, Limited, capitalization $2,000,000 in shares of $1.00 par value, operates the Lake Shore mine at Kirkland Lake. The officers of the company are: Harry Oakes, president and managing director; Arthur G. Slaght, vice-president: R. C. Coffey, mine manager.

An average of 65 men was employed.

The 60-ton mill operated seven months of the year and treated 11,907 tons of ore from which was produced $293,818.18 in gold, an average recovery of $24.67 per ton.

The mine is developed to the 400-ft. level. The following is a summary of the development for the year:

Synopsis of Development.

| — | Drifting feet | Cross-cutting feet | Raising feet | Total feet |
|---|---|---|---|---|
| On No. 1 Vein— | | | | |
| 400-ft. level | 488 | 60 | 90 | 638 |
| On No. 2 Vein— | | | | |
| 200-ft. level | 660 | 24 | .. | 684 |
| 400-ft. level | 305 | 162 | 75 | 542 |
| | 1,453 feet | 246 feet | 165 feet | 1,864 feet |

Two dividends, amounting to $100,000, were paid during the year.

*Ontario Kirkland.*—The Ontario Kirkland Gold Mines, Limited, is developing 88 acres half a mile south of the Kirkland Lake townsite in the township of Teck. The claims are known as H.R. 788 and H.R. 789.

The officers of the company are: Frank Huth, president, Nazareth, Pa.; Walter E. Hurd, vice-president, Philadelphia, Pa.; Albert J. Bolton, treasurer, Philadelphia, Pa.; W. A. Gordon, secretary, Haileybury, Ont.; Ralph Hurd, manager, Kirkland Lake, Ont.

During 1919 the shaft was sunk from a depth of 100 feet to 320 feet, and about 1,000 feet of cross-cutting and drifting was done on the 300-ft. level.

An average of 20 men is employed.

*Teck-Hughes.*—The Teck-Hughes Gold Mines, Limited, has an authorized capital of 2,500,000 shares of a par value of $1.00. The officials of the company are: president, C. L. Dennison: secretary, G. C. Miller; treasurer, H. C. Himrod; manager, D. L. H. Forbes; mill and mechanical superintendent, R. A. Sullivan; underground superintendent, H. Jardine.

Development work during the year amounted to 974 feet of drifting and cross-cutting. In the mill 18,387 tons of ore were treated and $169,590.41 worth of gold recovered.

An average of 55 men is employed.

*Tough-Oakes.*—The Tough-Oakes Gold Mines, Limited, resumed operations on March 15, 1919. The property was again closed down by the strike on June 12, and remains closed pending negotiations for an amalgamation with the Burnside and other properties.

*Wright-Hargreaves.*—The Wright-Hargreaves Mines, Limited, operates four claims at the eastern end of Kirkland Lake.

No mining work was done during the year 1919, but a 60-ft. headframe and a change house were erected at No. 3 shaft and preparations were made for the erection of a 150-ton mill. Half of the excavation for the latter has been completed and 70 per cent. of the material is on the ground. Fifty men were employed for a month previous to the strike.

The officials of the company are: Oliver Cabana, Jr., president; Edwin Lang Miller, vice-president; Gerhard F. Miller, secretary-treasurer; Albert Wende, manager; James E. Grant, superintendent.

### Larder Lake

*Associated Goldfields.*—The Associated Goldfields Mining Company, Limited, operated continuously during 1919. The company has an authorized capital of 5,000,000 shares of a par value of $1.00. On December 31, 1919, there were remaining in the treasury 1,073,588 shares and the company's financial statement showed liquid assets of approximately $1,100,000. The company's mining property at Larder lake includes the following: the Harris-Maxwell, now known as Block "B," with an area of 66 acres; the Kerr-Addison, or Block "C," being 120 acres; and the Reddick, or Block "D," adjoining the Kerr-Addison on the northeast and comprising five claims of 40 acres each.

The mining development accomplished during 1919 amounted to 1,766 feet of underground work on Block "B" and the straightening of the shaft on this property, which is 500 feet in depth. On Block "C," 6,442 feet of diamond-drilling was done, and on Block "D" 1, 767 feet of development work was done.

Building done during the year included: on Block "B" a two-storey, 70-ft. by 30-ft sleeping camp, a 50-ft. by 30-ft. one-storey dining hall, a barn and stables; on Block "D" a 50-ft. by 30-ft. dining room and kitchen and an assay office.

The officers of the company are: Geo. A. Mackay, president, Toronto; A. A. McFall, vice-president, Bolton; R. W. Mackay, secretary-treasurer; directors: A. Singer, J. Dinwoody and D. H. McCartney. The officials of the company are assisted by an advisory board of 38 members elected from the stockholders.

*Argonaut.*—Argonaut Gold, Limited, operates under a 30-year lease the property of La Mine d'Or Huronia in Gauthier township and has acquired two additional claims in Gauthier township and three in McVittie township.

The officers of the company, which operates under a federal charter, are: J. H. Rainville, president; H. B. Rainville, vice-president; H. A. Choquette, secretary. The head office is at 601 Royal Trust Building, Montreal. The authorized capital is $3,000,000 in shares of $1.00 par value, 800,000 of which are retained in the treasury.

The development for the year consisted in sinking the No. 3 shaft from 85 to 205 feet, 170 feet of cross-cutting and 190 feet of drifting, mainly on the 200-ft. level. The 15-stamp mill treated 735 tons during November and December.

J. W. Morrison is general superintendent. An average of 30 men was employed.

*Wisconsin-Skead.*—The Wisconsin-Skead Mines, Limited, operate on lot 10, concession V, and lot 10, concession VI, Skead township, 26 miles distant from Englehart station on the T. & N. O. railway.

The plant consists of two boilers of 50-h.p. and 60-h.p., a 4-drill compressor and a 7 by 9-in. hoist.

The shaft has a depth of 130 feet and about 100 feet of drifting have been done on the 112-foot level. The work was carried on during the summer with a force of 20 men and was stopped in the fall.

The head office of the company is at Racine, Wis., and the mine manager is Theophile La Fond.

### Porcupine

*Big Dyke.*—The Big Dyke Gold Mines, Limited, did a small amount of work on its property in Deloro township during the summer months. The officers of the company are: R. Bigley, president; J. G. Myer, vice-president; E. J. Currie, secretary-treasurer. The head office of the company is at 56-58 King St. West, Toronto.

*Clifton-Porcupine.*—The Clifton-Porcupine Mines, Limited, has a capitalization of $2,000,000 in shares of a par value of $1.00 each.

This company operates a 40-acre property in Deloro township. The directors of the company are: F. C. Preston, president, Midland; Homer L. Gibson, vice-president, Toronto; James Cowan, Toronto; W. E. Preston, Midland; and W. C. Offer, South Porcupine. Ernest H. Bridges, 703 Bank of Hamilton Building, Toronto, is secretary-treasurer.

In 1919 this company installed a complete mining plant, consisting of a 40-h.p. horizontal return tubular boiler and a 2-drill air compressor, and later added a vertical two-stage Alley and McLellan air compressor of 600 cu. ft. capacity, belt-driven by a 100-h.p. motor, and two single-drum, steam-driven hoists, one 6 by 8 inches and the other 8 by 10 inches. From the old shaft, which had a depth of 70 feet, 400 feet of drifting was done, and a raise put up 21 feet into the bottom of the incline shaft on No. 7. vein. This shaft was then continued on an 80° incline to a depth of 228 feet, and a station for the second level cut at 196 feet. An average of 20 men was employed during the eight months of operation.

*Davidson.*—The Davidson Gold Mining Company, Limited, operated its property on lot 2, in the fifth concession of Tisdale township with a force of 55 men. The company has acquired several adjoining properties, making a total of about 600 acres. The officers of the company are: C. G. Crean, president; H. H. Sutherland, vice-president and managing director; L. C. Platt, secretary-treasurer. The head office of the company is at 10 King St. East, Toronto.

The small 10-stamp mill brought from Nova Scotia and installed on the property continued in operation during the year, treating about 30 tons daily.

The development for the six months ending March 31, 1920, amounted to 1,136 feet of drifting and 53 feet of raising. A triplex electric pump has been placed on the 600-foot level.

N. J. Evered, South Porcupine, is manager.

*Dome.*—The Dome Mines Company, Limited, has an authorized capital of $5,000,000 of which $4,000,000 has been issued.

The officers of the company are: president and treasurer, J. S. Bache; first vice-president, W. S. Edwards; second vice-president, C. D. Kaeding; third vice-president, H. P. De Pencier; secretary, Alex. Fasken; assistant treasurer and assistant secretary, Alfred H. Curtis. The directors are: J. S. Bache, W. S. Edwards, Alex. Fasken, G. C. Miller, T. R. Finucane, Edward Poillon, A. H. Curtis, C. Hoyt, C. D. Kaeding. The last-named is general manager. The head office is at 36 Toronto St., Toronto.

The mill was placed in operation on May 8, 1919, and during the fiscal year a total of 279,665 tons was mined and hoisted. Of this, 270,080 tons was ore which was sent to the mill and treated, and 9,885 tons waste which was dumped on the surface. Of the 270,080 tons of ore milled, 255,764 tons, averaging $7.12 per ton, came from the stopes, 7,467 tons, averaging $4.00, came from development, and 6,849 tons, averaging $4.45, came from the Dome Extension. The 270,080 tons milled yielded bullion worth $1,773,374.44, the average yield per ton being $6.566.

Dividend No. 9, amounting to $100,000, was paid in January, 1920.

The following information is taken from the statement of the general manager in the Ninth Annual Report of the company for the year ending March 31, 1920.

The broken ore tonnage has been reduced 70,000 tons and now stands at 251,352 tons. Stoping and development have been carried on at the 3rd, 5th, 6th, 7th and 8th levels with some development and drilling on the 10th. The results of this work have been most satisfactory.

SUMMARY OF DEVELOPMENT WORK FOR YEAR 1919-1920

| Level | Drifts | Cross Cuts | Raises | Box Holes | Shafts | Stations | Pockets | Total | Diamond Drilling | Total | Excavation Cu. Ft. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3rd.... | 81 | ...... | ...... | 238 | ...... | ...... | ...... | 319 | ........ | 319 | ........ |
| 5th.... | 220 | 18 | 293 | 81 | ...... | ...... | ...... | 612 | ........ | 612 | ........ |
| 6th.... | 198 | 204 | 324 | 228 | ...... | ...... | ...... | 954 | ........ | 954 | ........ |
| 7th.... | 151.5 | ...... | 373 | 131 | ...... | ...... | ...... | 655.5 | ........ | 655.5 | 10,800 |
| 8th.... | 234 | 326 | 68 | 85 | ...... | ...... | ...... | 713 | 279 | 992 | 12,174 |
| 10th.... | 12 | 229 | 11 | ...... | ...... | ...... | ...... | 252 | 586 | 838 | ........ |
| | 896.5 | 777 | 1,069 | 763 | ...... | ...... | ...... | 3,505.5 | 865 | 4,370.5 | 22,974 |
| Dome Extension | | | | | | | | | | | |
| 6th.... | 221 | 408 | 26 | 182 | ...... | ...... | ...... | 837 | 1,285.5 | 2,122.5 | 2,400 |
| 10th.... | 321 | 14 | ...... | ...... | ...... | ...... | ...... | 335 | ........ | 335.0 | ........ |
| | 542 | 422 | 26 | 182 | ...... | ...... | ...... | 1,172 | 1,285.5 | 2,457.5 | 2,400 |
| Totals. | 1,438.5 | 1,199 | 1,095 | 945 | ...... | ...... | ...... | 4,677.5 | 2,150.5 | 6,828.0 | 25,374 |

Waste Hoisted—9,585 tons. Silling Dome Ext. Stope 6th Level—7,012 sq. ft.

*Dome Extension Development.*—A cross-cut on the 6th level, driven along the course of diamond drill hole No. 122, intersected the orebody indicated by this hole and was extended across the orebody a short distance into the hanging wall. Drifts were driven east and west from this cross-cut in the footwall and three more cross-cuts driven across the ore zone at intervals of about 75 feet, two to the east, and one to the west of the main cross-cut. The sampling of these cross-cuts indicates a lenticular orebody of about 12,000 sq. ft. area with an indicated grade of about $4.62 per ton. To explore this ore further, boxholes were put up and a stope sill of about 7,000 sq. ft. area cut out. Sampling on the back of this stope indicates a grade of $4.95 per ton. The work done here has shown the orebody to be very irregular in outline in the hanging wall side. To explore this body further, eleven diamond-drill holes have been drilled into it below the 6th level; these show that the mineralized zone extends downward at least 80 ft. below the 6th level; the values are very irregular, however, and it is still uncertain how much pay ore can be mined from this orebody.

A total of 6,849 tons of ore of an estimated value of $4.45 per ton have been mined and milled from this orebody.

On the 10th level since January, 1920, 587 feet of drifting, cross-cutting and raising, together with 1,172 feet of diamond-drilling, has been done. All this work has been undertaken with the object of locating and proving ore indicated by diamond-drill hole No. 9 and the results have already been given in detail under the development section of this report. The information obtained renders it likely that this orebody will prove to be of major importance; the grade and width shown in the intersections indicate that excellent-grade ore over good stoping widths may be expected, while there is every probability that this ore that lies at the Dome Extension boundary line will extend eastward at depth, into Dome Extension.

The main 10th level drift also has been driven east into the Dome Extension for a distance of 321 feet and a diamond-drill station cut at the end from which a large area can be explored by diamond-drilling. This diamond-drill station is vertically beneath the orebody opened at the 6th level, but as it is believed that this orebody has a dip to the east, it has not yet been cut on the 10th level. This extension of the 10th level drift will also be utilized to drill from, if further drilling to the west shows the orebody extending eastward into the Dome Extension.

*Dome Lake.*—The Dome Lake Mining and Milling Company, Limited, with a capitalization of $3,000,000 in shares of $1 par value, operated its property at Porcupine throughout the year. The officers of the company are: F. L. Bapst, president; A. A. McKelvie, vice-president; F. L. Hutchinson, secretary-treasurer; D. M. McPhail, manager. The head office of the company is at New Liskeard, Ontario.

The development for the year was confined to No. 3 vein, east and west of the main shaft on the 300, 500, and 600-ft. levels. The development work done consisted of 1,086 feet of drifting, 224 feet of cross-cutting, 20 feet of winze-sinking, and 103 feet of shaft-sinking.

The total ore broken amounted to 6,517 tons, of which 1,126 tons were from development.

The mill was in operation during the months of April, May and June and treated 4,433 tons of ore. The amount of gold recovered was $23,832.70.

*Gold Island.*—Messrs. Campbell and Fairburn operated this property under lease during part of 1919. A shaft was sunk 50 feet and a cross-cut driven to intercept the vein at this level.

H. G. Carmichael was in charge of operations.

*Hollinger.*—The Hollinger Consolidated Gold Mines, Limited, has an authorized capital of $25,000,000, in shares of $5 par value. The number of shares issued is 4,920,000. The officers of the company are: Noah A. Timmins, president; David A. Dunlap, vice-president and treasurer; John B. Holden, secretary; A. F. Brigham, general manager. The directors are: Noah A. Timmins, L. H. Timmins, Jules R. Timmins, and Dr. Wilfred L. McDougald, of Montreal, and David A. Dunlap and John B. Holden, of Toronto. The head office of the company is at 85 Bay St., Toronto.

The directors' report gives the yield for 1919 from 711,882 tons milled as $6,722,266.81. The total income from all sources was $7,063,099.21. Working expenses absorbed $3,222,617.11, taxes $286,272.65, depreciation and donations $1,232,819.40, making $4,741,809.14 in all, which leaves a net profit of $2,321,-290.07; out of the latter $1,722,000.00 was paid in dividends, and $599,290.07 was added to surplus account, which now stands at $2,670,577.08.

A number of new dwelling-houses for miners were erected during the year at a cost of about $55,000, and an extension of this house-building programme is projected. An up-to-date hospital, which will provide adequate accommodation in case of sickness or accident for employees and their families, is nearing completion. A sick benefit insurance, the cost of which is borne by the company, has been instituted. Stores have been established in Timmins where the employees may obtain the necessaries of life at net cost. A guarantee has been given of a reduction of 15 per cent. below the prices prevailing on August 1, 1919. This reduction was increased to 20 per cent. an March 1, 1920.

The general manager's report gives the following details regarding the year's operations:

| —— | Sundries | Labour | Stores | Total | Per ton of Ore |
|---|---|---|---|---|---|
| | $ c. | $ c. | $ c. | $ c. | $ |
| Total General Charges... | 67,039 54 | 172,548 42 | 63,975 03 | 303,562 99 | 0.4264 |
| Total Mining Charges .... | .............. | 1,248,852 97 | 804,357 04 | 2,053,210 01 | 2.8842 |
| Total Milling Charges.... | .............. | 288,703 28 | 577,140 83 | 865,844 11 | 1.2163 |
| Total........... | 67,039 54 | 1,710,104 67 | 1,445,472 90 | 3,222.617 11 | 4.5269 |

| — | Tons | Value |
|---|---|---|
| ORE RESERVES (DEVELOPED UNDERGROUND). | | |
| Above 425 feet level | 1,921,640 | $17,350,100 |
| Above 800 feet level | 1,950,020 | 18,033,410 |
| Below 800 feet level | 306,920 | 2,433,480 |
| Total | 4,178,580 | $37,816,990 |
| ORE RESERVES (NOT DEVELOPED UNDERGROUND). | | |
| Surface Outcrops calculated to a depth of 100 feet. | 210,360 | 2,077,780 |
| GRAND TOTAL | 4,388,940 | $39,894,770 |

EMPLOYEES.

Average of men employed during the year has been 1,207, distributed as follows:

| Miners | Mechanics | General | Totals |
|---|---|---|---|
| Exploration ........12 | Operation..........57 | Mill and Refinery 143 | Miners..........786 |
| Development ......208 | Maintenance .......94 | Engineering Staff ..27 | Mechanics..........168 |
| Production ........566 | Construction .......17 | Clerical Staff.......24 | General..........253 |
| | | Miscellaneous ......59 | |
| 786 | 168 | 253 | 1.207 |

MILLING RESULTS

| | |
|---|---|
| Tons ore milled | 711,882 |
| Average value per ton | $ 9.73 |
| Gross value | 6,924,214.05 |
| Old concentrates, 4,460 tons | 31,469.76 |
| Total gross value | $6,955,683.81 |
| Deduct loss in tailings | 233,417.00 |
| Net value recovered | $6,722,266.81 |
| Average tons per day | 1,950 tons |
| Per cent. of possible time run | 70.5% |
| Tons per 24 hours running time | 2,766 tons |
| Stamp duty per 24 hours running time | 14.95 tons |
| Solution precipitated per ton of ore | 2.45 tons |
| Value per ton in tailings | $0.33 |
| Cyanide consumed per ton of ore | 0.461 lbs. |
| Zinc consumed per ton of ore | 0.396 lbs. |
| Zinc per ton of solution | 0.160 lbs. |
| Lime consumed per ton of ore | 2.491 lbs. |
| Lead acetate per ton of ore | 0.034 lbs. |
| Average value pregnant solution | $3.85 |

### Development

Progress during the year was as follows:

| Level | Shafts | Drifts | Cross Cuts | Raises | Diamond Drilling | Timbering | | Excavation |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Shafts | Stopes | |
| | feet | feet | feet | feet | feet | feet | feet | tons |
| 100 feet. | .......... | 122 | .......... | .......... | 202 | ........ | 60 | .......... |
| 200 feet. | .......... | 1,263 | 2,359 | 253 | 6,043 | ........ | 761 | 40 |
| 300 feet. | .......... | 1,993 | 2,168 | 279 | 6,589 | ........ | 483 | 15 |
| 425 feet. | .......... | 2,335 | 1,111 | 650 | 8,484 | ........ | 1,240 | 12 |
| 550 feet. | .......... | 4,371 | 2,934 | 43 | 4,855 | ........ | 2,633 | 1,165 |
| 675 feet. | .......... | .......... | 22 | 94 | 8,114 | ........ | ........ | 483 |
| 800 feet. | .......... | 1,168 | 754 | 91 | 3,581 | ........ | ........ | 2,089 |
| 950 feet. | 129 | 22 | 48 | 93 | .......... | 146 | ........ | 4,253 |
| 1,100 feet. | 150 | 10 | 35 | .......... | .......... | 150 | ........ | 2,688 |
| 1,250 feet. | 146 | .......... | .......... | .......... | .......... | 131 | ........ | .......... |
| Total ... | 425 | 11,284 | 9,431 | 1,503 | 37,868 | 427 | 5,177 | 10,745 |

Total, Sinking, Drifting, Cross-Cutting and Raising—22,643 feet.

Mechanical haulage, using two 4-ton General Electric trolley locomotives, was introduced in 1915 on the 425-ft. level. The original plan was to make the 800-ft. level the next haulage level, but this has been changed, and mechanical haulage is now being used on all the levels below the 300 ft. The track consists of 35-pound rails on an 18-inch gauge. Six General Electric 4-ton trolley locomotives and two 2½-ton Whitcombe storage-battery locomotives are in use.

Heretofore levels have been made the full width of the ore, and the broken ore supported on caps and posts. Under the wider stopes this necessitated putting in intermediate setts to take the weight of the stoped ore, and finally only the haulage ways were left open. Now that more detailed information of the ore bodies is being obtained from drill holes, the drifts are lined up with the lenses and the backs cut only 7 feet in width, so as to permit the use of stulls for support. Diamond drill holes are bored every 25 feet along the drift to the limit of the ore. Wherever necessary, additional drifts are run from the main drift in the form of loops, so as to permit the chutes to tap all the ore from the stope above. Filling above the 425-ft. level will be undertaken as soon as the ore is removed from the upper levels.

The Armstrong shovel, or "mechanical mucker," has been tried out in the Hollinger mine in the past two months. The best shift's performance to date has been 100 tons with four men in attendance. Large pieces of rock cause most of the trouble. Sometimes the machine lifts the light track and at other times refuses to lift large pieces of rock. At first sight this performance does not seem very encouraging, for four men on contract will shovel and tram 80 cars in a shift, but it is the opinion of some that modifications can be made in the machine so as to adapt it to the local requirements.

*McIntye.*—On January 1, 1917, the assets of the McIntyre-Jupiter and McIntyre Extension companies were amalgamated with those of the McIntyre Porcupine Mines, Limited, and the combined properties are now operated by the McIntyre Porcupine Mines, Limited. The capitalization was increased from

3,000,000 to 4,000,000 shares of $1 par value each. Of this amount 3,600,000 shares have been issued and the balance remains in the treasury as unsold shares. The officers of the company are: president, J. P. Bickell; vice-president, Henry M. Pellatt; secretary-treasurer, M. P. Van der Voort, all of Toronto; directors, W. J. Sheppard, Waubaushene; J. B. Tudhope, Orillia; H. D. Symmes, Niagara Falls; general manager, R. J. Ennis; mine superintendent, J. E. McAllister; mill superintendent, A. Dorfman.

Work underground has been very satisfactory, and resulted in the opening up of the ore bodies at the lower levels. The main shaft was sunk 298 feet to the 1,550-ft. level and stations were cut at the 1,250, 1,375 and 1,500. These stations have been equipped with ore and waste pockets and automatic measuring boxes for skip loading.

The following is a statement of the work done on all levels of the mine during the period:

| | | |
|---|---|---|
| Drifts | 3,194 | feet |
| Cross-cuts | 372 | " |
| Raises | 765 | " |
| Shaft-sinking | 298 | " |
| Stations Cut | 177 | " |
| Ore and Waste Pockets | 178 | " |
| | 4,984 | " |

A diamond-drill was kept busy underground during the twelve months, running short holes from the different levels; 4,538 feet of drilling was done.

The cyanide plant continued to operate satisfactorily and give a high percentage of extraction. Ore milled amounted to 188,835 tons of an average value of $11.53 per ton, or a gross value of $2,177,688.15, yielding $2,081,524.90 in gold and silver.

Operating costs showed an increase, and are now in the neighbourhood of $5.40 average per ton for the twelve months.

New construction has been limited to the addition of a 5-ft. by 16-ft. tube mill in the cyanide plant, to reduce further the heavy sulphide ore encountered in the lower levels, and the installation of the Crowe vacuum precipitating process, which has been the means of saving 60 per cent. of the zinc dust. A Nordberg electric hoist was installed at the main shaft, capable of handling 2½-ton skips from a depth of 2,750 feet, fully equipped with Welch overwind and safety stops and other up-to-date safety appliances. A concrete transformer house was erected and equipped with three 600-k.v.a. transformers, switches, instruments, etc., together with a fire-proof boiler house at the main power plant.

The average number of men employed during the first half of the fiscal period was 360, including all classes, and during the second half 294. The worker has been attracted to other points by the higher wage scale, and, in order to overcome this, the wages were increased 50c. per day on March 15, and again 50c. on May 27. While these increases have not resulted in obtaining more men, they have had the effect of keeping the present force intact, thus largely stabilizing conditions.

*Porcupine-Crown.*—The Porcupine-Crown Mines, Limited, capital $2,000,000, in shares of $1 par value, is controlled by the Crown Reserve Mines of Cobalt. The officers are the same as for the controlling company, and H. W. Darling is superintendent.

In February, 1919, operations were resumed in a small way. The work consisted of general repairs on surface and underground, the salving of ore lost in the cave of April, 1917, and a small amount of actual mining. Prospecting and development work amounted to 325 feet; 2,000 tons of ore were broken in stopes; 1,500 tons of ore were drawn from the caved area, and 225 tons of ore were hoisted from the mine to the mill bins. The average value of the ore broken was $10 per ton and of the ore drawn from the caved area $8 per ton.

On May 1 an option was taken by the Porcupine Crown Mines, Limited, on the major portion of the stock of the Canadian-Kirkland Gold Mining Company, Limited, which owns four claims in the Kirkland lake area.

*Porcupine-Keora.*—Porcupine-Keora Gold Mines, Limited, owns four claims in lot 6 and one in lot 5 of the fifth concession of Whitney township.

There are two shafts on the property, about 60 and 120 feet deep. The deeper one only is timbered.

Some surface work and about 1,000 feet of diamond-drilling were done on the property in 1919 under the direction of A. J. Brant.

Early in 1920 the present manager, J. C. Waite, installed a mining plant consisting of an 80-h.p. boiler, a 4-drill compressor, and a small Lidgerwood hoist. The sinking of a new shaft was commenced in the spring of 1920.

Seventeen men were employed.

*Sovereign.*—Work on the claims of the Sovereign Porcupine Mine, Limited, Porcupine, during 1919 consisted of trenching and 4,000 feet of diamond-drilling. A well mineralized vein was found: the company intends to continue prospecting during the summer of 1920.

### Matachewan

*Matachewan Gold Mines.*—The Matachewan Gold Mines, Limited, worked on the Otisse and Robb claims in Powell township during the summer, with a force of 40 men. T. J. Flynn is manager, and E. Craig, Elk Lake, superintendent.

The plant consists of two boilers, 40- and 45-h.p., a 3-drill compressor, and a 5 by 8-inch hoist. No. 1 shaft is 168 feet and No. 2 shaft 37 feet in depth. The underground work consists of 625 feet of drifting and 303 feet of cross-cutting. Diamond-drilling operations were continued during the winter.

### West Shiningtree

*Atlas.*—The Atlas Gold Mines, Limited, did assessment work on a number of claims in 1919. Camps were built and an adit, 35 feet long, driven on the southwest shore of Wasapika lake on No. 1 vein. When the mine was visited on January 20, a shaft was being sunk by hand on the Evelyn vein, about 300 feet west of the camps; it was then 24 feet deep.

The directors of the company are: president, A. M. Bilsky, Montreal; secretary, Israel Singer, Toronto; J. Samenhof, Montreal; Capt. R. H. Fletcher, Montreal. The head office of the company is in Toronto; a Montreal office is also maintained at 157 St. James Street.

*Buckingham.*—The Buckingham Mines, Limited, was incorporated in 1918 with a capitalization of $1,000,000 to work the Cottingham claims in the eastern part of Asquith township and southeast of Stewart lake.

Comfortable camps have been built and a plant set up consisting of a portable boiler, a 6-inch by 8-inch hoisting engine and a small air compressor. A shaft was sunk to a depth of 87 feet on a vein striking east and west and dipping to the south at 60 degrees. Work was stopped in July, 1919.

The officers of this company are: president, J. W. Cottingham, Columbus, O.; vice-president, C. S. Buckley; secretary, Fred. Essex; treasurer, S. Cottingham.

*Churchill.*—Churchill Mining and Milling Company, Limited, was formed in 1918 with an authorized capital of $2,000,000 divided into shares of $1.00 par value. The company's property consists of four claims, T.R.S. 3741, 3773, 3774 and 4044 —235 acres in all—in Churchill township at the south end of Michikawakenda lake. The Wasapika group of claims adjoins on the east.

Considerable surface prospecting has been done and a pit sunk on a vein on T.R.S. 3774 to a depth of 38 feet.

The directors are: president, W. R. Knox, Orillia, Ont.; secretary-treasurer, J. G. Merrick, 117 King Street West, Toronto; K. G. Robertson, Toronto; A. E. Hill, Warren, Pa.; A. N. Broadhead, Jamestown, N.Y.

*Gosselin.*—The Gosselin claims on the boundary line between Asquith and Churchill townships are owned by Gosselin Gold Mines, Limited, incorporated in 1913 with a capitalization of $2,000,000. No work was done on these claims in 1919.

*Herrick.*—On claim T.R.S. 4105 the Herrick Gold Mines, Limited, sank a two-compartment vertical shaft to a depth of 50 feet. In January, 1920, 3,000 feet of diamond-drilling was completed; this consisted of four holes and the results are said to be highly satisfactory. H. H. Sutherland, of Toronto is president and general manager, and George R. Rogers, Coyne, Ont., consulting engineer.

*Holding.*—The Holding claims, T.R.S. 3118 and 3508, in Asquith township, were purchased in the autumn of 1918 by R. I. Henderson, 506 Lumsden Building, Toronto. During the year a six-drill compressor and a return tubular boiler were purchased, and a shaft, 48 feet deep, was sunk. A camp was built for the accommodation of the workmen. No work was being done when the district was last visited in January, 1920.

*Kubiak.*—N. Kubiak is the owner of a group of claims on the eastern boundary of Asquith township comprising the following: T.R.S. 4084, 4091, 4234, 4240, 4248, 4249, 4295, 4296 and 4327. Considerable trenching has been done on some of these claims and in several places very finely divided gold may be seen.

*Wasapika.*—The capitalization of Wasapika Gold Mines, Limited, which was originally $1,000,000, has been increased to $6,000,000, and 120 acres have been added to the holdings of the company.

Since the beginning of 1919, the camps have been completed and a steam plant put in operation. The latter consists of two locomotive-type boilers, 35 and 45-h.p., a 650-cu. ft. Rand compressor and an 8-inch by 10-inch Jenckes hoisting engine.

When the mine was last inspected on January 20, 1920, the two-compartment vertical shaft was being sunk and had reached a depth of 150 feet. On the 100-foot level, 56 feet of cross-cutting was done to the east and 15 feet to the west. The east cross-cut passed through 27 feet of ore.

The head office of the company is at 905 Bank of Hamilton Building, Toronto; the mine address is Shiningtree, via Coyne, Ont. The officers of the company are: president and general manager, George R. Rogers, Coyne, Ont.; vice-president, Lieut.-Col. L. W. Marsh, Belleville, Ont.; secretary-treasurer, J. A. M. Alley, Toronto; directors: Lewis Lahay, Toronto, and W. R. Scott, Toronto.

*West Tree.*—West Tree Mines, Limited, owns 182.6 acres in four claims, T.R.S. 2531, 2532, 2542 and 2543, in the township of MacMurchy. These were the Caswell claims and are on the waterway connecting Wasapika and Michikawakenda lakes. The Wasapika and Atlas holdings are contiguous on the west.

Some time ago, on T.R.S. 2542 on the east side of the waterway, a shaft was sunk and a pocket of rich ore was taken out. In 1919 camps and a boiler house were built and a vertical shaft sunk to a depth of 67 feet on T.R.S. 2532 west of the stream. Gold was seen in some of the quartz from this shaft. The plant consists of a 20-h.p. Jenckes boiler and a 5-inch by 5-inch Jenckes hoisting engine. Work was stopped in December. George R. Rogers was consulting engineer for the company until September; Martin Hassett was mine foreman. The nearest post-office is Coyne, Ont.

The officers are: president, Senator George W. Fowler; vice-president, Clayton S. Corson; secretary-treasurer, Gideon Grant; directors, W. D. McKay, W. J. J. Butler, George R. Rogers, and A. E. Way.

*White Rock.*—The White Rock Gold Mining Company, Limited, was incorporated in the early part of 1920 to work the McVittie-Saville claims in MacMurchy township. Camps have been built and a steam plant ordered. William McVittie, of Sudbury, is president of the company, which has an authorized capital of $1,000,000. Thomas Saville is in charge of the work on the claims.

## Silver Mines

### Cobalt

*Adanac.*—The Adanac Silver Mines, Limited, operated during the year with a force of 10 men. Morgan R. Cartwright, Haileybury, is manager.

The mine is developed from two shafts respectively 400 and 200 feet deep. The work has not disclosed any large ore bodies, but several small shoots of high-grade ore were encountered and some shipments of milling ore made.

*Aladdin.*—The Aladdin Cobalt Company, Limited, owns and operates the Chambers-Ferland mines. The directors of the company are as follows: D. H. Herbert, chairman; F. F. Fuller, C. R. E. Jorgensen, and S. B. Peech.

Shipments comprised 14 tons of high-grade and 695 tons of mill ore. The development work done during 1919 consisted of 1,185 feet of cross-cutting, 87 feet of drifting, and 211 feet of raising on the 350- and 425-ft. levels in No. 4 mine.

An average of 24 men was employed under the direction of superintendent John Matheson.

Late in the year the old No. 1 and No. 2 mines of the Chambers-Ferland were sold to the Northern Customs Concentrators, Limited, for $175,000.

*Beaver Consolidated.*—The Beaver Consolidated Mines, Limited, with a capital of $2,000,000 in $1 shares, operated the Beaver mine at Cobalt and the Kirkland lake gold mine at Kirkland lake. The head office of the company is in the Lumsden Building, Toronto. The officers of the company are: F. L. Culver, president and general manager; F. C. Finkenstaedt, vice-president; H. E. Tremain, secretary-treasurer; H. L. Donaldson, mine superintendent.

Development during the year at the Beaver mine consisted of 1,650 feet of drifting and cross-cutting and 220 feet of raising. Stoping amounted to 5,935.9 cubic yards, as compared with 3,285 yards in the previous year. At the end of the year, 25,696 tons of broken ore remained in the stopes, an increase of 5,933 tons during the year.

The mill operated for 268 days and treated 26,974 tons of ore. Total costs of mining and milling were $7.41 per ton.

*Buffalo.*—Until November 8, 1919, the Buffalo Mines, Limited, operated under the old directorate, which was as follows: Charles L. Dennison, president, New York; Robert W. Pomeroy, vice-president, Buffalo; Albert W. Johnston, 2nd vice-president, New York; George C. Miller, secretary-treasurer, Buffalo. On the above-mentioned date the controlling interest held by Mr. Dennison was sold to the Mining Corporation of Canada. In February, 1920, the other shareholders sold their equity in the assets to the Mining Corporation. The price paid was $432,000 in all, and the liquidation of the Buffalo Mines, Limited, was then consummated.

The following is a summary of the work done at this mine:

| —— | To April 30, 1919 | May 1, 1919 to Nov. 1, 1919 | Totals |
|---|---|---|---|
| Shaft Work | 2,609 feet | .................. | 2,609 feet |
| Drifting | 21,916 feet | 538 feet | 22,454 feet |
| Stoping | 3,670,240 cu. feet | 115,200 cu. feet | 3,785,440 cu. feet |

During the half-year prior to the sale 11,165 tons of ore and rock were broken, of which 1,565 tons were waste used for filling; 10,691 tons of ore were hoisted, part of which consisted of ore broken in previous years.

A summary of operations for the year 1919: Ore mined, 21,642 tons; total ore and tailings treated, 88,346 tons; concentrates produced, 1,942 tons; silver produced, 577,811 fine ounces of a value of $651,591.

During the past 13 years the Buffalo Mines, Limited, on a capital of $1,000,000, has paid in dividends $3,287,000, including $500,000 reduction in value of mineral rights authorized by supplementary letters patent. In the sale and resulting liquidation of the company sums of $350,000 and $450,000 have been paid to shareholders, making a grand total of $4,087,000 in dividends.

*Casey-Cobalt.*—The Casey-Cobalt Silver Mining Company, Limited, operated its property in Casey and Harris townships up to the time of the strike.

W. R. P. Parker is president of the company, and J. W. Shaw manager.

Diamond-drilling was prosecuted during the autumn, but mining work was not resumed. The mine closed down in December.

*Casey Mountain.*—The Casey Mountain Mining Company, Limited, operated its mine on lot 6 in the second concession of Casey township till November, 1919, when lack of fuel forced a shut-down for the winter months.

The general manager reports that No. 1 shaft was sunk to the Keewatin contact, which was encountered at a depth of 425 feet, and at this horizon 116 feet of cross-cutting was done. About 500 feet of diamond-drilling was done on the 300- and 400-ft. levels.

The officers of the company are: R. G. Williamson, president and general manager, 26 St. Vincent St., Toronto; Jas. Thompson, vice-president; W. A. Staples, secretary-treasurer.

*Cobalt Provincial.*—The Cobalt Provincial Mining Company, Limited, with a capital of $1,500,000, worked the Provincial mine during the first half of 1919. The officers of the company are: F. G. Logan, Chicago, president; C. L. Painter, St. Louis, secretary-treasurer; John Reddington, Cobalt, manager.

After the strike, a 28-by 36-ft. addition was made to the mill, and an additional Hardinge ball mill, a Wilfley sand table, two Diester slime tables, and two Callow thickeners were added to the plant. The capacity was thereby increased from 25 tons to 40 tons daily. The total tonnage treated in 1919 amounted to 3,384 tons, averaging 11 oz., about half of which was jig tailing from the dump and the other half mine ore. Total recovery amounted to 22,725 fine ounces.

Development at No. 1 and No. 2 shafts consisted of 95 feet of raising and 464 feet of drifting. An average of 20 men was employed.

*Coniagas.*—The Coniagas Mines, Limited, with a capital of 800,000 shares of a par value of $5.00, owns and operates the Coniagas mine at Cobalt, and the Coniagas Reduction Company at St. Catharines. The head office of the company is at St. Catharines, Ont., and the directors are: R. W. Leonard, president and general manager, St. Catharines; Alex. Longwell, vice-president, Toronto; R. P. Rogers, Cobalt; A. L. Bishop and Welland D. Woodruff, St. Catharines; R. L. Peck, Deschenes, Que.; F. D. Reid, Cobalt.

The Coniagas Reduction Company shipped during the year 1,741,841 ounces of silver, and paid in dividends $349,300, being deferred dividends which have accrued in the past 11 years. An average of 138 men was employed at the reduction works.

The Coniagas mine shipped during the year 915,068 ounces of silver, for which an average price of $1.06 per ounce was received. The production of silver to date aggregates 27,194,528 ounces. The cost of mining and milling amounted to 35 cents per ounce, as compared with 34 cents the previous year, and the cost of smelting, refining and marketing amounted to 7.45 cents per ounce of silver produced. Three dividends of $100,000 each, amounting to 7½ per cent., were paid during the fiscal year, and on November 1 a further dividend of 2½ per cent. was

Sauerman drag-line excavator at Coniagas mine reclaiming sands carrying 3 to 3½ ounces of silver per ton. The sand is re-ground in tube mills to 100-mesh and treated by the flotation process.

declared. Total dividends paid to the end of 1919 amount to $9,640,000. The average force employed at the mine was 105 men under superintendent F. D. Reid.

At the end of the year the Coniagas Mines, Limited, purchased the adjoining property of the Trethewey mine, for $100,000.

The following information is taken from the annual report of the company:

Development work was confined to the following of stringers of ore on all levels, driving of cross-cuts through small unexplored areas and following known veins below the fault zone. A large tonnage of low-grade milling ore was developed, with occasional patches of high-grade ore.

The reserve of broken ore in the stopes has been decreased by 8,153 tons. Shipments of high-grade ore amounted to 13.84 tons, dry weight, averaging 3,051.93 ounces per ton.

The Callow flotation plant, to which a third unit has been added, treated all tailings from the concentrating mill and all re-ground sand from the tailings pile. An extraction of 65.99 per cent. was effected, leaving a tailing of 1.38 ounces of silver to go to waste. Shipments of flotation concentrates amounted to 630.44 tons, dry weight, averaging 335.27 ounces per ton.

Re-treatment of sand tailings from the tailings pile was carried on during the year with the exception of the months of January, February, March and April, when the severity of the weather made the cost prohibitive. Tailings

Pioneer drag-line excavator used to reclaim a slime carrying 6 ounces of silver for treatment by the cyanidation process, Coniagas mine. The slime is reclaimed in the moist state, agitated in cyanide solution and pumped to the cyanide plant.

re-ground and re-treated amounted to 20,683 tons, from which an average of 1.89 ounces of silver per ton was recovered. The total tonnage re-treated to date amounts to 42,569.9 tons, and 134,430 tons containing 436,897 ounces of silver still remain to be treated. In addition there are 40,000 tons of slimes tailings containing 240,000 ounces of silver.

Mine ore, concentrates and approximately one-half of the slimes were shipped to the Coniagas Reduction Company, at Thorold, Ontario. The remainder of the slimes were shipped to the American Smelting & Refining Company, at Denver and Pueblo, Colorado.

*Cross Lake.*—The Cross Lake Silver Mining Company, Limited, did 544 feet of development work on the 70-ft. level of the Cross Lake mine. This working is in an area of conglomerate in the property at the south end of Cross lake. Carl Reinhardt was in charge of the work and 15 men were employed.

The officers of the company are: Carl Reinhardt, Cobalt, president; Geo. L. Kavanagh, Montreal, vice-president; R. F. Kellock, Cornwall, secretary-treasurer.

*Crown Reserve.*—The Crown Reserve Mining Company, Limited, has an authorized capital of 2,000,000 shares of a par value of $1.00 each. The officers of the company are: John W. Carson, president and managing director; William I. Gear, 1st vice-president; James G. Ross, 2nd vice-president; James Cooper, secretary-treasurer; John Reid, assistant secretary-treasurer; H. J. Stewart, manager; H. F. Strong, superintendent.

The development during the year included 305 feet of sinking and raising; 1,305 feet of drifting and 1,088 feet of cross-cutting. The total amount of silver recovered amounted to 196,812 ounces, having a value of $233,034.32, of which 42 per cent. came from high-grade ore. The Dominion Reduction Company, Limited, treated 13,755 tons of Crown Reserve ore averaging 13.029 ounces per ton.

The following information is taken from the annual report of the company, regarding operations during 1919 on properties other than the Crown Reserve.

*Porcupine Crown Mine, Porcupine, (gold).*—The work was of a general repair nature, both underground and on surface. Preparations were made to salvage ore lost in the fall of ground of April, 1917, and a small amount of development and prospecting work was completed.

During the past year this company has been operating under option a very promising prospect in the Kirkland Lake Area, known as the Canadian Kirkland Gold Mine.

*Drummond Fraction, Cobalt.*—Owing to the labour situation in Cobalt during the early part of the year, it was not thought advisable at that time to attempt the operation of this property. However, in November work was resumed and results from the work projected are awaited with interest.

*Silver-Leaf Lease, Cobalt.*—On this property 289 feet of development and 1,250 feet of diamond-drilling were accomplished. Eight hundred and ninety-nine tons of milling ore were drawn from various workings and delivered to the Dominion Reduction custom mill. This ore averaged slightly under 10 ounces per ton. A small amount of high-grade ore was also produced. Net revenue amounted to $1,963.44, of which $1,276.22 is due the company and the balance is payable to the Silver-Leaf Mining Company, as royalty. On October 15, 1919, the lease on this property expired. Negotiations are now under way for a renewal on terms satisfactory to both companies.

*Dickson Creek.*—Dickson Creek Silver Mines, Limited, continued development in the northeast quarter of the north half of lot 9, concession V, Bucke township.

The underground work amounted to 150 feet of drifting and 110 feet of cross-cutting on the 150-ft. level. This prospecting is being done under contract. A two-drill compressor, driven by a 35-h.p. motor has been added to the mine equipment.

The officers of the company are: Thos. Dempster, Perth, Scotland, chairman; directors, J. A. Crumble, Gillingham; W. H. F. Blanchford, London; P. Hurst, Rochester, England, and W. Eveling, Snodland, England. H. Holland-Hurst, Haileybury, is superintendent.

*Dominion Reduction Mill.*—During 1919 the Dominion Reduction Company, Cobalt, treated ore from the following mines: Adanac, Aladdin, Colonial, Crown

Reserve, Edwards and Wright, Hargreaves, Kerr Lake, Reliance and Three Star. The Crown Reserve and Kerr Lake supply the greater part of the ore treated. An average of 60 men was employed under the manager, G. W. Perram.

*Edwards and Wright.*—Edwards and Wright worked the old Green-Meehan mine with a force of about 20 men. Stoping was carried on in the 200-ft. level and the ore sent to the Northern Customs and Cobalt Reduction mills.

B. Neilly was consulting engineer and E. J. McMillan, superintendent.

*Foster Cobalt.*—The Foster Cobalt mine was worked under lease by Campbell and Fairburn until the end of September and about 400 feet of development work was done. The lease, which had about three and a half years to run, was then sold for $70,000 to the Mining Corporation of Canada, which continued the work under the name of the Central Operating Company, Limited, and did 279 feet of development work. From 15 to 35 men were employed.

*Genesee.*—The Genesee Mining Company, Limited, did 398 feet of drifting and cross-cutting and 62 feet of raising on its property on the southwest quarter of the south half of lot 9, concession one, Bucke township, during the last two months of 1919. A small amount of high-grade ore was found at one place in vein No. 3 and exploratory work on this shoot is now being actively pushed. L. F. Steenman, Cobalt, is manager.

*Hudson Bay.*—During the year 1919 the Temiskaming and Hudson Bay Mining Company, Limited, distributed the assets of the company, including the holdings in the Hudson Bay Mines, pro rata among the shareholders and surrendered its charter. Mining claims L. 2553 and L. 2566, at Kirkland Lake, were transferred to the Kirkland Hudson Bay Gold Mines, Limited, controlled by the Hudson Bay Mines, Limited.

The Hudson Bay Mines, Limited, worked No. 1 mine at Cobalt during 1919, but did not do any work on its Gowganda properties. Eighty-six feet of drifting was done and 21,263 tons of ore were produced, of which 210 tons came from development, 7,512 tons from stopes, 5,773 tons from open cuts, 5,932 tons from surface dumps, and 1,836 tons from reserves. The mill treated 21,102 tons, containing 132,358 ounces of silver, and 104,926 ounces of silver were extracted. The profit for the year amounted to $3,291.45.

The officers and directors of the company are: F. L. Bapst, president; A. A. McKelvie, vice-president; H. P. Burgard, T. McCamus, F. L. Hutchinson, W. H. Kinch, C. L. Sherrill. C. L. Sherill, Cobalt, is manager and F. L. Hutchinson, New Liskeard, secretary-treasurer.

*Kerr Lake.*—The Kerr Lake Mines, Limited, with a capitalization of $2,400,000, divided into shares of $4.00 par value, and head office at 61 Broadway, New York, owns and operates the Kerr Lake Mines at Cobalt. The officers of the company are: Adolph Lewisohn, president; Sam. A. Lewisohn, vice-president; E. H. Westlake, secretary-treasurer; H. A. Kee, manager, Cobalt.

The gross production for the year ending August 31, 1919, amounted to 1,482,649 ounces of silver and 90,586 pounds of cobalt. Four hundred and ninety-two thousand nine hundred and seventy-six ounces of this silver came from low-grade ore milled by the Dominion Reduction Company at Cobalt and the remainder from shipping ore.

During the fiscal year 2,382 feet of development was done by drifting, cross-cutting, raising and sinking, all of which failed to encounter new veins of importance, although commercial ore was obtained in extensions of ore shoots, portions of which were previously known.

Total development to March 1, 1920:

| | | |
|---|---|---|
| Previous to September 1, 1918 | 54,539 | feet. |
| Total for year | 2,382 | " |
| Total for past six months | 858 | " |
| Total | 57,779 | " |

During the past winter extensions of ore shoots on No. 7 vein above the adit level have added at least 400,000 ounces to ore reserves.

*La Rose.*—La Rose Mines, Limited, incorporated under Ontario laws with a capital of $1,500,000 in shares of $1.00 par value, operates several mines at Cobalt. The officers of the company are: D. Lorne McGibbon, president; Shirley Ogilvie, vice-president; Stephen J. LeHuray, secretary-treasurer; G. C. Bateman, general manager. The head office of the company is at 260 St. James St., Montreal.

During the year the company produced from all sources 289,317 ounces of silver and 6.6 tons of cobalt for which payment was received, having a total net value of $320,616.00. Twenty-five thousand five hundred and twenty-seven tons of ore averaging 11.1 ounces of silver, were shipped to the concentrator and yielded 660.7 tons of concentrates averaging 355.8 ounces per ton, or a total of 235,059 ounces. The net value of the product was $356,124.00, and the net profit for the year $51,736.00. The average price received for silver was $1.17 and the profit 12 cents per ounce. The current net surplus was increased during the year by $60,000 to a total of $496,504.

Details regarding the several mines of the company are as follows:

*La Rose.*—The La Rose mine shipped to the concentrator 7,840 tons, averaging 12.5 oz. per ton, and also produced 30,117 ounces from high-grade and cobalt ore, making a total output of 127,446 ounces.

*Violet.*—The Violet mine shipped to the concentrator 8,297 tons of ore, containing 86,993 ounces, and the total production from milling ore, high-grade and cobalt ore was 104,487 ounces.

*Princess.*—The Princess mine, which was unwatered during the year, shipped to the concentrator 5,149 tons averaging 12½ ounces, and produced in addition 6,647 ounces contained in high-grade and cobalt ore, or an aggregate of 71,296 ounces.

*Lawson.*—At the Lawson mine, where no underground work was done during the year, 4,241 tons averaging 8.6 ounces per ton were shipped from the surface dumps.

*University.*—The University mine shipped 794 tons from surface dumps. After an examination made in the autumn work was resumed at the University No. 1 shaft, which had been under water for ten years. Good ore has been found in a branch vein running northeast in a drift driven west from the top of the stope. The shaft has been continued from the 90-ft. level to the conglomerate Keewatin contact 140 feet, and cross-cutting has been started to explore an area which seems favourable.

The average number of men employed was 120.

*Lumsden.*—Messrs. Campbell and Fairburn began work on the Lumsden, under lease, on November 7, 1919.

J. H. Rattray of the Waldman mine is in charge.

*McKinley-Darragh-Savage.*—The McKinley-Darragh-Savage Mines of Cobalt, Limited, capital $2,500,000 in shares of $1.00 par value, operates the McKinley-Darragh and Savage mines. The company's offices are at the Trust and Guarantee Building, Toronto, and at Cobalt, Ont. The officers of the company are: J. R. L. Starr, president; Thos. W. Finucane, vice-president; Harper Sibley, treasurer; J. H. Spence, secretary; T. R. Finucane, general manager; H. C. McCluskey, resident manager.

The mines and mill, employing 160 men, were in operation in 1919 except during the strike period, and the tailings mill ran from May to the end of the year, when it was shut down for the winter.

The ore removed from mines and dumps was 56,631 tons; the silver recovered 767,398 ounces; and the silver shipped during the year 760,482 ounces.

The following are the details regarding the silver recovered:

| Classification | Tons of Product | Ounces of Silver | Percentage of Total | Average Ozs. per Ton |
|---|---|---|---|---|
| Nuggets | .740 | 13,597 | 1.8 | 18,374.3 |
| Below 550 ounces per ton | 130.736 | 37,783 | 4.9 | 289.0 |
| 550 to 1000 ounces per ton | 69.216 | 47,854 | 6.2 | 691.4 |
| 1000 to 2000 ounces per ton | 101.109 | 142,459 | 18.6 | 1,408.9 |
| Sand Concentrates | 816.297 | 292,483 | 38.1 | 358.3 |
| Flotation Concentrates | 741.538 | 233,187 | 30.4 | 314.5 |
| Cobalt Ore | 3.491 | 35 | ............ | 10.0 |
| Totals | 1,863.127 | 767,398 | 100.0 | 411.9 |

The total production of silver to date has been 19,000,000 ounces.

The underground work consisted of 1,241 feet of cross-cutting, 1,340 feet of drifting, 556 feet of raising, 26 feet of sinking; 27,218 tons were broken in the stopes.

Ore reserves are estimated at 1,000,000 ounces, an increase of 200,000 ounces.

Three 3 per cent. dividends, amounting to $202,292.28, were paid during the year and another distribution of $67,430.76 was made on January 1, 1920.

*Mining Corporation.*—The directors and officers of the Mining Corporation of Canada, Limited, are: Henry M. Pellatt, president; J. P. Watson, first vice-president; W. R. P. Parker, second vice-president; G. M. Clark, J. G. Watson, Thos. Plunkett, D'Arcy Weatherbe; W. W. Perry is secretary; Scott Turner is consulting engineer and M. F. Fairlie, resident manager. The head office is in the Bank of Hamilton Building, Toronto.

Three dividends of 12½ cents per share, or $207,506.25, were paid during the year.

The production of silver during 1919 amounted to 1,230,652.53 ounces and the ore reserves to 1,307,220 ounces.

The production of silver was proportioned as follows:

| | | |
|---|---|---|
| High-Grade Ore | 35.53 tons | 72,192.93 ounces silver |
| Milling Ore | 35,374.45 " | 1,111,567.09 " " |
| Tailings | 28,494.00 " | 46,892.51 " " |
| Totals | 63,903.98 tons | 1,230,652.53 ounces silver |

The total silver production to December 31, 1919, amounts to 30,553,487 ounces.

The work done in the concentrating mill is shown in the following table:

| | | Table Concentrate Produced | Slimes sent to Cyanide Plant of Cobalt Reduction Co. |
|---|---|---|---|
| Ore Milled | | | |
| Tons | 35,374.45 | 437.65 | 26,326.85 |
| Ounces silver contained | 1,185,558.95 | 888,579.53 | 275,902.85 |
| Tailings | | | |
| Tons | 28,494.00 | 13.86 | 6,577.54 |
| Ounces silver contained | 96,790.52 | 26,023.26 | 26,086.57 |
| Total Tons | 63,868.45 | 451.51 | 32,904.39 |
| Total ounces contained | 1,282,349.47 | 914,602.79 | 301,989.42 |

The work of the cyanide plant in recovering silver from ore slime and concentrate slime is shown by the figures appended:

| | Tons slime from ore and retreatment of concentrate | Silver Content | | Silver Produced by Cyaniding | | Percentage Extraction by Cyaniding |
|---|---|---|---|---|---|---|
| | | Total | Per Ton | Total | Per Ton | |
| Mine Ore | 26,326.85 | 275,902.85 | 10.48 | 222,987.56 | 8.47 | 80.82 |
| Tailings | 6,577.54 | 26,086.57 | 3.97 | 20,869.25 | 3.17 | 80.00 |
| Total | 32,904.39 | 301,989.42 | 9.18 | 243,856.81 | 7.41 | 80.75 |

The underground work consisted of 58 feet of development and 548 feet of exploration; 24,272 tons of ore were broken.

The ore reserve estimate below covers the Townsite, City and Lake properties of the Corporation.

| | Tons Ore, 1919 | Ounces Silver, 1919 |
|---|---|---|
| Total | 38,735 | 1,307,220 |

The total is made up of 15,716 tons carrying 440,275 ounces in place, and 23,019 tons carrying 866,945 ounces of broken ore in stopes and on dumps.

An increase in both tonnage and silver content over the previous year is shown in reserve, this new ore having been largely developed in stoping operations. Two important veins continued to show values above faults which might have been expected to cut them off.

There are over 350,000 tons of tailing available for re-treatment. This material will be pumped from Cobalt lake, de-slimed in the classifier plant already installed, and the slimes cyanided in the plant of the Cobalt Reduction Company. The sands from the classifier plant will be transported by aerial tramway to the Buffalo Mines plant where they will be crushed in tube mills and treated by flotation at the rate of 400 to 500 tons per day during the working season.

During the year the Corporation acquired a lease of the Foster mine and purchased a controlling interest in the Buffalo Mines, Limited, both in the Cobalt camp.[1] The development work on the properties has not been sufficiently advanced by the end of the year to judge of the importance of their acquisition, but good results are anticipated.

This plant treated during the year 1,059.04 tons of high-grade material, which produced 1,635,561.59 ounces of silver.

*National.*—The National Mines, Limited, did 60 feet of drifting during November and December of 1919 in the old King Edward mine, which they had leased.

C. A. Filteau was manager.

*Nipissing.*—The Nipissing Mines Company, Limited, has an authorized and issued capital of 1,200,000 shares of a par value of $5.00. The officers of the company are: E. P. Earle, president; Alexander Fasken, secretary; P. C. Pfeiffer, treasurer. The directors are: W. H. Brouse, John H. Black, and David Fasken, of Toronto; Richard T. Greene, E. P. Earle, August Heckscher and R. B. Watson, of New York. The head and corporate office is in the Excelsior Life Building, Toronto, and the New York office is at 165 Broadway.

The operating company is the Nipissing Mining Company, Limited, with an authorized and issued captal of 2,500 shares of a par value of $100. The officers are: David Fasken, president; E. P. Earle, vice-president; Alexander Fasken, secretary; P. C. Pfeiffer, treasurer. The directors are: John H. Black and David Fasken, of Toronto; E. P. Earle, Richard T. Greene and R. B. Watson, of New York. The operating officials are: R. B. Watson, general manager; Hugh Park, manager; James J. Denny, manager research department. The head office is in the Excelsior Life Building, Toronto.

During 1919 the production amounted to 2,905,474.93 ounces of silver with a gross value of $3,752,083.60 and a net value of $3,734,149.93, giving a net value per ounce f.o.b. Cobalt of $1.2077. The total cost of producing this silver was

[1] Since the beginning of the year the remaining interest in tho Buffalo Mines has been acquired, and this company is the sole owner.

35.61 cents per ounce and $15.630 per ton of ore treated. Up to the end of 1919 this mine had shipped 56,023,954.69 ounces of silver with a net value received of $35,806,474.99 and $20,940,000 has been paid in dividends.

The following information is taken from the fifteenth annual report of the company.

### High Grade Ore Treatment.

The new high grade section installed in the low grade mill in 1918 has given good results during the past year.

It can handle a larger tonnage than the old high grade and at a less cost per ton.

The material treated in this plant during the year was made up of:

| Tons. | | Assay. | Contents. |
|---|---|---|---|
| 962 | Nipissing ore | 1,590 ozs. | 1,529,864 ozs. |
| 695 | Nipissing concentrates | 1,319 " | 917,136 " |
| 205 | Custom ore | 2,339 " | 479,579 " |
| 56 | By-products | 2,520 " | 141,577 " |
| 1,918 | | 1,599 " | 3,068,156 " |

The material is ground and given a preliminary treatment with bleaching powder and water in a tube mill; this is followed by excessive agitation in a strong cyanide solution. After filtering, the residue is sent to the dump; the pregnant solution is precipitated by sodium sulphide; the precipitate is desulphurized by aluminium and caustic soda and sent to the refinery to be melted down into fine bullion.

The residue, which contains about 8 per cent. cobalt, commands a good market; there is a growing demand for cobalt at a high price.

Shipments of cobalt residue and cobalt ore amounted to 842 tons containing 7.9 per cent. cobalt.

The refinery treated precipitate from the high grade and low grade mills, Nipissing nuggets and custom bullion, with a total content of 4,122,015 ounces. Shipments of fine bullion in 1919 amounted to 3,602,040 ounces. Since last May practically all the bullion has been shipped directly to China.

### Low Grade Mill.

| | Tons | Assay | Ounces |
|---|---|---|---|
| Ore treated | 65,392 | 27.09 | 1,771,797 |
| Recovered in products: | | | |
| Precipitate | 29 | 24,875 | 727,140 |
| Coarse concentrates | 559 | 1,377 | 769,920 |
| Fine concentrates | 78 | 961 | 74,724 |
| Total recovery | | | 1,571,784 |

Average tailing, 3.06 ounces. Recovery 88.71 per cent.

The total Nipissing high-grade and low-grade ores treated amounted to 66,354 tons, averaging 49.9 ounces per ton; the recovery on this head was 93.76 per cent., taking into consideration the silver paid for in the cobalt residue.

A low-grade cyanide made in Canada is now being used.

Forty stamps ran 260 days, 10 hours, or 71.34 per cent. of the possible running time. They crushed 251 tons per day or 6.27 tons per stamp per day.

Mill was shut down 63 days on account of strike.

SUMMARY OF UNDERGROUND WORK, 1919.

| Shaft No. | Drifting feet | Cross-cutting feet | Raising feet | Sinking feet | Total feet | Stoping cubic yards |
|---|---|---|---|---|---|---|
| 63 | 248.5 | 1,295.5 | 16.0 | ........... | 1,560.0 | ........... |
| 64 | 184.5 | 406.0 | ........ | ........... | 590.5 | ........... |
| 73 | 693.5 | 2,569.5 | 155.0 | 64.5 | 3,482.5 | 14,278.5 |
| 96 | 767.5 | 417.5 | 102.0 | 66.5 | 1,353.5 | ........... |
| 128 | ........... | 684.5 | ........ | 45.5 | 730.0 | ........... |
| Total | 1,894.0 | 5,373.0 | 273.0 | 176.5 | 7,716.5 | 14,278.5 |

As shaft 63 is in the favourable territory at the south end of Cobalt lake, a considerable amount of exploration was done in that vicinity and in the direction of Cart lake. Several small veins were found, one or two of which have possibilities. On account of the good results in 96 tunnel lying to the south, a cross-cut is being driven to connect the 63 shaft workings with the tunnel workings. This will facilitate the extraction of ore in veins 99 and 109, and at the same time will open up good country.

Work from shaft 64 consisted largely in driving a cross-cut north toward the Bucke township line. Several small veins cut were followed up, but have produced no ore.

As in past years, most of the underground work was done at shaft 73, through which a number of the most productive veins were worked. Among the favourable developments were the increase in ore reserves in vein 4,067, near the eastern line, the finding of the extension of vein 73 to the north, and the erratic but generally favourable results obtained in developing vein 544. Vein 490 was actively stoped during the year; the ore body proved to be of greater height and width than estimated. This vein continues to be the heaviest producer and shows the largest ore reserve. Although most of the underground tonnage treated by the mill came from this shaft, the present reserves show a decrease of only 433,000 ounces. Without exception, all the stopes at this shaft exceeded expectations both in tons and in ounces.

No work was done at shaft 80 during the year.

The most important developments of the year were obtained on two new veins in the 96 tunnel workings, which are situated a short distance south of the Little Silver, the oldest producing vein on the property. Vein 99, found late in 1918, is a comparatively small vein, though high in assay. Up to the first of the year 252,000 ounces had been added to the reserves; since then the developments at depth have been favourable, and further ore will be blocked out in 1920. The other vein, No. 109, has been opened up on two levels and now shows a reserve of 675,000 ounces. The best part of the ore shoot on the tunnel level assays 6,800 ounces over a width of 2.5 inches for a length of 80 feet. This vein has more than compensated for decreases in the reserves in other directions.

Shaft 128, which is located on the east side of Cobalt lake, was completed to the 120-ft. level early in the year, and 685 feet of cross-cutting was done in various directions to explore a basin of conglomerate which it was thought had possibilities. No ore has been found to date, and the workings have not been pumped out since the strike. Operations will be resumed in 1920.

ORE RESERVES, DEVELOPED AND PARTLY DEVELOPED ORE, DECEMBER 31, 1919.

| | High Grade Ore | | Mill Ore | | |
|---|---|---|---|---|---|
| Shaft No. | Tons | Ounces | Tons | Assay | Ounces |
| 63 | 160 | 356,700 | 6,088 | 25 | 152,200 |
| 64 | 159 | 121,653 | 3,710 | 20 | 74,200 |
| 73 | 998 | 1,528,900 | 35,747 | 20 | 714,940 |
| 80 | 73 | 148,700 | 2,392 | 25 | 59,800 |
| 96 | 260 | 764,808 | 13,978 | 20 | 269,560 |
| 490 | 1,246 | 1,056,013 | 24,855 | 20 | 497,100 |
| Totals | 2,896 | 3,976,774 | 86,770 | 20.5 | 1,777,800 |
| Dumps | ........... | ........... | 26,790 | 22.4 | 600,082 |
| Grand Totals | ........... | ........... | 113,560 | 20.9 | 2,377,882 |

### Outside Properties.

A systematic campaign was carried on to find other promising properties in Canada and the United States. A scout, with headquarters at Cobalt, examined a large number of prospects in Northern Ontario, and two parties of prospectors were sent out for the summer season to investigate special districts. An option was taken on the Tucker-Walsh group in the Larder lake district but was not exercised, as, after some preliminary work, the results did not appear sufficiently encouraging to go on with it.

A considerable amount of development work was done on the Ophir mine in the Cobalt district, but this likewise proved disappointing.

An engineer employed by the company, with headquarters in the western United States, covers that part of the field, and several special examinations were made by other engineers.

After strong recommendations by technical men in the business, the company acquired an oil lease on 1,000 acres in Clay county, Texas, for a small outlay. The first hole is now being drilled on this lease; it has reached a depth of 2,500 feet without striking oil; it is in favourable formation and will be continued. As this lease is in new territory, the most favourable horizon for oil has not yet been determined.

Another oil lease was acquired near Osawatomie, Kansas, and is being actively developed. The oil sand lies at narrow depth, and a well can be put down for a few hundred dollars. These are small wells of long life and should constitute a safe investment.

*Nipissing Extension.*—The Nipissing Extension Mines, Limited, began work on the old Farah mine on October 10, 1919. At the end of the year No. 2 shaft had been sunk from 20 feet to 98 feet and 150 feet of drifting completed on the 90-ft. level.

A. J. Young is president of the company and E. H. Birkett manager.

*Northern Customs.*—The operations of the Northern Customs Concentrators, Limited, were somewhat curtailed during the year owing to the strike and the decrease in the quantity of customs ore shipped from the mines.

The following table gives the sources of the ore milled and the amounts of concentrates produced:

| Mine. | Tons of ore. | Tons of concentrates. |
|---|---|---|
| La Rose | 26,324 | 707 |
| Right of Way | 871 | 15 |
| Silver Cliff | 4,110 | 99 |
| Silver Queen | 1,610 | 55 |
| Waldman | 392 | 20 |
| Chambers-Ferland | 222 | none shipped |
| Total | 33,529 | 896 |

The mill is now operating to full capacity—80 stamps—on ore from La Rose, Silver Cliff, Right of Way and Chambers-Ferland mines.

Besides operating under lease the Silver Cliff mine the company acquired by purchase late in the year the No. 1 and No. 2 mines of the Chambers-Ferland at a price of $175,000. Negotiations are under way for the purchase of control of the Bailey Cobalt mines.

The officials of the company are: A. J. Young, president, Toronto; C. J. Booth, vice-president, Ottawa; F. J. Bourne, general manager, Cobalt; C. J. B. Armstrong, superintendent, Cobalt.

*O'Brien.*—The work done during the year was as follows: drifting and cross-cutting, 3,031 ft.; sinking, 94 ft.; tons stoped, 38,000; tons milled, 47,800.

During the year a new winze level was established at 800 feet below the collar of No. 6 shaft.

What is known as the main shaft, situated near the mill, has been equipped for balanced hoisting and the 340-ft. level from this shaft has been made the main haulage level of the mine. A storage-battery locomotive supplies the motive power.

The officers of the M. J. O'Brien, Limited, are: president, M. J. O'Brien, Renfrew; vice-president, J. A. O'Brien, Ottawa; manager, J. G. Dickenson, Cobalt; mining engineer, Angus Campbell; mine secretary, A. E. McKee.

*Penn Canadian.*—The Penn Canadian Mines, Limited, continued to work its mine until the strike. The development work done consisted of 393 feet of drifting and 59 feet of cross-cutting, and the ore milled amounted to 29,910 tons.

The officers are: president, Wm. J. Haines, Philadelphia, Pa.; secretary-treasurer, R. B. Haines, Jr., Philadelphia, Pa.; directors, Spencer D. Wright, Philadelphia, Pa.; Jansen D. Haines, Des Moines, Ia.; E. C. P. Laidlaw, New York; manager, B. Neilly, Cobalt. The mine foreman is R. Sandoe and the mill foreman is W. Kelly. The head office is at 1011 Chestnut St., Philadelphia, Pa.

*Peterson Lake.*—During 1919 the Peterson Lake Silver Cobalt Mining Company, Limited, treated 5,720 tons of tailings and dump ore from its property on Cart lake, formerly leased to the Seneca Superior Silver Mines, Limited. The production amounted to 127.274 tons of concentrates, of a value of $34,010 in silver and $1,230 in cobalt.

C. A. Filteau is manager.

*Reliance.*—The Reliance property, owned by Moorhead, Tough, *et al.,* was operated under lease by Shaw and Dean with a force of about 8 men.

The underground development during the year consisted of 70 feet of sinking, 306 feet of drifting and 162 feet of raising, or 538 feet in all. The ore mined and sent to the Dominion Reduction mill amounted to 1,265.7 tons.

*Right-of-Way.*—During the year The Right-of-Way Mines, Limited, milled 898 tons of ore and did 162 feet of sinking and 932 feet of drifting and cross-cutting in its No. 2 mine at the north end of Cobalt Lake. An average of twelve men was employed.

The officers of the company are: president, C. Jackson Booth; vice-president, A. E. Larmouth; secretary, Jas. Cunningham; all of Ottawa; manager, D. H. Angus, Cobalt. The head office of the company is in Central Chambers, 46 Elgin Street, Ottawa, Ont.

*Silver Cliff.*—The Silver Cliff mine was leased from the owners by the Northern Customs Concentrators, Limited, and work began on May 15, 1919. The leasing company has mined and treated at its mill 4,110 tons of ore, and has broken on stulls in the mine another 4,000 tons.

Development work consisted of 195 feet of drifting and 90 feet of raising. A fair tonnage of ore has been opened up and the operations have been entirely successful.

C. J. B. Armstrong is superintendent and 20 men are employed.

*Silver Queen.*—The Silver Queen mine was operated under a lease for five months during 1919 by Messrs. Brewer, who employed six men. About 400 tons were shipped from the mine and 1,600 tons from the dumps.

*Temiskaming.*—The Temiskaming Mining Company, Limited, with a capitalization of $2.500.000 divided into shares of $1.00 par value and head office in the Standard Bank Building, Toronto, operates the Temiskaming mine at Cobalt. The officers of the company are: J. P. Bickell, president; W. J. Sheppard, vice-president: Gordon F. Dixon, general manager. The company employs about 150 men.

The silver produced from 15,899 tons milled, exclusive of 1,125 tons of custom ore, amounted to 243,037 ounces of a net value of $283.623.71. This makes a total of 11.501.036 ounces produced to the end of 1919. The mill ran 43.8 per cent. of the possible running time; stoppages due to shortage of ore accounted for 20.8 per cent., new foundations and repairs for 15.4 per cent., and the strike period for 20 per cent. of running time. Total costs were $265,930.88, or $15.61 per ton milled.

Dividends of $100,000 were paid at the end of the year, and the net surplus then stood at $864,016.70.

The following extract is taken from the last annual report of the company:

### Exploration and Development.

The following is a summary of the development work accomplished during the year:

| | |
|---|---|
| Drifting | 1,203 feet |
| Cross-cutting | 365 " |
| Raising | 686 " |
| Winzing | 29 " |
| Total | 2,283 " |

The schemes of development, adopted from the proposals by Mr. Whitman, for the Gans area and for the 1,600-ft. level below the diabase sill, were completed, the former in December, 1918, and the latter in February, 1919. No immediately favourable results were obtained from this work and further development on the property was temporarily suspended.

In April, 1919, as the result of sampling the 506 drift at the 500-ft. level, silver-bearing ore was proved in the back of the drift at a point 226 feet south of 509 crosscut. Development work was then resumed and a zone of irregular silver deposition was proved to a height of 60 feet above the 500-ft. level, which contained patches of high-grade ore in a vein averaging two inches in width over a length of 110 feet. In the southerly extension of 506 drift, at a later date, there was proved a further length of 22 feet of ore, but this, as in the previous instance, did not extend upward for more than 40 feet above the level and was of an equally patchy character.

A total of 584 feet of development was done in the southern area of the property in drifting and raising on Nos. 506, 508 and 502 veins, but although the results were on the whole of a somewhat encouraging nature, the work so far carried out has not proved the enrichment of the veins to be of equal persistence to that in the older workings.

Development will be continued, however, in extending the 400-ft. level south and drifting on the Keewatin-Diabase contact from No. 1 winze at 80 feet below the 500-ft. level, to positions, respectively, above and below where the ore was discovered in the 506 vein.

While the development of 506 vein was in progress, exploratory work was commenced in the older workings in directions indicated from sampling as likely to give favourable results.

A raise, put up on the south end of No. 1 vein at the 575-ft. level on the Keewatin-Diabase contact, was the means of eventually disclosing an extension of values 120 feet in length on this vein, which has been one of the chief sources of supply of ore for the mill.

The opening up for stoping of a length of 320 feet of profitable milling ore at the 200-ft. level on Nos. 2 and 3 veins was accomplished as the result of exploratory and development work in that area of the property.

A raise on No. 6 vein from the 575-ft. level connected to the 500-ft. level and subsequent drifting south at the latter level has resulted in proving an extension of milling ore.

In addition to the work described, development is being conducted in other directions with definite objects, which have a fair promise of realization.

*Cochrane Property.*—An option was taken on this property during May, 1919. The unwatering of the mine was not finished until the first week in July. Sampling of the workings was then commenced, but before this could be wholly completed the strike occurred and the water again rose in the mine to the 200-ft. level. Some exploratory work was done at the 100-ft. level from the Cochrane shaft with indifferent results, and attention was then directed to the extension of the drift from 502 cross-cut at the Gans-Cochrane boundary. The drift was continued to a total distance of 87 feet on a vein 2 inches wide in which, at 60 feet from the boundary, a small patch of rich ore was met. Further development has, however, so far not shown any extension.

*Trethewey.*—The Trethewey Silver Cobalt Mine, Limited, operated during the year, except for the strike period. I. S. McReavy was manager, and a force of 45 men was employed.

The work done was confined to extending old stopes, taking out remaining pillars and re-treating sand tailings. The high price of silver made possible the extraction of this ore at a small profit and 21,676 tons of ore was broken in the stopes, and 29,416 tons treated in the mill. The silver recovered amounted to 137,334 ounces, including a recovery of 26,634 ounces from tailings.

The total revenue on operating account was $169,294, compared with $254,038 in the previous year. The profit on operating account was $31,814, compared with $106,872 in 1918.

In January, 1920, the mine and all the company's assets at Cobalt were sold to the Coniagas Mines, Limited, for $100,000. The company will in future work in the Gowganda field where it owns the Castle properties with an area of about 450 acres, adjoining the Miller Lake-O'Brien mine.

*Waldman.*—The Waldman Silver Mines were operated under lease by Mosher & McKay from March 10, 1919. An average of three men was employed. From a stope and raise above the 80-ft. level 1.9 tons of 2,000-ounce ore and 392 tons of mill ore averaging 15 ounces, were produced.

## Elk Lake and Gowganda

*Camburn.*—The Camburn Silver Mines, Limited, began work under lease on a claim in the township of Nicol, on the southeast side of Leroy lake. On one claim there already was a shaft 80 feet deep with about 100 feet driven on the 70-ft. level. This shaft was sunk an additional 60 feet. The property was closed down on December 2, 1919, and the machinery, consisting of a 60-h.p. boiler, a 3-drill compressor and a 6 by 8 hoist, removed.

The officers of the company are: C. L. Campbell, Montreal, president; Wm. Fairburn, Toronto, vice-president, and G. B. Christison, manager. From eight to fourteen men were employed.

*Castle.*—The Castle Mining Company, Limited, which is controlled by the Trethewey Silver Cobalt Mining Company, Limited, carried on mining operations on a group of mining claims in Nicol and Haultain townships between Miller and Everett lakes. I. S. McReavy is manager, and R. E. Margenau, superintendent. An average of fifty men was employed.

The development work for the year on the property on Miller lake consisted of 1,317 feet of cross-cutting, 1,335 feet of drifting, 80 feet of sinking and 40 feet of raising. No ore body of importance was encountered in these workings.

A discovery of silver was made in August, 1919, on claim R.S.C. 101 near Everett lake. An incline shaft 109 feet in depth was sunk on this vein, which shows high-grade ore to the bottom of the shaft. A shipment of six tons was made in December.

*Collins.*—F. Howard Collins resumed work on his claim on the west side of Leroy lake in August, 1919, with a force of 10 men. The shaft was sunk with a steam drill from a depth of 130 feet to about 200 feet. The plant consists of a 40-h.p. boiler and a 6 by 8 Jenckes hoist. Work was discontinued in November.

*Crews-McFarlan.*—The Crews-McFarlan Mining Company, Limited, continued work on the Bartlett mine in Milner township. The capitalization of the company is $3,000,000, divided into shares of $1.00 par value. The officers of the company are: C. H. Strait, president; Walter Little, vice-president; H. R. Crews, secretary; W. J. McFarlan, treasurer. The head office of the company is in Patterson, New Jersey.

Isaac G. Wheaton is manager and an average of 16 men is employed.

The work during the first half of the year 1919 consisted of surface trenching and stoping in an open cut from which 30 bags of ore were taken. A shaft was then sunk to a depth of 70 feet at a point between this vein and a parallel one. Three hundred feet of drifting was done on the 50-ft. level without very encouraging results.

*Kell.*—The Kell group of five claims with an area of about 140 acres was acquired in November by J. G. Smith, ex-Governor of Vermont, under option to purchase. The property is situated in the southwest corner of Corkill township. At a later date seven more claims with an area of about 280 acres were added.

In December a shaft was started and on April 16, 1920, it was 104 feet deep at an angle of 52 degrees. Two levels have been started: the 54-ft. level, on which 208 feet of drifting has been done and the 100-ft. with about 50 feet. On the 54-ft. level a lens of rich ore was found south of the shaft, but the rich shoot discovered on the surface has not been encountered underground.

The machinery includes an 80-h.p. boiler, a 4-drill Ingersoll Rand compressor and a 6-inch by 8-inch Jenckes hoisting engine.

Thirty men are employed under manager A. F. Bennett.

*Miller Lake O'Brien.*—The Miller Lake O'Brien Mine, at Gowganda, is owned and operated by M. J. O'Brien, Limited. J. G. Dickenson, of Cobalt, is manager, and H. G. Kennedy, resident superintendent.

The exploration and development work during the year amounted to 2,260 feet of drifting and cross-cutting, 220 feet of raising, and 77 feet of sinking in No. 4 winze. The mill treated 9,934 tons of ore.

An average of 85 men was employed.

*Northcliff.*—The Northcliff Mines, Limited, with an authorized capital of $100,000.00, commenced operations in the autumn of 1919 on its property of about 160 acres at the head of the northwest arm of Gowganda lake. The officers of the company are: A. E. Vogt, president; Herbert R. Lewis, secretary-treasurer, 804 Granite Building, Rochester, N.Y. Norman E. Dye is manager and 8 men are employed.

A 25-h.p. vertical boiler was obtained from the Hewitt mine in October, 1919, and an adit commenced. The portal is near the shore of the lake and it is expected to cut several veins which occur within a distance of 250 feet. This adit was 150 feet long on April 17, 1920.

*Palmer-Paine.*—Operations by the Palmer-Paine Mines, Limited (T.C. 177) were carried on during the summer months by Neil Morrison with a force of 16 men. Operations consisted in drifting from the shaft on the 170-ft level.

*Paragon-Hitchcock.*—The Paragon-Hitchcock Mines, Limited, operated the Hitchcock mine on lot 10, in the second concession of Tudhope township during seven months of 1919.

The shaft was continued from the 100-ft. to the 200-ft. level. The total amount of drifting and cross-cutting done to the end of 1919 consists of 250 feet on the 100-ft. level and 500 feet on the 200-ft.

The officers of the company are: Dr. McKay, president; David Melville, secretary; J. P. Welsh, manager, all of Collingwood, Ont. A force of 12 men was employed.

*Purcell and Hitchcock.*—On the Purcell and Hitchcock claim, situated on the south half of lot 7 in the first concession of Tudhope, a 75-ft. adit was driven to cut a vein which outcrops on the surface of the hill. The owners are: Patrick and George Purcell, and others, Leeville, and W. R. Hitchcock, Wabun, Ont.

*Reeve-Dobie.*—The Reeve-Dobie Mines, Limited, capital $2,000,000 in shares of $1.00 par value, resumed operations in May, 1919, with a force of 14 men. The officers of the company are: Charles Ward, president; Herman Myering, vice-president; Robert Thomson, secretary, all of Rochester, N.Y.; M. H. Jacobs, managing director. The head office of the company is at 426 Powers Building, Rochester, N.Y.

The development work for the year consisted of 400 feet of drifting, 80 feet of cross-cutting and 35 feet of raising.

A 70-ton flotation plant was added to the mill, which operated 50 days and treated 300 tons. A shipment was made of 42 sacks of ore and concentrates of a net value of $1,208.

*Silverado.*—The Silverado Mining Company, Limited, capital $1,000,000, owns 400 acres adjoining the Hudson Bay mine in Leith township. The officers of the company are: D. R. O'Gorman, president and general manager; Charles A. Zenkert, vice-president; A. S. King, director; Geo. S. O'Gorman, secretary-treasurer, 67 Bond Street, Toronto.

The machinery consists of a 125-h.p. return tubular boiler, a 7-drill Ingersoll-Rand straight-line air compressor, a 6-by 8-in. Jenckes hoist, and a saw mill with a daily capacity of 17,000 feet, run by a 40-h.p. engine.

In 1919 a force of 15 men was employed; this number was increased to 30 when sinking was commenced in January, 1920. The shaft had reached a depth of 95 feet in April, 1920.

*Silver Alliance.*—A small amount of work was done during the summer of 1919 by Lieut.-Col. McKee of Elk Lake, on the Silver Alliance claim, which is situated on the Charlton road in the northwest corner of Tudhope township.

*Silver Bullion.*—The Silver Bullion Mines, Limited, is prospecting two claims in Leroy lake, Gowganda district. The officers of the company are: James Robinson, president; R. A. Kennedy, secretary-treasurer; H. A. Frank, managing director. The head office is at 703 Drummond Building, Montreal.

In August, 1919, a shaft was started on an island near the east end of Leroy lake and at the end of the year was 80 feet deep. Albert Terrill is in charge and has a force of 8 men.

*Silver Diadem.*—The Silver Diadem Mines, Limited, was formed to work the old Powerful mine near Calcite lake and had 15 men employed during the latter half of the year, under superintendent J. A. Montague.

The plant consists of a 100-h.p. return tubular boiler, a 3-drill compressor and a 6 by 8-in. Jenckes hoist.

The underground workings consisted of about 2,000 feet in all, mainly on the adit level. In addition there is a 100-ft. winze with 200 feet driven on the 50-ft. level and 300 feet on the 100-ft. level. The work done in 1919 consisted of 238 feet of drifting on the adit level and some surface trenching.

*Triangle Silver Mines, Limited.*—This company owns 520 acres in the township of Auld, seven miles from Kenabeck station on the Elk Lake Branch of the Temiskaming and Northern Ontario railway. The capital of the company is $2,000,000 in shares of $1.00 par value. The officers are: L. A. Chittenden, president; John C. Crapser, vice-president; R. J. Roth, treasurer; C. H. Cline, secretary; W. R. Hitchcock, managing director. The head office of the company is at Cornwall, Ontario. W. H. Jeffery is manager and 20 men are employed.

The company operated during the latter part of the year. The shaft was continued from the 132-ft. level to the 182-ft. level; 11 feet of cross-cutting and 88 feet of drifting were done on this level, and an additional 78 feet on the 130-ft. level.

The total development work to date consists of a shaft 188 feet on the incline; about 300 feet of drifting on the 130-ft. level and 100 feet on the 182-ft. level.

Some silver ore has been taken out, but no shipment has been made.

### South Lorrain

*Curry-Wettlaufer.*—The Pittsburg Lorrain Syndicate started to re-treat sand tailings at the Wettlaufer mill in South Lorrain in June, 1919, and were handling 20 to 30 tons daily during the autumn. Two small shipments of concentrates were made.

H. F. Strong was manager, and from 6 to 10 men were employed.

*Keeley.*—The Keeley mine, in South Lorrain, was worked during the summer months of 1919 by the Associated Gold Mines of West Australia, Limited, with a force of 15 men. Sixty feet of drifting was done and from the 90-ft. level of No. 2 shaft a raise was started to provide an escapement. This had reached a height of 30 feet above the level when all work was stopped.

J. Mackintosh Bell was manager and F. Zabel, superintendent.

## IV.—SOUTHERN AND EASTERN ONTARIO

### Corundum

*Corundum, Limited.*—The Corundum, Limited, during the year leased the properties of the Manufacturers Corundum Company at Craigmont and built a new mill to treat the tailings from the Canada Corundum mill. The construction of the mill was commenced in June, 1919, and the mill was in operation in December, with thirty men employed.

The tailings are hauled by tram-cars to a 200-ton storage bin and elevated to a Duplex Callow screen. The oversize, consisting of 16-mesh or coarser, goes to a 4-by 6-ft. Hardinge conical ball mill. From the ball mill all fines pass through the classifiers to fourteen Wifley tables and one Reid Deisler table. The concentrates from the tables go to settling tanks and from there to the dryers and graders. The graders consist of 1 splitter, 2 grades, 2 Hooper pneumatic air jigs and a magnetic separator. The product consists of 18 grades, from 14-mesh to flour. The present capacity of the mill is 100 tons per day. During December, 1919, 1,300 tons of tailings were treated and it is estimated that there are 300,000 tons of tailings on the property.

Power is supplied to the mill by two Fairbanks-Morse-Diesel fuel oil engines, one 75-h.p. and one 25-h.p. One 80-h.p. boiler furnishes steam for heating and drying. Two water tanks are used for storing the water, one of 3,000-gal. capacity located in the upper part of the mill, and one of 4,000 gallons at an elevation of 30 feet above the mill; the latter supplies water to the classifiers and is also used for fire protection.

The officers of the company are: G. B. Ferguson, president, Renfrew; E. B. Clark, vice-president and general manager, Craigmont; James A . Lamb, secretary-treasurer, 63 Powell Avenue, Ottawa.

### Feldspar

*Allan.*—The Silica Milling Company, Monadnock Building, Chicago, Ill., began in January, 1920, to prospect a feldspar occurrence at Allan Mill, six miles southwest of Perth. The vein is on the property of J. K. Allan in lot 12, concession X, North Burgess. When visited in February, 1920, four men were employed under the direction of Michael F. Powers of Perth. The spar was being hoisted from the pit by means of a horse and whim and no shipments had yet been made.

*Brebner.*—Work was started in April, 1919, on the Brebner or Gamey quarry, which had been idle since 1910. It is in lot 4, concession XII, of the township of Portland. The pit is 300 feet long and 65 feet deep. At the bottom it is about 14 feet wide.

Fourteen men were employed under foreman Thomas McCumber.

The plant consists of one 40-h.p. locomotive-type and two small vertical boilers, a Canadian Ingersoll-Rand compressor, two contractor's hoists and two derricks.

*British America Feldspar, Limited.*—This company worked a feldspar deposit on the west shore of Bobs lake from June to November. The quarry is in lot 28, concession V, Bedford township. Shipments were made from Drafton siding on the Kingston and Pembroke railway. From 12 to 15 men were employed under superintendent Alfred Richardson. The head office of the company is at 152 Bay Street, Toronto.

*Cecebe Lake.*—W. B. Woods, 305 Board of Trade Building, Wheeling, W. Va., has bought a feldspar prospect on lot 26, concession II, township of Chapman. The deposit is on the east side of Cecebe lake near Harlem's wharf and is reached by taking the steamboat plying east from Burk's Falls on the Maganatawan river. Mr. Woods expects to ship during the summer of 1920.

*Eureka Flint and Spar Company, Limited.*—This company continued to operate the feldspar quarry on the Emery farm directly north of and adjoining the Reynolds quarry. It is in the west half of lot 16, concession XI, township of Portland, and was worked during all of 1919 except for one period of five weeks. Twelve men were employed.

John Wilkes, 39 Logan Avenue, Trenton, N.J., is manager, and Richard Wagar is foreman.

*Feldspar Milling Company, Limited.*—The Feldspar Milling Company, Limited, owns a feldspar-grinding plant at Drafton siding about a mile and a half south of Tichborne on the Kingston and Pembroke railway. The mill ran during part of the year, the feldspar being bought from several quarry operators. Five men were employed.

F. H. Hurlburt, 33 Richmond Street West, Toronto, is president and George A. Stainton, Tichborne, Ont., is manager.

*Feldspar Quarries, Limited.*—Feldspar Quarries, Limited, worked two feldspar properties near Verona in 1919 and at the end of the year bought machinery for a third.

*Hoppins.*—The International Feldspar Company, Limited, opened a new deposit of feldspar during the year on the farm of Aaron D. Hoppins in lot 2, concession III, Bedford township. Work began in March, 1919, and when inspected in February, 1920, twelve men were employed. The plant consists of a 20-h.p. locomotive-type boiler, a Dominion Rock Drill Company hoisting engine, and a derrick. In the summer, shipments are made from Glendower and in winter from Godfrey.

The officers of the company are: president, John A. McLean; vice-president, Robert E. Tyler; secretary and treasurer, Alfred E. Patterson; all of Detroit, Mich. The head office of the company is at 316 Moffat Block, Detroit, Mich.; the quarry address is R.R. No. 2, Hartington, Ont. A. D. Hoppins is superintendent of the quarry.

*Huffman.*—On the Huffman farm north of Fourteen Island lake two feldspar quarries were opened in 1919 and worked on a small scale. They are both on the south half of lot 3, concession XII, township of Portland, and are about three miles northeast of Verona.

In October W. A. Dillon and W. A. Mills began work on one deposit and continued working until February, 1920. Steam was obtained from a 20-horsepower traction boiler and hoisting was done with a horse-whim. Six men were employed.

In November, 1919, George W. Hurlburt, of Verona, Ont., began to quarry feldspar from another vein on the same property. He used a Sawyer-Massey threshing boiler of about 20 horsepower to furnish steam and employed six men. He stopped work in February, 1920.

*Rinaldo McConnell and Son.*—Rinaldo McConnell and Son are working two feldspar quarries near Maberley, Ont.

One of these is on James Morrow's farm on lot 10, concession IV, township of South Sherbrooke. Work began in October, 1919, and since then shipments have been made regularly from Feldspar station, which is about a mile away. When inspected in February, 1920, drilling was being done by hand and six men were employed.

The second deposit being worked by this firm is on the farm of Thomas H. Kirkham in lot 3, concession VII, Bathurst township. This quarry was started in 1917 by George Gray, of Tichborne, but no shipments were made until 1918, when Joseph H. Mendels, of Perth, shipped two carloads of feldspar. McConnell and Son began work in 1919 and shipped two car loads near the end of the year. This quarry was visited in February, 1920, when it was found that work had been stopped as railway cars could not be procured. There was a considerable tonnage of broken feldspar on hand and a small steam plant had been bought but was not set up.

R. W. McConnell, Jr., of 1558 Yonge Street, Toronto, is manager of both quarries.

*McDonald.*—In October, 1919, the Pennsylvania Feldspar Company, 404 Harrison Building, Fifteenth and Market Streets, Philadelphia, Pa., began work on a vein of feldspar on the farm of Peter McDonald, a mile and a half east of Hybla station on the Central Ontario railway. The vein is in lot 18, concession

VII, township of Monteagle. The quarry was inspected in March, 1920, and it was then 30 feet wide, 75 feet long, and from 8 to 18 feet deep. Ten men were employed under foreman Robert Elliott. The work was being done under the supervision of G. V. Baker, of Philadelphia, the general superintendent of the company.

Since the quarry was inspected a letter has been received from Mr. Baker in which he states that the work is now being continued by the Verona Mining Company, which has an authorized capitalization of $20,000. The officers of the latter company are: president, S. Harry Worth, 404 Harrison Building, Philadelphia, Pa.; secretary, M. Moore, Philadelphia.

*McGregor.*—The most promising feldspar prospect seen during the year was one on the farm of Archie McGregor about three miles east of Tichborne. It is in the northeast corner of lot 25, concession III, Bedford township, and was discovered by John Bragg of Tichborne. The mining rights have been acquired by Alfred Richardson, who started stripping on December 22. The property was visited on December 30, when four men were at work drilling by hand. Reddish feldspar with but little quartz associated was seen at several points, but neither the width nor the length of the vein was known at that time. Mr. Richardson stated that an analysis showed 12.98 per cent. of $K_2O$.

*Morrow.*—The Morrow feldspar quarry in lot 13, concession V, township of South Sherbrooke, was worked until September 1, 1919, by the Orser and Kraft Company; after that date the work was continued by Ontario Feldspar, Limited. This quarry is three miles southeast of Maberley and was described in detail in the Twenty-sixth Annual Report of the Bureau of Mines, as it is here that the radio-active mineral euxenite is found in a pegmatite dike. In 1920 a trial shipment of the euxenite-bearing material accumulated in the course of quarrying will probably be made to the Department of Mines testing laboratory at Ottawa for concentration. Shipments of feldspar were made throughout the year from Feldspar station two and a half miles away.

When inspected in February, 1920, the excavation was 115 feet long, 24 feet deep, and varied in width from 40 feet at the top to about 18 feet at the bottom. Eight men were employed. The plant consisted of a 40-h.p. locomotive-type boiler, a hoisting engine and a derrick.

The directors of Ontario Feldspar, Limited, are: W. G. Edwards, Toronto; S. H. Orser, Perth, Ont.; Harry H. Kraft, Buffalo, N.Y.; G. G. Plaxton, Toronto, Ont.; W. A. Wood, Hamilton, Ont.; R. A. Leaker, Toronto. The head office is at 34 Toronto Street, Toronto; the post office for the quarry is Maberley, Ont. Sidney H. Orser, Perth, Ont., is manager.

*Munroe.*—In January, 1920, Joseph H. Mendels of Perth began shipping feldspar from a vein about two miles west of Maberley station. This vein is in lot 11, concession VIII, township of South Sherbrooke, on the farm of William Munroe.

*The National Potash Corporation, Limited.*—The National Potash Corporation, Limited, which owns a quarry and a potash reduction plant at Gravenhurst, was replacing the blast furnace by an electric furnace when last inspected in September, 1919. This change was being made because the blast furnace had proved unsatisfactory.

The rock in this company's quarry consists of biotite gneiss cut by small veins of feldspar. The feldspar forms so small a proportion of the material which has to be handled in the quarry that it is difficult to understand why, if the process has merit, an expensive plant has been erected at this point.

The directors are: president, E. L. Wettlaufer, Toronto; secretary-treasurer, W. S. Milne, Toronto; A. B. Crosby, Toronto; W. L. Wettlaufer, Buffalo, N.Y.; George W. Morris, Buffalo, N.Y.; J. A. L. Macpherson, Islington, Ont.; T. S. Holdgate, Bowmanville, Ont. The head office is at 178 Spadina Avenue, Toronto.

*O'Brien and Fowler.*—O'Brien and Fowler, a subsidiary company of M. J. O'Brien, Limited, is opening two new feldspar properties. One of these is in March township about 12 miles southwest of Ottawa and the other is near Perth Road in Loughboro township.

In the 10th Annual Report of the Geological Survey of Canada, 1897, E. D. Ingall refers to a deposit of microcline and albite in the township of March in lot 6, concessions II and III. Notwithstanding this allusion, showing that at least one feldspar deposit was known in this area 22 years ago, no work was done to test its value until October, 1919, when O'Brien and Fowler bought the mineral rights to parts of lot 6 in concessions II and III. Shipments were made regularly during the winter from South March station on the Grand Trunk railway. The haul to the station is short, being about three-quarters of a mile in winter and a mile and a half in summer. Open-cuts have been started on two different deposits: one is a vein 50 feet wide which has been traced for 600 feet, and the other measures 60 feet at the widest point and is 300 feet long. The feldspar is mixed with quartz but is said to have a high potash content. Several other veins are known to occur on the property but have not yet been prospected. The quarry equipment includes an E. Ledward and Sons vertical boiler of about 12 horsepower, a 5-inch by 5-inch Jenckes hoisting engine and two small derricks.

In January, 1920, O'Brien and Fowler began to test a feldspar claim on the south shore of Long lake, three miles west of Perth Road station on the Canadian National railway. The claim is in the northern part of lot 11, concession IX, township of Loughborough. No. 1 vein has been traced for 800 feet and varies in width from 20 to 50 feet; at the south end it seems to have a dip of 60 degrees, but near the north end it is vertical. No. 2 vein outcrops on a hill overlooking the lake and consists of a light pink to cream coloured feldspar with large amounts of white quartz. Euxenite in small quantities is reported to have been found along the footwall. No. 2 vein seems to have a dip of 85 degrees to the northwest.

Shipments were made during the winter, and in March, 1920, when the property was visited, roads were being made and a scow was being built to carry the feldspar to the south end of the lake in summer. From 10 to 20 men have been employed under the direction of Sherman Orser.

Norman B. Davis, Union Bank Building, Ottawa, is manager for O'Brien and Fowler.

*O'Holloran.*—Early in 1919 J. H. Mendels of Perth shipped three carloads of feldspar from Elliott's siding near Christie lake. The spar was obtained from a vein on the farm of Michael O'Holloran in Bathurst township. This was the first work done on this deposit.

*Reynolds.*—Work was continued in the Reynolds' pit in the east half of lot 16, concession X, Portland township, until September 1, 1919. At the end of the year fourteen men were engaged in sorting the dump.

*Timmins.*—A steam plant bought by Feldspar Quarries, Limited, will be set up in January at a feldspar deposit on the farm of John Timmins in part of lots 17 and 18, concession XI, Portland township.

The officers of Feldspar Quarries, Limited, are: president and general manager, Gordon C. Edwards, Toronto; vice-president, H. R. Schneider, Rochester, N.Y.; secretary-treasurer and superintendent, W. T. Coates, Verona, Ont. The head office is at 15 Manning Arcade Annex, Toronto. The Company is controlled by Dominion Feldspar Corporation, incorporated in the State of Delaware.

*Universal Silicates, Limited.*—Universal Silicates, Limited, started drilling by hand in February, 1920, to test a feldspar deposit near Maberley. The deposit is in lot 15 of concession VI, township of South Sherbrooke, and about two miles from Maberley station by the winter road and three and a half miles by the summer road. It is on the farm of Robert J. Patterson, who is in charge of the work.

The company is capitalized at $40,000 divided into shares of $100.00 par value. H. T. Bush, 1408 Royal Bank Building, Toronto, is president, and P. J. Dwyer, 59 Yonge Street, Toronto, vice-president and manager.

In March, 1920, this company began work with a force of nine men on a feldspar deposit near Hybla on the Central Ontario railway, north of Bancroft. This deposit is on the farm of George Watson in lot 22, concession VI, Monteagle township. The first shipments will probably be made from Hybla station, which is two miles from the quarry, but later a siding within a quarter of a mile of the deposit may be used. Fred W. Musclow, Hybla, Ont., is foreman at this quarry.

### Fluorite

*Dwyer.*—In the winter of 1919-1920, P. J. Dwyer, of 59 Yonge Street, Toronto, was driving an adit on lot 8, concession XXII, Cardiff township, to reach a vein of fluorite.

*Noyes.*—The Canadian Industrial Minerals, Limited, continued work on the Noyes mine near Madoc during 1919 and employed an average of 30 men.

The No. 2 shaft was sunk to a depth of 230 feet and a winze put down 103 feet from the first level. Drifting was done for a distance of 1,240 feet on the 100-ft level and 150 feet on the 200-ft level; 80 feet of cross-cutting was done on the 100-and 200-ft. levels. An electric hoist with a 75-h.p. motor was installed and a washing, picking and crushing plant erected during the year.

During the year 2,586 tons of fluorite were mined and shipped. R. C. Bryden, Madoc, is manager.

*Perry.*—Cross, Wellington and Bowman worked the Perry mine on lot 11, concession XIII, Huntingdon township, near Madoc, during the year 1919. The work consisted chiefly in sinking No. 3 shaft, which was continued to a depth of 148 feet and in drifting 175 feet north and south. Six hundred tons of fluorite were shipped and 13 men were employed.

## Gold

*Golden Fleece.*—The Cobalt Frontenac Mining Company, Limited, worked all of 1919 at the Golden Fleece mine near Flinton, Ont., and carried on underground development during part of the year.

When inspected on February 12, 1920, the shaft was 100 feet deep at an angle of about 70 degrees. The first level has been opened at 90 feet and 200 feet of drifting and cross-cutting done. There are also two disused shafts on the property which are said to be 75 and 85 feet deep.

The mill, which contains a 24-inch by 14-inch Mitchell jaw crusher, ten stamps and amalgamating plates, ran at intervals during the year; a 200-ton orebin was built beneath the crusher. An extension, 72 feet by 115 feet, has been added to the mill building and will be used to house a cyanide plant, most of the machinery for which had arrived but had not yet been set up.

The directors of this company are: president, George W. Milne, Stoney Creek, Ont.; vice-president, Noah Dyment, Guelph, Ont.; manager, D. H. Fletcher, Flinton, Ont.; John McFarlan, London, Ont.; Andrew Dodds, Belmont, Ont.; J. W. Guyatt, Binbrook, Ont.; M. E. Fletcher, Hamilton, Ont.; A. S. Glover, Hamilton, Ont. The secretary-treasurer is V. A. Burke, Toronto. The head office is at Flinton, Ont.

*Ore Chimney.*—The Ore Chimney Mining Company, Limited, Northbrook, Ont., capitalization $1,200,000, did no mining in 1919, but completed six dams on the Skootamatta river. In 1920 four more dams will be built and a hydro-electric power plant completed.

The officers are: president and managing director, A. E. Fletcher, Northbrook, Ont.; vice-president, A. Bauer, Waterloo, Ont.; directors, F. E. Misener, Hamilton, Ont.; Charles Zinn, New Dundee, Ont.; Charles Siple, Woodstock, Ont.; F. E. Slater, Woodstock, Ont.; J. M. Fletcher, Buffalo, N.Y.; A. E. Cumming, Buffalo, N.Y.; secretary-treasurer, S. G. Both, Northbrook, Ont.

## Graphite

*Black Donald.*—The Black Donald Graphite Company, Limited, operates the Black Donald graphite mine on Whitefish Lake fourteen miles west of Calabogie.

During the year 1919, advantage was taken of the decreased demand for graphite to remodel the mill and equipment. The buddles formerly used were replaced by flotation machines; as a result of this the carbon content of the

Black Donald graphite mine, Whitefish Lake, 14 miles from Calabogie.

lubricating flake has been increased from 85 per cent. to 95 per cent. of graphite carbon. Three grades of lubricating flake are manufactured: No. 1, or coarse; No. 2, or fine; and No. 3, or powdered flake. In addition to the flake graphite, three grades of foundry and stove polish plumbago are produced. These are sold in competition with the products from the islands of Ceylon and Madagascar. The plant now has a capacity of 25 tons of refined graphite per day.

The mining during the year consisted in continuing the drift from No. 3 shaft. The ore was taken from the raises and stopes at a depth of 300 feet and about 400 feet northeast of the shaft.

The refined product is hauled to the railway at Calabogie by a number of 2-ton trucks and 4-horse teams.

The plant consists of two 125-h.p. Goldie-McCullough boilers for heating and drying, an electrically driven compressor of a capacity of 450 cu. ft. per minute and an electrically driven hoist. The mill is equipped throughout with motors, the total amount of power used being about 350 horse power, which is obtained from the company's hydro-electric generating station.

An average of 50 men was employed during the year.

The officers of the company are: R. F. Bunting, president and treasurer; R. A. Telfer, secretary, Calabogie; John D. Patno, superintendent.

*Timmins.*—At the Timmins graphite mine near Stanleyville the mill and refinery, which were being built in 1918, were completed and milling commenced in May, 1919.

The mill was operated during part of May, June, July and August, and treated 2,600 tons of ore, from which 150 tons of graphite concentrates were obtained. Most of the material treated was the over-burden or surface soil overlying some of the deposits and containing graphite. In addition to this, approximately 10,000 tons of ore was mined from an open-cut, and is stock-piled for use on the resumption of operations.

At the beginning of September, 1919, the mill was closed down, and two additional units installed, making four units of the Spearman process, which have a capacity of 125 tons or more of ore per day.

The process of treatment is briefly as follows, as indicated by the accompanying flowsheet:

The ore passes through a gyratory crusher, and is elevated into a large storage bin, from which it is fed (together with the required amount of oil and water) automatically into a six-foot ball mill, and a classifier in closed circuit. The fine from the classifier passes to a Spearman concentrator, which delivers the concentrates to an unwatering machine; the latter in turn delivers it to a rotary dryer. The concentrate from this dryer runs about 70 per cent. carbon. The product is then refined and graded into the different sizes by passing through finishing rolls, burr stones, and 90- and 150-mesh silk reels, giving three grades of concentrates: No. 1 Flake, No. 2 Flake, and Dust. No. 1 Flake, or plus 90-mesh, gives the following screen test and analysis:

| Screen Test. | Per cent. |
|---|---|
| Coarser than 10 mesh | 0.00 |
| Minus 10 Plus 20 mesh | 7.31 |
| 20 40 | 52.97 |
| 40 60 | 28.29 |
| 60 80 | 10.24 |
| 80 100 | .44 |
| 100 150 | .29 |
| 150 200 | .18 |
| 200 | .28 |
| | 100.00 |

| Analysis. | Per cent. |
|---|---|
| Graphitic Carbon | 92.76 |
| Silica | 2.46 |
| Iron (as pyrite $FeS_2$) | .04 |
| Iron Oxide (FeO) | 1.17 |
| Alumina | .70 |
| Lime | .76 |
| Magnesia | .88 |
| Manganese Oxide | trace |
| Potash ($K_2O$) | .09 |
| Soda ($Na_2O$) | .12 |
| Carbon dioxide ($CO_2$) | .30 |
| Sulphur | .05 |
| Combined water and loss at red heat excluding carbon dioxide | .47 |
| | 99.80 |

No. 2 Flake analyses from 75 per cent. to 80 per cent. in carbon and the dust 55 to 65 per cent.

The flake produced amounted to about 72 per cent. of the total, and 55 per cent. of the flake grades as No. 1.

The power plant consists of two 100-h.p. locomotive-type boilers, one 150-h.p. steam engine and a 30-h.p. steam engine.

W. P. Alderson is superintendent, employing 65 men.

## Gypsum

*Ontario Gypsum Company, Limited.*—This company operates a plant at Caledonia, Ont., for the manufacture of gypsum products and obtains gypsum from its own mines—the Caledonia mine at the town of that name and the Carson or Garland mine about three miles south of Caledonia. In December the company bought the plant of the Canada Plaster Board Company, Limited, which was built beside the Ontario Gypsum Company's mill.

The Caledonia deposit is tapped by means of a slope 450 feet long which has a grade of 10 per cent. for the first 300 feet and 20 per cent. for the remainder of the distance. There are three seams of gypsum here at 50, 65 and 77 feet vertical depths respectively, but only the seam at 65 feet is now being worked. About 100 men are employed at the mine and mill. John Renwick is mine foreman.

The Carson mine was worked until July and was not re-opened until January, 1920. Wm. Smith is foreman.

The company has continued to work at the shaft at Lythmore, but progress has been slow owing to a large inflow of water. At the end of the year the shaft was 53 feet deep. Joseph Marks is foreman.

The officers of the company are: president, W. G. Case, Buffalo, N.Y.; vice-president, Melvin B. Church, Grand Rapids. Mich.; secretary-treasurer and general manager, R. E. Haire, Paris, Ont.; director and superintendent, A. J. Parkhurst, Caledonia, Ont.

### Iron

*Consolidated Iron and Steel Corporation, Limited.*—The Consolidated Iron and Steel Corporation, Limited, was formed in 1919 with $8,000,000 stock in shares of $10 par value and $6,000,000 bonds. This corporation is giving $1,750,000 stock and $750,000 bonds in payment for the Dreany magnetite claims which are situated about four miles north of Goudreau station on the Algoma Central railway. It also has an option on some 600 acres in Leeds county about half way between Delta and Lyndhurst stations on the Brockville and Westport railway in concession X of the township of Bastard and the adjoining portions of the township of Lansdowne.

The work done by the company in 1919 was limited to prospecting and test-pitting some of the Leeds county deposits. These are of hematite and occur in the Potsdam sandstone. They are of particular interest because it was to smelt ore from similar deposits in this locality that the first iron furnace in Ontario was built about 1800 at Furnace Falls (now called Lyndhurst) on the Gananoque river. Four cars of hematite were shipped during 1919.

The acting directors are: president, Thomas Daigle. Detroit. Mich.: F. Farnham and J. McDonald, Detroit; Lieut.-Col. R. C. Le Vesconte and J. Costigan, Toronto.

### Iron Pyrites

*Grasselli Chemical Company.*—Operations were carried on by this company at Clyde Lake siding, near Flower station on the Canadian Pacific railway, about 22 miles south of Renfrew. The property is located on lots 1 and 2, in the first concession of Blithfield township, Renfrew county, and was formerly known as the Caldwell pyrite mine.

The underground work consists of two shafts, the old shaft being 60 feet deep on a 60° incline and the new shaft 234 feet deep on a 56° incline. The two shafts are connected by a drift 460 feet long on the first level. On the first level a drift has been run 120 feet east and from it a cross-cut of 50 feet driven a distance of 25 feet from the shaft. Two raises were made to a height of 22 feet and connected. About 400 tons of ore were shipped during the year, all of which was taken from development work. A loading pocket was built in the new shaft at a depth of 135 feet. The shaft was timbered, tracks were laid, and the manway completed. A new shaft-house was completed and the headframe enclosed.

The new plant consists of two 200-h.p. Goldie-McCullough boilers; one steam-driven compressor, 450 cu. ft. per min.; one Marsh Engineering Company hoist 10 by 12, and a Bowden 100 gal. pump. During the year a railway of 36-inch gauge was built between the mine and the railway, a distance of 8,500 feet. At the railway the foundations were laid for a concentrating plant, which will be completed early in the year. The ore is brought into the mill in cars and dumped on a grizzly, from which the coarse product goes through an 18-inch Wabi jaw crusher and thence to a 75-ton storage bin. From the storage bin it is elevated to a grizzly, from which the fine product passes into a pair of 14- by 36-inch Wabi Cornish rolls and the coarse product goes first to a picking belt, and then to the Cornish rolls. From the rolls the ore is elevated by a 14-in. belt bucket-elevator to a trommel of ¼-in. mesh, the oversize passing to 14-in. by 24-in. Wabi Cornish rolls. The fine product is then elevated to a 7-cell Hartz jig. The tailings are discharged by an elevator and the ore loaded in cars.

The capacity of the plant will be 100 tons of finished product per day. The plant will be supplied with power by two fuel oil engines, one of 70 h.p. and one of 35 h.p. A 15-k.w. 250-volt generator will be driven by the 35-h.p. engine and will furnish power for lighting and for a pump at the lake.

The officers of the company are: T. C. Grasselli, president; E. R. Grasselli, Cleveland, Ohio, secretary. D. S. Tovey, Flower Station, is superintendent, employing 45 men.


Kingdon Mining, Smelting and Manufacturing Co., Limited, Galetta.
(1) Shaft House; (2) Mill; (3) Lead Smelter.

*Queensboro.*—The Canadian Sulphur Ore Company, Limited, operated the Queensboro pyrite mine near Madoc continuously during 1919 with a force of 80 men. The No. 3 shaft was sunk 80 feet and a raise was made from the third level of No. 3 shaft to the second level of No. 2 shaft. During the year the ore was stoped between the second and third levels and between the fifth and sixth levels. All the ore was shipped to Hamilton.

The officers of the company are: Alex. Longwell, Toronto, president; George H. Gillespie, Madoc, Ont., vice-president; H. F. Smeaton, Queensboro, Ont., superintendent.

### Lead

*Kingdon Mine.*—The Kingdon Mining, Smelting and Manufacturing Company, Limited, at Galetta, operated continuously during 1919.

Stoping was completed on 1st and 2nd levels, and the shaft continued to the 400-ft. level.

Drifts were run 135 feet east and 165 feet west on the 333-ft. level.

During the year a mill was enlarged and now has a capacity of 200 tons per day. The ore from the shaft is taken up an incline to the grizzly, and from there the coarse is taken to the crusher and then elevated to the trommel screen. The oversize from the trommel goes to the rolls and the fines to the second screen. From the second screen the fines go to the five James tables and the coarse to the 200-ton James jig. The concentrates are then taken to the smelter for treatment.

The power in the mill is supplied by one 20-h.p. and one 50-h.p. motor.

A. G. Munich is manager and C. N. Thompson, superintendent, employing 80 men.

*Murphy.*—Towards the end of the year preparations were being made to start work on a galena prospect in Bedford township, Frontenac county, locally known as the "Murphy lead mine." It is on lot 17, concession VI, and is nine miles northeast of Godfrey station on the Kingston and Pembroke branch of the C. P. railway. The claim is said to be owned by George Heck of Prescott, Ont., and J. D. McLaurin of South Orange, N.J., holds an option on it. There is an open pit, 25 feet deep, on the vein.

M. W. Wambaugh, of 616 Eastgate Avenue, St. Louis, Mo., completed in December the placing of the following plant on the property: a 20-h.p. semi-Diesel engine, an 8-inch by 8-inch Sullivan air compressor, and a 10-h.p. single-drum hoisting engine. It is reported that a company is being formed.

## Marble

*Bronson Marble Quarries.*—The Bancroft Marble Quarries, Limited, worked under lease the marble quarries at Bronson on the Central Ontario branch of the Canadian National railway until November, 1919, when work was stopped.

The officers are: president, Walter Page; vice-president, John T. Hepburn; secretary and manager, John R. Hoidge; all of Toronto. The head office is at 34 Price Street, Toronto.

## Mica

*Bedford.*—In the summer of 1918 Orser and Kraft began working a mica mine near Glendower, on the farm of James Fitzgerald, three miles east of Godfrey station on the Kingston and Pembroke railway. In August, 1919, the Orser Mica Company succeeded Orser and Kraft. This deposit is in the south half of lot 5, concession II, township of Bedford, and was first worked in 1896 by F. Folger, of Kingston. It has since been worked intermittently by the Bedford Mining Company and other operators.

The mine was inspected in February, 1920, and the shaft was then 70 feet deep. Stoping has been carried on but a short distance on each side of the shaft. The machinery consisted of a George White and Sons threshing boiler and a 6-inch by 8-inch hoisting engine. Six men were employed. Sidney H. Orser, Perth, Ont., is manager, and Frank J. Judge, Glendower, Ont., mine foreman.

*Connors and Daly.*—Sidney H. Orser, of Perth, Ont., began working the Connors and Daly mica mine with a small force of men in September, 1919. This mine is in the east half of lot 6, concession VIII, township of Bedford, near the west end of Devil's lake.

*Ess Creek.*—The Ess Creek mica mine is owned by the Standard Mica Company. It is situated near Ess Creek Station on the Canadian National railways, 25 miles east of Capreol. Work was started in May, 1919, and was still in progress when last inspected in February, 1920. Five men were then employed. At this time the open cut on the pegmatite vein was 150 feet long and 30 feet in depth at the deepest point. Shipments of muscovite mica to Chicago were made during 1919.

This occurrence was described in the 28th Annual Report of the Bureau ot Mines.

The officers of the company are: president, W. C. Smith, 218 South Wabash St., Chicago, Ill.; secretary, Ben Cohn, La Salle St., Chicago; mine foreman, Albert Arnold, Ess Creek, Ont.

*Lacey.*—The Lacey mine in lot 11, concession VII, Loughborough township, was worked continuously in 1918 by The Loughborough Mining Company, a subsidiary of the General Electric Company, of Schenectady, N.Y. This mine, which has been the largest producer of mica in Ontario for many years, is still yielding a fine grade of amber mica. The shaft is 185 ft. deep, and on December 29, 1919, when last inspected, the deepest working was the stope on the "milky vein," which had reached a depth of 200 feet, mica still showing in the bottom of the stope.

The officers of the company are: manager, George W. McNaughton; superintendent, Richard Smith; mine foreman, John Lees. The mine post office is Sydenham, Ont. Twenty-three men were employed at the time of inspection.

### Phosphate

*Silver Queen.*—In December, 1919, work was started by the Dominion Improvement and Development Company on the Silver Queen phosphate and mica mine which has been idle for some seven years. This mine is in the east half of lot 13, concession V, township of North Burgess, and was first worked for mica in 1903, but some phosphate was probably shipped before that year.

The mine was visited in February, 1920, and was reached by driving 14 miles southwest from Perth. Sixteen men were employed, mostly in sorting the dumps. An adit was being driven into the side of a small hill near an open cut which is 60 feet long and reputed to be 120 feet deep. Power for drilling was being supplied by a 16-h.p. Waterous threshing boiler. A six-drill Sullivan compressor and a 75-h.p. locomotive-type boiler were on order, but had not yet arrived at the mine. The manager stated that in the spring three other phosphate mines owned by the company in North Burgess, would be opened, namely, the Haggerty in lot 3, concession V; the Tully in lot 9, concession V, and the Fairy in lot 9, concession VII.

Notwithstanding fairly heavy falls of snow, the company has succeeded in operating a Linn tractor between the mine and Perth during the winter. This tractor carries six tons and by using sleighs as trailers as much as 17 tons has been taken to Perth at a time. On iced roads, it is said, this tractor will draw three sleighs carrying five tons each, which with the load carried by the tractor makes a total load of 21 tons.

The apatite is being shipped to the International Agricultural Corporation, Buffalo, N.Y., and to the Capelton Chemical Fertilizer Company, Buckingham Junction, Que.

The officers of the company are: president, Edward Smith, Prescott, Ont.; managing director, Frank E. Smith, Box 26, Perth, Ont.

### Talc

*Connolly.*—The Anglo-American Talc Corporation, Limited, operated the Connolly talc mine and mill near Madoc continuously during 1919 and employed 25 men. All the stoping was done between the first and second levels. No. 2 shaft

Gratalc mill and power house, Eldorado Mining and Milling Company.

was started 300 feet east of the main shaft. A new lead mill was installed in the mill for pulverizing the talc.

The officers are: H. S. Predmore, New York; secretary, H. J. Gilchrist, New York; superintendent, Thomas Carswell, Madoc.

*Eldorado.*—The Eldorado Mining and Milling Company, Limited, head office at 818 May Street South, Chicago, Ill., is operating the Eldorado talc mine, situated on lot 20, in the fifth concession, Madoc township.

The officers of the company are: S. J. Morand, president; J. J. Morand, secretary; Robt. Morand, treasurer; Charles Brent, manager; R. M. Phillips, superintendent. The Canadian office is at Eldorado, Ontario.

The ore body is an altered siliceous magnesian limestone, showing a width on the surface of over 200 feet.

The mine development consists of two shafts: No. 1, 153 feet deep; No. 2, 155 feet deep. Levels at 75 feet and 135 feet connect the two shafts. A cross-cut has been driven at the second level across the ore body, which shows a width of 90 feet, with ore in both headings.

Ore is hoisted from both shafts by steam hoists. A small Ingersoll-Rand steam-driven compressor supplies air for three drills. The mill is driven by a 100-h.p. Goldie and McCulloch, Wheelock condensing engine. The boiler plant includes one 60-h.p. and one 100-h.p. return tubular boiler.

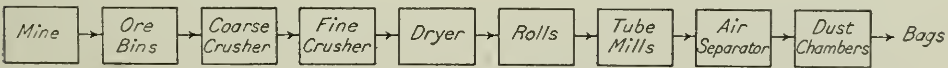
Rock is hoisted from the mine by a skip at No. 1 shaft and a cage at No. 2 and dumped into ore bins. From the bins it passes over a grizzly to a Champion jaw crusher. followed by a Sturtevant fine crusher. The ore then passes through a steam dryer and a pair of Sturtevant rolls to the tube-mill bins. It is ground

Talc mill, "white," Eldorado Mining and Milling Co.

in two 5-ft. by 22-in. tube mills and passes direct from the tubes to an air separator and down this to a series of dust chambers, beneath which are pointed bins, from which the products are drawn directly into bags. Four grades are turned out. The mill has a capacity of 100 tons per day. Products are sold to Canadian trades, but the greater part of the output is shipped to the United States.

A waterpower plant is being installed on the Moira river, which passes through the property within 200 feet of the mill. The plant comprises a concrete dam with stop-log sluice and flume; two 140-h.p. little giant turbines and the necessary transmission shafting, gears, etc., to carry power from the wheels direct to the mill.

A second mill, to grind "gratalc," a special product obtained from a large deposit of dark grey talc lying east of the white deposit, is being erected in connection with the powerhouse. This mill will be driven direct from one of the turbines.




Flow sheet, Eldorado talc mill.

*George H. Gillespie and Co.*—The talc mill at Madoc was in continuous operation in 1919 treating the talc from the Henderson mine, and gave employment to 17 men.

An additional unit was added during the year, including two 8-foot tube mills with the necessary equipment.

George H. Gillespie is manager and T. Ashley, superintendent.

*Henderson.*—The talc mine of the Henderson Mines, Limited, at Madoc, operated continuously during the year 1919 with a force of six men. The talc was produced from between the third and fourth levels and was hauled to the George H. Gillespie and Company's mill at Madoc station. A small amount of drifting was done.

The officers of the company are: president, M. H. Ludwig, Toronto; secretary, George H. Gillespie, Madoc; superintendent, Richard Rayner, Madoc.

## V.—QUARRIES, CLAY AND GRAVEL PITS

### Granite

*Washago.*—The granite quarry at Washago in Rama township, Ontario county, is owned by Granite Crushed and Dimension, Limited. The head office is at 88 St. David Street, Toronto.

This quarry was worked for six weeks in the summer by Robert Theodore, of Gravenhurst. Crushed rock was supplied on a contract to J. H. McKnight Construction Company, Limited, of Toronto.

### Limestone

*Beachville White Lime Company.*—The limestone quarry of this company at Beachville operated throughout the year 1919.

The face of the pit varies in height from 32 to 42 feet. The shipments amounted to about 320,000 tons of stone and 4,300 tons of lump lime. The greater part of the limestone was shipped to the blast furnaces at Hamilton to be used as a flux, and the remainder to sugar refineries and to the American Cyanamid Company, at Niagara Falls.

If the rock is to be shipped, it is loaded directly into railway cars from the quarry by two derricks; if it is to be calcined, a third derrick carries the stone to the kilns for the manufacture of lime.

A second quarry was opened a short distance to the west.

The officers of the company are: M. S. Shell, president; J. W. Blow, secretary-treasurer; C. E. Downing, manager; about 42 men were employed during the year.

*Britnell and Company, Limited.*—The quarry at Burnt River, Ont., operated by this company, was reopened in the spring of 1919 after having been closed for about two years. A new plant was procured and crushing and shipping were commenced about August 1.

The part of the quarry which is being worked is 500 feet long and has a face of 13 feet of limestone. The rock is hauled by tram cars and horses to a derrick which lifts it to a No. 6 crusher, from which it is elevated to a screen. The oversize passes to a No. 3 crusher. The crushed rock from both crushers is elevated above the storage bins, where it is screened, and distributed in three bins according to size. The railway cars are run under the bins for loading. The grades are 2-inch, 1-inch, ½-inch, ⅜-inch, and dust.

A 160-h.p. boiler furnishes steam to the 150-h.p. engine which drives the crushing and screening plant. The derrick hoist is also fed from this boiler. Two steam rock drills are run by a 10-h.p. vertical boiler.

The average daily shipment from August 1, 1919, amounted to about 200 tons of crushed rock. An average of 18 men was employed.

The officers of the company are: William Britnell, president; Edward Britnell, general manager; Miss Agnes Britnell, secretary-treasurer. The head office of the company is at the rear of the new C. P. R. Station, North Toronto.

*Canada Cement Company, Limited, Plant No. 8.*—The Port Colborne plant of this company resumed operations on February 1, 1920. Since that date two electrically driven well drills and two steam shovels have been used in the quarry.

In September, 1919, construction work began on a leaching plant to recover the potash from the kiln gases.

S. R. Preston is superintendent and John Cuthbert assistant superintendent.

*Canada Cement Company Plant No. 5.*—The Canada Cement Company, Limited, worked the limestone quarry at Plant No. 5, Point Anne, Ont., during all of 1919. All the stone quarried is used in the local plant for the manufacture of cement. Another 20-foot bench is being removed and the pit is now from 65 to 80 feet deep. Twenty-five men are employed in the quarry, which is in charge of foreman Stuart Long.

H. L. Shock was superintendent at this plant until August, when he was succeeded by Albert A. Huck. The post office address for the plant is Belleville, Ont.

*Canada Lime Company.*—The quarry at Coboconk was operated from April 1st to the end of the year. The face of the quarry is 20 feet in height, and drilling is done by a steam drill and a well drill driven by a gasoline engine. The rock is raised to the kilns by a steam derrick. Two kilns are in operation and lump lime only is produced. They employed 16 men.

C. R. Christie is president and A. S. Pearce, superintendent.

*Canada Crushed Stone Corporation, Limited.*—The limestone quarry at Dundas was worked by the above company continuously during the year 1919.

The quarry is now worked in three benches with a total face of 98 feet—the upper bench 38 feet; the middle 35 feet; and the lower 25 feet. Limestone for flux, sold to the blast furnaces at Hamilton, is taken only from the upper level. The two lower levels supply the material for the crushed rock, which is marketed in sizes from 4 inches to ⅜ inch.

The capacity of the plant has been increased and reached a maximum daily output of 4,700 tons of crushed stone during the month of September. The total output for the year was about 386,000 tons. Work was also commenced on the construction of a new screening plant and belt conveyors. The crushed stone will be conveyed to a stock-pile from which it will be elevated to the screens and loading bins.

In the quarry are two steam shovels, seven electric drills and five locomotives. Preparations have been made for considerably increasing the production by purchasing an additional steam shovel, drills and locomotives.

An average of 125 men was employed during the year 1919.

C. M. Doolittle is president and general manager; J. B. Hart, secretary-treasurer and assistant manager; George Gruht, superintendent.

*Christie Henderson Company.*—The Christie Henderson Company at Kelso, about five miles west of Milton, worked continuously during 1919 and kept two kilns in operation. The quarry is 400 feet long and has a face of 65 feet. Eighteen men are employed.

W. P. Gamble is manager.

*Coldwater.*—A quarter of a mile south of Coldwater Junction, in lots 19 and 20, concession XII, Medonte township, is a limestone quarry which has been worked continuously since 1912. It was opened by the Peters Coal Company, but is now being worked by George Higginson and Son, Coldwater, Ont. Crushed limestone is produced.

The machinery consists of a No. 5 Gates gyratory crusher, a bucket elevator, a 30-h.p. motor and a Cyclone drill.

When inspected in October eight men were employed. Fred Higginson, Coldwater, is superintendent.

*Crookston.*—Quinlan and Robertson, Limited, worked the limestone quarry at Crookston, Ont., during the summer of 1919. It is situated in lot 10, concession IX, Huntingdon township, and is served by both the Canadian Pacific and Grand Trunk railways. This quarry has been worked for many years and at present the working face is 28 feet high. Only crushed rock was shipped in 1919.

William E. Tummon, Crookston, Ont., is superintendent and had 16 men employed when the last inspection was made. The head office of the company is in Montreal.

*Crushed Stone Company, Limited.*—The limestone quarry of this company, near Kirkfield in Victoria county, operated continuously during the year. The crushing plant and quarry are on adjacent lots in the township of Elgin, the plant being on lot 49, North Portage road, in the ninth concession, and the quarry on the east half of lot 32, in the eighth concession, and are served by the Trent Canal and the Grand Trunk railway.

The quarry has a face of 16 feet and is 800 feet long. A 20-ton steam shovel is used for stripping, and drilling is done by a 4⅝-in. well drill. The rock is loaded by a 100-ton steam shovel with a 5-yard bucket into side-dump cars, which are hauled to the crushing plant by two dinky engines. The cars are hauled up the incline to the crusher by a 25-h.p. electric hoist. The rock is crushed to 4 in. and is then screened to remove all material over 2 in. A small part of this oversize is shipped direct and the remainder is crushed and screened into five grades: 2-in., $1\frac{1}{2}$-in., 1-in., $\frac{3}{8}$-in., and $\frac{1}{4}$-in. grit. The different grades are conveyed to five bins which have a total capacity of 450 tons. The rock is loaded directly into cars, and the grit passes through a dryer and is ground by three sets of rolls to a dust which is used for asphalt paving. The average output of limestone dust is about 30 tons per day. A locomotive crane engine is used for shunting cars and handling crushed rock from stock piles.

The steam plant has recently been replaced by one electrically driven. This plant consists of a transformer house with three 75-k.w. transformers, 12,000 volts primary and 600 volts secondary. Ten electric motors, ranging in size from 5 h.p. to 60 h.p., supply the crushing and screening plant.

During the year 75,000 tons of crushed rock were shipped.

The officers of the company are: Mrs. W. H. Esler, president; G. W. Esler, manager and secretary; W. T. McRae, superintendent. The head office is at 47 Yonge St. Arcade, Toronto.

*Foster and Cram.*—In concession II of Ottawa front, Nepean township, Foster and Cram opened a new limestone quarry in 1919. It lies on the west side of the Merivale road and is but a short distance south of the quarry of the Rideau Canal Supply Company, Limited. Only crushed rock is produced. The machinery consists of: a 15-horsepower vertical boiler which supplies steam for drilling, a 20-inch by 18-inch Sawyer-Massey crusher, a 50-horsepower motor, a rotary screen and a bucket elevator. Robert R. Foster, 99 Irving Street, Ottawa, is manager, and J. N. Connell, foreman.

*Hambleton.*—The Hambleton limestone quarry east of the village of Hagersville is now owned by the Hagersville Crushed Stone Company, of which Robert Hambleton, Hagersville, Ont., is president and manager. It is situated in the southwest half of lot 28, concession I, "east range, plank road," township of Oneida. The excavation now extends over three acres, and most of it is 26 feet deep. One 14-foot layer has been completely and a 12-foot layer partially removed.

The machinery consist of three gyratory crushers—a No. 4 and a No. 8 Austin and a No. 5 Gates—a trommel, two 75-h.p. motors and a belt-driven hoisting engine.

This quarry was worked for a short time in 1919. The output consisted entirely of crushed rock.

*E. Harvey and Son.*—The quarry of this company at Rockwood was in operation for nine months during the year 1919. The face of the quarry is about 30 feet. There are two kilns, but only one was in operation during the year and produced about 2,500 tons of lime. Twelve men are employed.

E. Harvey is owner and T. Hanna, manager.

*Ingles.*—The Ingles limestone quarry near Hagersville is situated in lot 14, concession XIII, Walpole township, and is owned by the Hagersville Contracting Company, Limited. The plant consists of three gyratory crushers—a No. $7\frac{1}{2}$ and a No. 3 Gates and a No. 5 Austin, two trommels, and a 150-h.p. Jenckes return tubular boiler. Hydro-electric power is now used.

This quarry was worked from June, 1919, to January, 1920, the output consisting entirely of crushed rock. John Stephens, Hagersville, Ont., is superintendent.

*The Longford Quarry Company, Limited.*—The quarry of this company situated near Longford, Ont., in the east part of lots 20, 21, 22, 23 and 24, Front concession, Rama township, was worked on a small scale during the summer of 1919. Building, dimension and monumental stone was produced.

The officers of the company are: president, William Thomson, Orillia, Ont.; vice-president, E. C. Wainwright, Huntsville, Ont.; secretary-treasurer, Allan McPherson, Longford, Ont.; directors, the above mentioned and John Adams, Longford, Ont., Andrew Craig, North Bay, Ont., and Mrs. Alma Wainwright, Huntsville, Ont.

*Michigan Central.*—The Michigan Central Railroad quarry west of Hagersville, Ont., in lot 13, concession XIII, Walpole township, has been described in previous reports of the Bureau. The quarry was opened for the season in April and work was continued until January, 1920. Most of the output consisted of crushed rock for track surfacing. Dennis E. Cronin, Hagersville, Ont., is superintendent.

*Midland Iron and Steel Company, Limited.*—This company worked a limestone quarry near Longford, Ont., in the east part of lots 26 and 27, Front concession, Rama township, from October, 1918, to August, 1919. The product was used for flux in the Midland blast furnaces. About 35 men were employed under the supervision of Thomas Morgan.

*Point Anne.*—Crushed limestone was produced during all of 1919 at the quarry of Point Anne Quarries, Limited, Point Anne, Ont., and from 50 to 75 men were employed.

The officers of the company are: president, M. J. Haney; secretary-treasurer, A. M. Harnwell; manager, J. F. M. Stewart: all of Toronto; superintendent, A. G. Bennett, Point Anne, Ont. The head office is in the McKinnon Building, Toronto.

*Queenston.*—The limestone quarry near St. David in Niagara township was worked throughout the year by the Queenston Quarry Company, Limited, and produced both crushed stone and building stone. The crushed stone shipped during the year amounted to about 20,000 tons, in sizes 3-in., 2-in., 1-in., and ½-in., and was used for building purposes, roads and a small amount for flux. The building stone includes dimension blocks, bases and cut stone. The cut stone is shaped by two gang saws and one diamond saw. An average of 40 men was employed.

Charles Lowrey is president and manager and G. W. McKeown, secretary.

*Rideau Canal Supply Company, Limited.*—The Rideau Canal Supply Company, Limited, continued to work their limestone quarry on the Merivale road in concession II, Ottawa front, Nepean township, near the city of Ottawa. Crushed rock only was produced in 1919. The machinery consists of: a Climax crusher, 26 inches by 14 inches; a bucket elevator: a trommel; a 75-horsepower motor and two small vertical steam boilers for drilling. Gilbert Julien, Canal Basin, Ottawa, is manager, and Thomas Holmes is quarry foreman.

*D. Robertson and Company, Ltd.*—This company operated its limestone quarry near Milton throughout the year 1919. The production during the year consisted of 7,125 tons of lime and 240 cords of rubble stone; twenty-two men were employed. D. Robertson, Milton, is manager.

*H. Robillard and Son.*—H. Robillard and Son are working in conjunction with Laurentian Stone Company, Limited, a large limestone quarry in lot 22, concession I, township of Gloucester. This quarry is about two miles east of Ottawa on the south side of the Montreal road. Crushed, building and dimension stone are produced and two lime kilns are kept burning when market conditions warrant. The machinery includes a gasoline engine, a crusher, a trommel and a 10-horsepower vertical boiler for drilling. Bruno E. Robillard, 195 Nicholas Street, Ottawa, is manager.

*Standard White Lime Company, Limited.*—This company, with headquarters at Guelph, operates limestone quarries and lime kilns at Beachville, St. Marys and Guelph.

At Beachville, where the largest plant is situated, the company has two quarries, one of which supplies limestone for burning and the other rock for use at blast furnaces, sugar refineries and the American Cyanamid Company's factory at Niagara Falls. The face of the latter quarry was formerly about 20 feet high, but during the year another bench of 22 feet was started, making the greatest depth now 42 feet. Loading is done by steam derricks. Sixty men are employed in these quarries.

The Guelph quarry was worked all year and both lump and hydrated lime were produced. The force consisted of 10 men.

The St. Marys quarry was worked for six months, all work being done by hand with a force of six men. One kiln only was used and produced lump lime.

The officers of the company are: D. D. Kennedy, president; J. Kennedy, manager.

*St. Marys Cement, Limited.*—The St. Marys quarry was operated continuously during the year 1919.

The new crushing plant and conveyor were put into operation and an additional 85-ton steam shovel with a 2½-yard bucket and a 6-ton gasoline locomotive were added to the quarry equipment. The broken limestone is loaded by steam shovels into cars, hauled by the gasoline locomotive to the foot of an incline and then raised to the crusher.

The material from the clay pit is loaded into cars by a shovel operated by an electric motor.

During the year 80,000 tons of clay were excavated and 150,000 tons of rock quarried.

Work was commenced on a new office and laboratory building; this will be a three-storey building, 100 feet by 50 feet, of steel and concrete. The testing laboratory will be on two floors, each 50 feet by 50 feet, and will also contain a fully equipped first-aid room.

Twenty-five men are employed in the quarry.

The officers of the company are: Geo. H. Gooderham, president; Mark Irish, secretary; J. G. Lind, manager.

*Toronto Plaster Company, Limited.*—This company operated at Teeswater from March 1 to the end of the year.

The quarry has a face of 38 feet and is worked in benches, the rock being hoisted up the incline to the plant. Three kilns were in operation, each with a daily capacity of 8 tons. The production during the year amounted to 4,900 tons of hydrated lime and a small amount of lump lime for the local trade. Eighteen men were employed.

The officers of the company are: president, John Kennedy, Guelph; vice-president, H. W. Calkins, Toronto; secretary-treasurer, D. E. Kennedy, Teeswater.

*Toronto Lime Company.*—The plant of this company at Dolly Varden was in operation for six months in 1919. The quarry has a face of 38 feet. Only one kiln was operated during the year. Twelve men were employed.

W. Gowdy, Limehouse, is manager. The head office of the company is at 26 Queen Street East, Toronto.

*Uhthoff.*—A limestone quarry at Uhthoff, Ont., near the C. P. R. station, has been worked continuously since 1912 for crushed rock. It is owned by the Ontario Stone Corporation, Limited, whose head office is at 611 Excelsior Life Building, Toronto, and lies in lot 10, concession four, North Orillia township.

The plant consists of: a No. 6 Kennedy gyratory crusher driven by a 75-h.p. motor; a Canadian Ingersoll-Rand 12-inch by 12-inch compressor driven by a 75-h.p. motor; a 16-foot trommel driven by a 10-h.p. motor; and the necessary conveying belts. In addition to the conveyors for stock-piling the crushed limestone, a conveying belt driven by a 26-h.p. motor leads through a concrete tunnel below the stock-piles and delivers the rock to an inclined belt which loads the railway cars.

The head office of the company is at 611 Excelsior Life Building, Toronto. W. A. McCaffrey, of Toronto, is president, and George F. Morse, Uhthoff, Ont., is superintendent.

*Wentworth Quarry.*—The crushing plant of the Wentworth Quarry Company, Limited, at Vinemount, was operated from April 15, 1919, to the end of the year.

This limestone quarry has a face of 17 feet from which the rock is loaded into cars by a No. 2 Marion steam shovel with a 1½-yd. dipper. The cars are taken up an incline to the crushing plant, which consists of 2 crushers, a set of rolls and screens. A gas-producing plant supplies the 115-h.p. engine which furnishes power for the mill. The shipments during the year amounted to 69,000 tons. Sixteen men were employed.

The officers of the company are: William Martin, president; James Thompson, secretary; S. Schwendeman, manager, Vinemount.

## Quartz

The quartz quarries of the Dominion Mines and Quarries, Limited, on East Neebish Island, of the McPhail and Wright Construction Company, Limited, at Bellevue, Ont., and of Electro-Metals, Limited, near Killarney, Ont., were all idle in 1919.

## Trap

*Bruce Mines Quarry.*—Bruce Mines Trap Rock Company, Limited, worked the trap rock quarry at Bruce Mines, Ont., during the summer and employed 55 men.

The officers of the company are: president, W. S. Edwards. Sault Ste. Marie, Mich.; secretary, Perry E. Wurst, Tabor Pump Co., Buffalo, N.Y.; directors, the above-mentioned and B. C. Tabor, Buffalo, N.Y., and W. B. Tabor, Alpena, Mich. Irvine Appleton of Bruce Mines was superintendent.

*Intercities Quarry.*—The trap quarry, situated between the cities of Port Arthur and Fort William, and owned by the Intercities Quarries Company, Limited, was worked for road metal for three months in the summer of 1919. It had been idle since 1914. The president of the company is J. F. Hewitson, Port Arthur; the secretary and manager is Wm. Colquhoun, Whelan Building, Port Arthur.

*Marrigan Quarry.*—The Marrigan trap quarry east of the city of Port Arthur on Barepoint near the shipyard was worked during 1919 by the contracting firm Chambers, McQuigge and McCaffrey Company, Limited, 612 Excelsior Life Building, Toronto. The trap is being used for fill in connection with the Port Arthur breakwater. W. C. Chambers, Port Arthur, Ont., was in charge of the work.

*Ontario Rock.*—The Ontario Rock Company operated its trap rock quarry near Havelock from April to December, 1919, and shipped 42,350 tons of trap. Thirty men were employed.

During 1920 the company expects to increase production, and with this end in view extensive additions are being made to the plant, which will be electrically operated.

The officers of the company are: president, Alex. Longwell, Toronto; vice-president and general manager, G. W. Rayner, Toronto; superintendent, S. Bradley, Preveneau, Ontario.

## Brick Plants

*Boyd Brick Company.*—The Boyd Brick Company, Limited, commenced the manufacturing of shale bricks near Milton in June, 1919. An 18-foot face of red shale is being worked. The plant has a capacity of about 20,000 bricks per day. Seven men are employed in the pit.

Robert Boyd, Milton Heights, is manager.

*Credit Forks Tile and Brick.*—The Credit Forks Tile and Brick Company, at the Forks of the Credit, commenced work in July, 1919, and closed in November. The company has two kilns with a daily capacity of 25,000 bricks. The pit has a face of 40 feet of red shale; 4 men are employed.

The officers of the company are: president and manager, J. H. McKnight; secretary-treasurer, W. E. Douglas, 88 St. Davids St., Toronto. S. H. Palmer is superintendent.

*Don Valley Brick Works.*—The Don Valley Brick Works at Toronto operated continuously throughout the year 1919. This is one of the largest brick manufacturing companies in the Province. The pit contains different grades of material, hence a number of varieties of brick are produced. The total height of the faces is about 200 feet. The lower stratum is Hudson shale, with a height of 65 feet; it is worked in benches of 8 feet and is taken up the incline to the plant. The second layer has 21 feet of sand, the third layer 65 feet of Erie clay, and the upper pit 25 feet of buff clay. Each of the different grades of material is worked as a separate pit. The production consists of red and buff bricks, grey stock and hollow-ware. Twenty-five men are employed in the pits.

The plant is operated by the Robert Davies Estate. John Bowman is manager and William Burgess superintendent.

*Hamilton Pressed Brick Company.*—The plant of this company at the head of Kensington Ave., Hamilton, was operated in 1919 from May to the end of the year.

The quarry, which has a face 25 feet high, contains red shale which is loaded by hand into tram-cars and taken to the plant. Four men were employed in the quarry. Ten kilns were in operation during 1919, the output being over 4,000,000 bricks.

The officers of the company are: Robert New, manager; Herbert New, secretary-treasurer. The head office is in the Spectator Building, Hamilton.

*Interprovincial Brick Company.*—The plant of this company at Cheltenham was in operation during the year. The face of the pit is 23 feet. The material is loaded into cars by an Erie steam shovel of ¾-yard capacity. Six kilns are operated and the total daily capacity of the plant is 40,000 bricks.

During the year 1919 the company purchased a steam shovel and erected one new kiln and coal-handling plant capable of holding 600 tons. Thirty-eight men are employed.

The officers of the company are: president, A. O. Dawson, Montreal; secretary, E. G. Glenn, Toronto; manager, F. B. McFairen; superintendent, K. Stillwaugh.

*Logan Brick.*—The Logan brick works on Greenwood Avenue, Toronto, operated from April 1 to the end of the year 1919.

The production for the year amounted to 4,500,000 red stock bricks.

Thomas Logan is manager, employing 26 men.

*Milton Pressed Brick Company.*—This company operated at Streetsville from March, 1919, to the end of the year. The face of the pit is 45 feet. Four kilns were in operation with a total capacity of 24,000 bricks per day. Four men are employed.

J. Behoo is superintendent.

*John Price, Limited.*—The plant of this company, on Greenwood Avenue, Toronto, was operated during the year 1919, the production amounting to 1,400,000 bricks. Five men are employed in the pit, which has a face of 45 feet.

George and Charles H. Price are managers.

*Price and Smith.*—In May, 1919, Price and Smith, Greenwood Ave., Toronto, commenced the manufacture of red brick; the production to the end of the year amounted to 4,000,000 bricks. The pit contains blue clay and is about 45 feet deep; four men are employed on it.

Price and Smith are owners and managers.

*Red Star Brick and Tile Company, Limited.*—This company operated at Stratford for five months during 1919, producing bricks and tiles. The tiles are made in sizes from 2½ inches to 10 inches in diameter. Six men were employed.

The plant is operated by W. H. Barnhardt.

*Standard Brick.*—The plant of the Standard Brick Company, Limited, on Greenwood Avenue, Toronto, was operated throughout the year 1919. The daily capacity of the plant is 23,000 red bricks.

The pit shows a face of 55 feet of blue clay. Four men are employed.

W. Hayes, 532 Greenwood Ave., is manager.

*Stratford Brick, Tile and Lumber Company, Limited.*—The plant of this company, at Stratford, was in operation for five months during 1919. The production consisted of about 300,000 wire-cut red bricks and a small quantity of drainage tile. The clay suitable for brick-making extends only to a depth of about three feet. Eight men are employed.

The plant is owned and operated by J. H. Killer and E. W. Killer.

*Sun Brick Company.*—The plant of this company in the Don Valley, near Toronto, was operated throughout the year. The pit is now being worked in three benches: the first and second are in clay with a face of about 10 feet each; the third bench, which was started during the year, is in shale and has a face of about 13 feet. The plant has a capacity of about 40,000 bricks per day. Thirteen men are employed in the pit.

Henry M. Pellatt is president and R. F. Wilson, manager.

*Toronto Brick Company.*—The plant of this company at Scarborough, Ont., resumed operations in March, 1919, after being closed down for two years. The sand is taken from the pit by a 1½-yard clam-shell bucket and placed in a bin from which the tram cars are loaded. It is then hauled by horses to the plant.

where it is made into sand-lime bricks. The capacity of the plant is 40,000 bricks per day. Three men are employed in the pit, which has a face 20 feet high. F. E. Watterman, Sun Life Building, Toronto, is manager.

The brickyard of this company at Swansea was operated during 1919. At the plant sand and lime bricks are manufactured, the lime being supplied from the company's kilns at Coboconk. The sand pit has a 50-ft. face and the material is loaded by a steam shovel with a ¾-yard bucket. The average output of the plant for the year was about 20,000 bricks per day.

J. D. Smith, Swansea, is superintendent, employing 25 men.

The limestone quarry at Coboconk was operated from about March 1 to the the end of the year. The face of the quarry is 18 feet in height. The kilns are charged by means of a steam derrick. Lump lime is produced and also powdered lime for the sand and lime brick plants of the company at York and Swansea. The lime for the brick plants is ground by rolls electrically driven. Two kilns were kept in operation and 6 men were employed.

C. M. Callan is superintendent.

*A. H. Wagstaff.*—The plant of A. H. Wagstaff, brick manufacturer, on Greenwood Avenue was operated for eight months in 1919, and turned out about 5,000,000 red bricks. Five men were employed.

A. H. Wagstaff is owner and manager.

*York Sandstone Brick.*—The plant of the York Sandstone Brick Company at East Toronto was operated from April 7 to the end of 1919. During the winter months the material is hauled by teams to the brick plant and in the summer months it is taken from the pit to the plant by a belt conveyor. After screening, the sand is used for the manufacture of sand-lime bricks. The face of the pit is 20 feet. The plant has a daily capacity of 46,000 bricks.

Thos. J. Smyth is secretary-treasurer and managing director.

## Sand and Gravel

*Armstrong Supply Company.*—The Armstrong Supply Company operated a gravel pit and washing plant at Burlington Heights during the year 1919. The plant has a daily capacity of 500 tons of sand and gravel in two grades, ¾-inch and 2-inch. A 15-ton shovel loads the material into cars which are elevated to the plant where the material is crushed, screened and washed. Power is supplied by two 75-h.p. and one 40-h.p. motor for the screening and washing plant. The face of the pit is 40 feet in height; 7 men are employed.

The officers of the company are: president, Chas. Armstrong; manager, C. K. Armstrong; secretary, Z. M. Armstrong, 324 Lister Chambers, Hamilton.

*Barton Sand and Gravel Company.*—The plant of the Barton Sand and Gravel Company at Bartonville near Hamilton was operated from May to December 1, 1919, the production of sand and gravel being 14,000 yards.

From the face of the pit, which is 46 feet high, the gravel is carried by a cable tram to the plant, where it is crushed and screened and the greater part of it washed.

The plant is driven by two 75-h.p. motors and one 40-h.p. motor, and has a capacity of 200 yards per day of washed sand and gravel of 2 grades, ¾-inch and 1½-inch. Five men are employed.

The officers of the company are: president, C. W. King; secretary-treasurer, Mildred Pickering, Bartonville, Ont.

*Joseph Bennet.*—Joseph Bennet's sand and gravel pit at Weston was operated during 1919. The machinery consists of one bucket loader driven by a gasoline engine and one motor-driven screen. Part of the material is screened and sold as sand, gravel and pea gravel, being delivered to building contractors by teams and motor trucks. The face of the pit is 10 feet high.

Jos. Bennet, 145 Caledonia Road, is owner and manager and employs four men.

*Benson and Patterson.*—The sand and gravel pits at Stamford were worked by Benson and Patterson during 1919. One pit has a face of about 50 feet and yields different grades of sand and gravel which are loaded directly into railway cars by a clam-shell bucket. Two other pits were also worked for moulding sand, which is also loaded into cars by bucket. The shipments during the year were about 12,000 yards of moulding sand and 13,000 yards of coarse sand and gravel. An average of 9 men was employed.

F. L. Benson and Robert Patterson are the owners.

*Ellins Sand and Gravel.*—The plant of the Ellins Sand and Gravel Company, at Lambton Mills, was operated continuously during the year. The material is loaded directly into trucks with a ¾-yd. clam-shell bucket and delivered to contractors in Toronto. Only a small amount of the material is screened. The face of the pit is about 20 feet high. Three men are employed in the pit. Wesley Ellins is manager.

*Forbear Sand and Gravel.*—The Forbear Sand and Gravel Company at Maple commenced operations in August, 1919, and during the year shipped about 200 cars of sand and gravel. The face of the pit is about 20 feet in height and the material is loaded into a bin with a McNyler one-yard clam-shell bucket. The railway cars are filled at the bin and the material shipped to Toronto and Hamilton. Six men are employed. Thos. E. Forbear is owner and manager.

*Hamilton Sand and Gravel Company.*—The Hamilton Sand and Gravel Company, at Burlington Heights, operated to full capacity during the greater part of the year. The gravel is obtained from a pit 35 feet deep and is loaded into cars by a shovel; it is then hauled up an incline to the plant, where it is crushed, screened and washed. The product is sold in two grades of sand, fine and coarse, and four grades of gravel, ½-inch to 1½-inch. The plant has a daily capacity of 200 yards. The total production for the year amounted to 22,350 yards, all of which was used in Hamilton for building purposes. Twelve men were employed.

The officers of the company are: president, Fred H. Yapp; secretary-treasurer, William Kerr, 110 Queen St. W., Hamilton; manager, E. S. Kerr.

*Hydro-Electric Commission.*—A pit was opened in January, 1919, by the Hydro-Electric Commission at Stamford to obtain sand and gravel for the concrete construction work on the Chippewan canal development. The material is delivered into a screening plant and elevated to a bin, from which it is loaded into cars. Four men were employed under the direction of D. Jackson.

*Maple Sand and Gravel Company.*—This company operated a gravel pit at Maple, Ont., continuously during the year 1919. The daily shipments averaged about 400 tons, the greater part of which is screened and sold in Toronto for building purposes. The gravel is handled by a 15-ton locomotive crane and is screened before loading into cars.

Thos. Cousins is manager, employing five men.

*Rocsand.*—The Rocsand Company, Limited, operated its gravel pit at Erin from May 1 to December 15, 1919, and employed an average of six men. The material is all run through the plant where it is crushed and screened to three sizes: sand, 1-inch gravel and 2-inch gravel. The pit is 20 feet deep.

The officers of the company are: president, H. M. Kittson; secretary-treasurer, C. J. Baby, 21 Sun Life Building, Hamilton; superintendent, W. J. Dickson.

*York Sand and Gravel Company, Limited.*—The production of this company at East Toronto during the year 1919 was 1,240,000 tons. A small amount of the material is shipped from the pit, but the greater part is screened and sold as screened sand and gravel. The face of the pit is 30 feet in height. Twelve men are employed.

The officers of the company are: president, Samuel Ryan; secretary-treasurer, Frank Ryan; manager, H. T. Conlin.

## VI.—SMELTING AND REFINING WORKS

### Blast Furnaces

*Algoma Steel Corporation.*—In 1919 the blast furnaces of the Algoma Steel Corporation at Sault Ste. Marie, Ont., ran as follows: No. 1 furnace ran until August 9 when it was closed down for relining; it was blown again on October 20. No. 2 ran throughout the year. No. 3 ran until January 20, when it was blown out; it was again put in blast on August 2. No. 4 furnace ran until June 4 and was idle for the remainder of the year.

The officers of the corporation are: president, W. C. Franz; vice-president, David Kyle; general superintendent, James D. Jones; blast furnace superintendent, James H. Bell: assistant blast furnace superintendent, James Dale; blast furnace foremen, John A. Murphy and Arthur Strand; secretary of the mines department, George S. Cowie: all of Sault Ste. Marie, Ont.

As at the present time all structural steel and shapes of more than 35 pounds per yard have to be imported into Canada, the corporation has decided to build a new combined rail and structural mill at Sault Ste. Marie, Ont. In this mill beams and channels up to 24 inches, as well as steel rails, will be rolled. In January, 1920, ground was being cleared for this plant, which will contain the following main units:

Two four-hole pit furnaces, with a capacity of 32 ingots each and arranged to use coke-oven gas either alone or in conjunction with blast furnace gas. These furnaces may also be fired with producer gas, if desired. A 7½-ton stiff-leg ingot-charging crane will take the ingots from the cars to the pits and from the pits to the ingot buggy.

A 40-inch blooming mill, driven by a 5,900-horsepower, 600-volt motor operating in conjunction with a fly-wheel motor generator set.

A 1,000-ton steam hydraulic shear with an electrically operated shear gauge.

Three Siemens bloom reheating furnaces with fuel arrangements as in the pit furnaces. These furnaces will be served with two charging cranes.

A 35-inch roughing mill driven by a 4,400-horsepower motor.

A 28-inch finishing mill driven by a 4,400-horsepower motor.

Two rail hot saws of drop type with 42-inch diameter blades and electric drive and feed, and one structural hot saw of sliding-frame type with 54-inch blade and electric drive and feed.

Hot beds with pull-on and pull-off machinery so connected by means of couplings that the beds may be divided into sections of various widths to suit the lengths of material being produced. A setting-up rig for beams and channels will be included.

A rail finishing department containing five rail straightening units, each consisting of a straightening press and two drills with skid beds. A cold saw, a redrilling unit and two 20-ton magnet cranes for loading rails will also be provided.

A structural finishing department containing two gag straightening machines, one 60-inch sliding-frame cold saw, a vertical angle shear with the necessary transfer and rolling tables. This department will be served by three cranes each with two 5-ton trolleys, one of 110 feet span and two of 80 feet span.

Miscellaneous equipment, including two 1,500 cubic feet air compressors, a 1,000-gallon hydraulic pump, new lathes and tools for roll shop, two 750 k.v.a. motor generator sets and a complete equipment of overhead cranes.

*Canadian Furnace Company, Limited.*—The blast furnace of the Canadian Furnace Company, Limited, at Port Colborne, was operated to capacity during the year 1919. The ores were obtained from the Lake Superior district and about 115,000 tons of malleable and foundry iron were produced. There were about 160 men employed.

The officers of the company are: Frank B. Baird, president; B. Marron, manager; F. E. Deschenes, superintendent; G. J. Higgins, mechanical superintendent.

*Midland Iron and Steel Company, Limited.*—The 125-ton furnace of the Midland Iron and Steel Company, Limited, at Midland, Ont., which had been in blast since October 9, 1918, was closed down on August 17, 1919. The ores smelted were from Michigan and Minnesota.

The officers of the company are: president and general manager, James Playfair, Midland, Ont.; vice-president, A. E. R. Schneider, Cleveland, O.; secretary. M. E. Tully, Midland; superintendent, E. Heist, Midland.

*Parry Sound Iron Company, Limited.*—The 67-ton blast furnace at Parry Sound, formerly owned by the Standard Iron Company, was started on January 2, 1919, by the Parry Sound Iron Company, Limited, and was blown out on September 26. The ore used was Michigan hematite. Sixty-five men were employed.

The officers of the company are: president, Col. J. A. Currie, Toronto; treasurer, C. G. Neeve, Parry Sound; secretary, F. H. Kilbourn, Owen Sound; directors, E. Hodson of Hamilton, H. P. Smith of Owen Sound and George S. Kilbourn of Owen Sound; superintendent, John J. Dunn.

*Standard Iron Company, Limited.*—The 6-ton blast furnace at Deseronto. Ont., owned by the Standard Iron Company, Limited, was blown out on June 9, 1919, and was idle for the remainder of the year.

The officers of the company are: president, R. J. Mercer, Montreal; secretary-treasurer, S. F. Belknap, Montreal; superintendent, O. O. Laudig, Deseronto. The head office is at 318-321 Coristine Building, Montreal.

*Steel Company of Canada, Limited.*—The Steel Company of Canada, Limited, have two blast furnaces at Hamilton, a 200-ton furnace known as "A," and a 400-ton furnace known as "B." "A" furnace was banked for a short time owing to shortage of coal; it has been in blast since March 1, 1917. "B" furnace was also operated with the exception of the period from May 1 to July 20, when it was being relined. There were 170,000 tons of pig iron produced in 1919 with a force of 175 to 200 men in the blast furnace department.

The officers of the company are: president, Robert T. Hobson; works superintendent, R. G. Wells; superintendent of blast furnaces, H G. Hilton.

*Tivani Electric Steel Company, Limited.*—The Tivani Electric Steel Company, Limited, which has a plant at Belleville, Ont., and has been making pig iron from steel turnings, stopped work in January, 1919.

W. M. Goodwin, of Kingston, Ont., rented the plant in March and ran one reducing furnace and a small steel-making furnace during April and May on titaniferous magnetites for experimental purposes.

## Refineries

*Coniagas Reduction Company.*—The refinery at Thorold was operated during the entire year on the reduction of silver ores from the Cobalt mines. The products of the refinery are silver, cobalt metal, cobalt oxide (black and grey). nickel oxide, nickel metal and refined white arsenic. During the latter part of the year preparations were made to manufacture copper sulphate, and this material is now being produced. About 150 men were employed.

The officers of the company are: R. W. Leonard, president; D. A. Mutch, superintendent; J. J. Mackan, secretary-treasurer. The head office is at St. Catharines.

*Deloro Smelter.*—The Deloro Mining and Smelting Company, Limited, treated about 500 tons of ore, concentrates and residues per month in 1919 at its plant at Deloro in Hastings county. After the close of the war a smaller quantity of steelite was produced. The machinery for the manufacture of steelite cutlery is nearly all assembled and will be started in 1920. Insecticides also will be manufactured before the end of 1920. About 300 men are now employed.

The officers are: president, M. J. O'Brien, Renfrew, Ont.; vice-president, J. Ambrose O'Brien, Ottawa; managing director, Thos. Southworth, Ottawa: general manager, S. B. Wright, Deloro, Ont.; consulting metallurgist, S. F. Kirkpatrick, Ottawa; general superintendent, R. A. Elliott, Deloro; secretary-treasurer, F. A. Bapty, Deloro.

*Metals Chemical, Limited.*—This company operated its refining plant at Welland throughout 1919, treating residues on hand, and producing nickel and cobalt oxides and various other compounds of these metals in addition to crude arsenic and a little silver. On April 1st, 1920, the plant was taken over by the Ontario Smelters and Refiners, Limited. Since that date many changes have been made in the plant and a new method of treatment introduced. This newly organized company also owns the Chippawa plant, formerly operated by the Standard Smelting and Refining Company.

*International Nickel Company.*—The refinery of this company at Port Colborne was in full operation during 1919 with a force of between 475 and 500 men. A complete description of this plant written by W. L. Wotherspoon, consulting engineer of the company, was published in the twenty-eighth Annual Report of the Bureau of Mines. The products of this refinery are nickel oxide, metallic silver and blister copper. Small quantities of gold, silver, platinum. palladium and other metals of the platinum group are recovered.

The resident officials are John Moore, general manager; J. T. Kemp, assistant manager; W. E. Murphy, works auditor, and W. P. Hall. purchasing agent.

# SECOND REPORT OF JOINT PEAT COMMITTEE

By

B. F. Haanel, Secretary

## Introduction

When the Peat Committee was appointed in the early spring of 1918, it was confidently expected that a mechanical demonstration of the two different types of peat machines, which the committee had given its engineer instructions to design, would be completed during the working season of that year. However, a short time after the contract for the construction of these machines had been awarded, it became apparent that in all probability the machines would not be completed in time to try them out before winter set in. The causes of the delays in the shop which prevented their delivery at the time specified were fully set forth in the first report of the Peat Committee for the year ending December 31, 1918.[1]

The season of 1919 was consequently begun with one plant (No. 2) which was of an altogether new and novel design, partly erected on the grading of the old Alfred railway siding, and the other plant (No. 1), loaded on cars held on the main line of the Canadian Pacific railway.

## Testing the Two Peat Machines

During the next six months the two plants were completely assembled, taken to their working faces and put in operation in order to discover weak points which it was anticipated would develop in machines of new design and incorporating many novel features which had not been tried out before. The only radical change in the design of Plant No. 1 or the Anrep plant was the mounting of this machine on caterpillars, consequently, but little trouble was expected with it, and the committee had every reason to expect that as soon as this machine was moved to its working face, the operation of manufacturing peat fuel could be begun immediately.

Difficulties of a serious nature were, however, disclosed in the driving mechanism of the caterpillars when the plant was moved under its own power from the railway siding to its working face, a distance of some 2,000 feet over the bog, which at that time was partially covered with water. After it had been placed in position for operating, a thorough inspection of the caterpillars disclosed the seat of the trouble, and since this mechanism of the two machines is identical, arrangements were immediately made to alter the design. It is necessary here to point out that very serious trouble was also experienced with the field spreader and track layout system for transporting the pulped material to the drying field.

[1] Rep. Ont. Bur. Min., Vol. XXVIII, 1919, Part I, pp. 187-192.

The designs for these were obtained from Sweden, and moreover were strictly adhered to, inasmuch as this method for spreading the pulped peat is an integral part of the Anrep plant. In making the necessary alterations to overcome this trouble several weeks were consumed, and it was, therefore, not until some time in June that an attempt could be made to manufacture peat fuel at anything approximating a normal rate.

Inasmuch as a machine of this type had been employed before, and the Peat Committee were desirous of obtaining as large an output of manufactured peat as possible during the working season, the larger part of the time of the engineer and his staff was devoted to this plant.

Plant No. 2, was an entirely new departure in peat machinery design, and it was, therefore, not expected that it could be successfully operated before a great deal of experimentation entailing many alterations had been conducted, but the difficulties which were discovered were not of a serious character, and if the machine had been placed in a more favourable position on the bog, it could have been got into condition for manufacturing peat fuel before the end of the season. As stated above, the driving mechanism for the caterpillars on both machines was strengthened, and later on in the season a differential drive was installed on both. With these alterations the caterpillars worked perfectly.

Plant No. 1 (Anrep plant) was put in operation on the old working face situated on that part of the bog which has been well drained for some years. Moreover, this portion of the bog was in excellent condition, owing to the manufacturing operations which had been conducted during past years. No difficulty, therefore, was encountered from holes, soft spots or the sinking of the machine in the bog, as was the case with Plant No. 2 (Moore plant) which had to be operated on an undrained portion of the bog parallel to the C. P. Ry. tracks over a distance of about a mile. This portion of the bog was not only undrained, but had been previously burned, leaving soft spots and holes, some of which it was necessary to fill as the work proceeded. Plant No. 1 had also a well-prepared working face and could, therefore, begin manufacturing operations at once, while in the case of Plant No. 2 it was necessary to construct a working face before peat fuel could be made. This plant was therefore employed during the time it operated in excavating a working face.

A certain amount of peat fuel was manufactured with Plant No. 2 during the time it was employed on this work, but the machine was not operated for this purpose, but for observing difficulties and in remedying the same. The principal feature in the design of this machine is the arrangement for replacing the ordinary track system, cars, cable ways, etc., which are absolutely necessary for transporting the pulped peat and spreading it on the drying field when the Anrep system is employed. With the Moore system this is effected by means of a bridge about 150 feet long attached at right angles to the peat machine. This bridge is equipped with a belt conveyor, and a spreader which is attached to the bridge and travels in a direction parallel to that of the peat machine. Inasmuch as this system for spreading peat has never before been tried on any machine, it was naturally found upon trial that certain alterations were necessary before it would operate satisfactorily. For example, it was found on trial that the bridge work was hung so low that sufficient clearance between the bottom of the bridge and the top of the bog could not be obtained. This, with a few minor alterations to the spreader, constituted the principal changes which had to be made. If, however, the machine had been tried out on a more solid portion of the bog, the bridge work might have worked satisfactorily without any alterations. Notwithstanding the difficulties under which this plant was operated, about 800 tons of peat fuel were manufactured during the period of its mechanical try-out.

Plant No. 1 manufactured over 2,000 tons of peat fuel, and its capacity per day increased steadily up to the time operations were discontinued. With the information which the Peat Committee has at hand for this season's mechanical try-out and operations, they have every reason to expect an average output of six tons per hour for each machine during a normal season. This output it is expected will be exceeded with Plant No. 2; six tons per hour, however, is looked upon as a conservative average hourly production.

Sufficient data concerning mechanical difficulties and weak points in the design of both machines were obtained to enable the Peat Committee to put the machines in first class working order for the season of 1920.

## Boiler Difficulties

The Peat Committee encountered a great deal of difficulty in purchasing boilers for the two plants; in fact, the great demand for materials of all kinds for war work made the construction of these two peat plants not only difficult but very costly. It was originally intended to install water tube boilers for burning peat fuel, since such boilers for the same capacity are much lighter and more compact than the locomotive type of boiler, but it was found to be absolutely impossible to obtain boilers of the former type, and the committee was, therefore, forced to install coal-burning locomotive boilers in order to permit the operation of the plants during this season. Attempts were made to burn peat in these boilers, but these were not successful owing mainly to the grate area and combustion chamber being too small.

Arrangements have now been made for installing water tube boilers suitable for the burning of peat fuel, so that when the season of 1920 begins, power for operating the peat machines will be derived from this fuel.

## Offices; Light Railway; Harvesting

A two-story frame building was erected in a convenient position with regard to the two peat machines, and the other parts of the field. The upper story of this building is used as an office for the engineer and his staff, and the lower part is used for storage and as a repair shop. This office is connected with the main line of the Bell Telephone company, and with the peat machines and other parts of the field by means of a field telephone system. This telephone installation has been the means of saving much time.

Approximately two miles of narrow gauge tracks with sidings and the necessary switches were constructed, and a loading trestle erected adjacent to the C. P. R. siding. Later on in the season it was found necessary to erect also a storage trestle.

The harvesting equipment consists of a gasoline locomotive and sixteen narrow gauge trucks. Provision is now being made to obtain another train of harvesting cars. This will enable the full output of both plants working day and night to be handled conveniently and without loss of time.

Attention should be directed to the fact that this is the first time, in any of the attempts to manufacture peat fuel, that a standard harvesting and loading equipment has been installed; thus the manufacture of peat fuel can now be performed more efficiently and at less cost than ever before.

### The Drying of Peat Fuel

In all previous efforts which have been made in Canada to make peat fuel, little or no attention has been paid to the drying of peat on the field. This is one of the most important phases of the process, since the quality of the fuel very largely depends on its removal from the drying field at the proper time. With a view to obtaining such information as would best assist those desirous of engaging in the manufacture of peat fuel, the Peat Committee deemed it a duty to conduct an investigation concerning problems connected with the drying of the fuel—for example, the rate at which it dries during the summer months, the logical time for harvesting and shipping it, and the proper time for beginning and terminating operations.

With the permission of the Mines Branch of the Department of Mines, the services of H. A. Leverin were obtained for conducting this investigation. Mr. Leverin spent a considerable portion of the summer months on the bog systematically sampling the peat fuel in order to ascertain its moisture content from time to time as the drying proceeded, and to determine the rate of evaporation and other factors necessary to enable him to make a complete report regarding this phase of the manufacture. The necessary meteorological instruments were installed to enable daily observations to be made of the rainfall, humidity, barometric pressure and temperature.

This report will be included in the final report of the Peat Committee, since this investigation has not yet been carried to completion.

### Operation of Plant No. 1

Plant No. 1 was operated intermittently from June 6th until September. In June peat was manufactured for a period of 74½ hours, during which time 32½ rows or 357 tons of 25 per cent. moisture peat fuel were laid down; in July 104 hours produced 53 rows or 583 tons; in August 110½ hours produced 62½ rows or 687 tons, and during the first part of September the plant operated 44 hours and produced 25½ rows or 280 tons. From these figures it will be seen that the capacity of this plant was in June 4.8 tons per hour, in July 5.6 tons per hour, in August 6.2 tons per hour and in September 6.4 tons per hour.

In June it took an average of 2¼ hours to lay one row of peat, in July 1 hour and 50 minutes, in August and September 1 hour and 45 minutes, which shows that this machine was approaching its average normal capacity per hour as the season advanced and the men became better acquainted with their work. The above figures are based on the assumption that a row of peat will yield eleven tons of 25 per cent. moisture peat fuel. This figure was verified as the minimum figure from the weights of peat fuel which were taken from the field during the harvesting operations. The average capacity of the harvesting cars is over 3,000 pounds of fuel per car, and five rows yield about 38 cars or 57 tons. Plant No. 1 actually excavated 437,000 cubic feet of raw material which should yield 11 pounds of fuel per cubic foot. The total quantity of peat excavated should therefore total 2,400 tons, and this should represent the season's output, but according to the above figures the season's output was only 1,900 tons. The difference between these two quantities can only be accounted for by the peat left on the ground, the raw material washed back into the cut, and the lower yield per cubic foot from the top six to 12 inches of the bog. The figures given here are therefore conservative as regards the capacity of the machines during the hours they actually manufactured peat fuel.

## Operation of Plant No. 2

During the entire season which was spent in experimentation and alterations, nine rows of peat fuel were laid down, the first two amounting to very little, the third at about half the capacity of the machine, and the balance at approximately full capacity. One hundred and sixty thousand cubic feet of raw peat were excavated from the working trench, which had an average depth of five feet at the end of the season. This quantity of raw material represents a production of about 800 to 900 tons, but on account of the deep moss covering the top layers of the bog which was included in the total excavation, probably not over 600 to 700 tons were made, and this was laid down so late that only a small portion could be sufficiently dried for fuel purposes.

Number 2 drying field was practically undrained, and therefore was very wet. Drying therefore did not take place as rapidly as it will in the season of 1920, when this field will have had the benefit of the drainage produced by the excavation of its working face.

Excellent fuel, however was made with this machine, which was operated with a maximum of six men, and when it approached its normal capacity it produced an equivalent of six to seven tons per hour. No positive data could be obtained regarding its maximum capacity, since the working face never reached its normal condition.

This plant is now in first-class working order, and no trouble of a serious nature due to mechanical defects is expected when it begins operations again.

## Cost of Turning and Cubing Peat

With Plant No. 1, 170 rows of peat fuel were manufactured. Of these 168 rows were turned by contract at $1.80 per row, and 58 rows were cubed at the same price; the other rows, 59 to 70, were cubed at $2.00 per row, and the balance in an effort to hasten drying before the frost, was cubed prematurely by day labour during the time the men were idle while alterations were being made. The peat up to about row 85 was harvested, and the balance left in the field, rows 85 to 140 being in cubes. It may be necessary here to explain that in manufacturing peat fuel by the air dried machine process, the peat spread on the ground is allowed to dry until the peat blocks are strong enough to stand handling, when they are turned to permit the reverse side of the block to dry. After drying has proceeded to a certain point which is determined by experience, these peat blocks are piled up in open stacks to complete the drying.

The production cost of the fuel is indicated in the sheet showing operating costs, but while these costs are estimated only on the time during which the plants actually manufactured peat fuel, it is satisfactory to observe that of the $3,050.77 shown, not over two-thirds or $2,000 can be charged to the manufacture of the 1,900 tons of fuel mentioned above. The remaining third of the time the men were idle while repairs or changes were being made, of which no detailed account was taken in the distribution of the time of the men.

With regard to the item for turning and cubing, the figure "$503.21 straight time" (Table No. XI), produced only 770 tons of cubed peat, which would show a cost of 62 3/10 cents per ton for cubing by adults as straight time, but it must be borne in mind that this peat was still very wet, nearly three times its normal weight being handled, and cubing under these conditions would never have been resorted to if it had not been deemed necessary to make every effort to get as much fuel as possible dried out before the frost. The actual contract basis in 1919 was $1.80 per row for turning, and $1.80 per row for cubing. This latter figure towards the end of the season was raised to $2.00 per row. At this figure the maximum cost of turning and cubing a row or 11 tons amounts to 35 cents per ton. It is the opinion of the engineer in charge of operations that it will not be necessary to cube peat fuel manufactured prior to August, and if this is borne out in practice next season it will mean a considerable saving.

## Repairs

The $672.72 expended in repairs (Table No. XI), represents mainly the cost of renewing the grips on the spreader cars, also splicing the cable, which operation had to be performed many times before a new cable could be obtained. This cable was purchased according to the Swedish specifications, but proved to be too small for the grips on the cars, consequently both the grips and the cable underwent excessive wear. One man and sometimes two men had to be kept at this work continually in order to keep the plant running, but after the new cable was installed only one man was necessary to look after the cars and the cable, and even he had very little to do. It is hoped that with the new cars which will be purchased there will be one spare car all the time. This will permit any repairs to the cars to be made by the general repair man, which will very materially reduce the expenditure mentioned above.

## Fuel

The item for fuel and supplies cannot be accurately distributed, since steam was kept up practically all the time on both plants, while the plants themselves were actually manufacturing fuel for a comparatively short period. Only a portion, therefore, of the fuel cost can be charged to the manufacturing of peat fuel. The installation in 1920 of boilers on both plants suitable for the burning of peat will very greatly reduce the fuel cost just cited. It is estimated that with these new boilers peat fuel will be burned at a rate of about three tons per ten hours for each machine, or six tons in ten hours for the two machines.

## Summary of Work During 1919

The two types of plants were assembled and moved to the respective portions of the peat bog where it was intended they should operate. Both machines were given a severe mechanical try-out covering a period of several months. The minor defects in the design and mechanical weaknesses which were disclosed as the test progressed were rectified on the field, and those which were of a more serious character and which required more attention were performed at the close of the season.

No fundamental mistakes in the design of either plant, with the exception of the track lay-out system and spreader for Plant No. 1, for which the committee was in no way responsible, were disclosed. It was found necessary to make only minor alterations, and to strengthen certain parts at the end of the season. The area of the caterpillars of both machines was increased, which will permit these machines to travel over a comparatively soft bog without inconvenience. A novel departure in peat machinery design, namely, the employment of caterpillars on which the machines are mounted, proved a great success and during a season's operations when peat fuel will be manufactured continuously, a very great saving in time and money will result from their introduction.

Mistakes inherent in the spreading system of Plant No. 1 will have been corrected by the time operations commence in the season of 1920.

Plant No. 2 had a sufficient mechanical try-out to determine its weaknesses, and all these will be remedied by the beginning of the 1920 season, so that it is expected both plants will be operated at full capacity during the coming season for two ten-hour shifts. If this hope is realized production next year will be on a large scale.

A large amount of experience has been gained in the harvesting of the manufactured fuel and its loading on to cars, and a material reduction in the cost of transportation of the fuel from the field to the cars has been realized. The Peat

Committee, in addition to the work conducted at the bog, have been in negotiation with the C. P. Ry. company with a view to obtaining a reduction in the freight rates between Alfred, Ottawa, Montreal and other points. The freight rates on a ton of peat fuel to these points were $1.50 from Alfred to Ottawa, and $1.65 from Alfred to Montreal. As a result of the negotiations carried on with the C. P. Ry. company these rates have been reduced to $1.25 and $1.35 respectively.

### Selling Cost at Alfred

The cost of manufacturing one ton of peat fuel has been estimated on the basis of the fuel manufactured during a short period when Plant No. 1 was operating at about normal capacity, but it is confidently hoped that the operations to be undertaken next season will confirm our estimate of $3.50 as the price at which one ton of peat fuel can be sold f.o.b. Alfred. This figure is subject to change when the expense encountered during the entire working season is charged against the output of fuel manufactured during that time. It is expected, however, that the figure will not be increased, but slightly reduced.

### Distribution of Moneys Expended

The following statement of expenditures requires no explanation other than has been incorporated in this report. In these statements all moneys expended up to the end of the season is accounted for. There are certain outstanding accounts which have not yet been turned in, but these represent small amounts and will be included in the next report.

Detailed information can be obtained by referring to Table I, which shows the distribution of time during the period Plant No. 1 was operated. Table II shows the following labour costs for Plants Nos. 1 and 2, namely, excavation. spreading and extra men used for various purposes, also fuel costs. From this it will be seen that the cost of one ton of fuel on the field for Plant No. 1, exclusive of overhead charges, is $1.05 and for Plant No. 2, 60 cents. Table III shows the approximate cost of machines Nos. 1 and 2 and the estimated cost to replace same, harvesting equipment and siding, office tools, telephone, experimenting. manufacturing fuel and committee expenses. Table IV gives in detail the various items which make up the cost of one ton of peat fuel f.o.b. cars. Tables V and VI are entitled " the trouble sheets " for Plant No. 1 and Plant No. 2 respectively. and give in detail the troubles which they experienced, and remarks concerning same. Tables VII, VIII, IX, X and XI show the approximate distribution and total of all moneys paid out by the committee from its appointment to the end of 1919.

With the assistance of this information the work which has been accomplished during the season of 1919 can be appreciated.

TABLE I.—DISTRIBUTION OF TIME (PLANT No. 1 ONLY).

| Days of month | June | | | | | July | | | | | August | | | | | September | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Possible hours | Hours lost by rain | Unproductive hours | Productive hours | Rows Peat laid | Possible hours | Hours lost by rain | Unproductive hours | Productive hours | Rows Peat laid | Possible hours | Hours lost by rain | Unproductive hours | Productive hours | Rows Peat laid | Possible hours | Hours lost by rain | Unproductive hours | Productive hours | Rows Peat laid |
| 1 | .... | .... | .... | .... | ... | 10 | .... | 4 | 6 | 3½ | 10 | .... | 5 | 5 | 3 | 10 | .... | 10 | .... | .... |
| 2 | .... | .... | .... | .... | ... | 10 | .... | 4 | 6 | 3½ | 10 | .... | 2½ | 7½ | 4 | 10 | .... | 5½ | 4½ | 1½ |
| 3 | .... | .... | .... | .... | ... | 10 | .... | 4½ | 5½ | 2 | .... | .... | .... | .... | ... | 10 | .... | 3½ | 6½ | 4 |
| 4 | .... | .... | .... | .... | ... | 10 | .... | 6 | 4 | 2 | 10 | .... | 4½ | 5½ | 3½ | 10 | .... | 4½ | 6½ | 4½ |
| 5 | .... | .... | .... | .... | ... | 10 | 5 | 2½ | 2½ | 3½ | 10 | .... | 5 | 5 | 2½ | 10 | .... | 4½ | 5½ | 3½ |
| 6 | .... | .... | .... | .... | ... | .... | .... | .... | .... | ... | 10 | .... | 3½ | 6½ | 3½ | 10 | 8½ | .... | 1½ | ½ |
| 7 | .... | .... | .... | .... | ... | 10 | .... | 3½ | 6½ | 4 | 10 | .... | 5 | 5 | 3 | .... | .... | .... | .... | .... |
| 8 | .... | .... | .... | .... | ... | 10 | .... | 3½ | 6½ | 3½ | 10 | .... | 9½ | 1½ | 1 | 10 | 2½ | 2 | 4½ | 2½ |
| 9 | .... | .... | .... | .... | ... | 10 | .... | 7 | 3 | 1 | 10 | .... | 3½ | 6½ | 3 | 10 | .... | 5 | 5 | 3 |
| 10 | .... | .... | .... | .... | ... | 10 | 2 | 4½ | 3½ | 1½ | .... | .... | .... | .... | ... | 10 | .... | 3½ | 6½ | 4½ |
| 11 | .... | .... | .... | .... | ... | 10 | 10 | .... | .... | ... | 10 | .... | 3½ | 6½ | 3 | 10 | 10 | .... | .... | .... |
| 12 | .... | .... | .... | .... | ... | 10 | .... | 3 | 7 | 3½ | 10 | .... | 3½ | 6 | 4 | 10 | 10 | .... | .... | .... |
| 13 | 10 | .... | 3 | 7 | 2 | .... | .... | .... | .... | ... | 10 | .... | 3 | 7 | 3 | 10 | .... | 10 | .... | .... |
| 14 | 10 | .... | 4 | 6 | 2 | 10 | .... | 4 | 6 | 3½ | 10 | .... | 5½ | 4½ | 2½ | .... | .... | .... | .... | .... |
| 15 | .... | .... | .... | .... | ... | 10 | 10 | .... | .... | ... | 10 | .... | 5½ | 4½ | 3 | 5 | .... | 1 | 4 | 2 |
| 16 | 10 | .... | 4 | 6 | 2½ | 10 | .... | 9 | 1 | ... | 10 | .... | 7 | 3 | 2 | .... | .... | .... | .... | .... |
| 17 | 10 | .... | 4 | 6 | 3 | 10 | .... | 3 | 7 | 1 | .... | .... | .... | .... | ... | .... | .... | .... | .... | .... |
| 18 | 10 | .... | 5 | 5 | 1½ | 10 | .... | 10 | .... | ... | 10 | 6 | 1 | 3 | 2 | .... | .... | .... | .... | .... |
| 19 | 10 | .... | 8 | 2 | 1 | 10 | .... | 10 | .... | ... | 10 | .... | 2 | 8 | 5 | .... | .... | .... | .... | .... |
| 20 | 10 | .... | 7 | 3 | 1½ | .... | .... | .... | .... | ... | 10 | .... | 4½ | 5½ | 3½ | .... | .... | .... | .... | .... |
| 21 | 10 | .... | 5 | 5 | 2½ | 10 | .... | 3½ | 6½ | 3 | 10 | .... | 5 | 5 | 2 | .... | .... | .... | .... | .... |
| 22 | .... | .... | .... | .... | ... | 10 | .... | 3 | 7 | 4½ | 10 | .... | 2½ | 7½ | 5 | .... | .... | .... | .... | .... |
| 23 | 10 | .... | 4½ | 5½ | 1½ | 10 | .... | 4 | 6 | 3½ | 10 | .... | 4½ | 5½ | 4 | .... | .... | .... | .... | .... |
| 24 | 10 | .... | 8 | 2 | 1 | 10 | .... | 8 | 2 | 1 | .... | .... | .... | .... | ... | .... | .... | .... | .... | .... |
| 25 | 10 | .... | 3½ | 6½ | 3 | 10 | .... | 10 | .... | ... | 10 | .... | 8½ | 1½ | ½ | .... | .... | .... | .... | .... |
| 26 | 10 | 10 | .... | .... | ... | 10 | .... | 10 | .... | ... | 10 | .... | 10 | .... | ... | .... | .... | .... | .... | .... |
| 27 | 10 | .... | 2½ | 7½ | 4½ | .... | .... | .... | .... | ... | 10 | .... | 10 | .... | ... | .... | .... | .... | .... | .... |
| 28 | 10 | .... | 3 | 7 | 3 | 10 | .... | 2½ | 7½ | 4 | 10 | .... | 10 | .... | ... | .... | .... | .... | .... | .... |
| 29 | .... | .... | .... | .... | ... | 10 | .... | 5 | 5 | 2 | 10 | .... | 10 | .... | ... | .... | .... | .... | .... | .... |
| 30 | 10 | .... | 4 | 6 | 3½ | 10 | .... | 10 | .... | ... | 10 | .... | 10 | .... | ... | .... | .... | .... | .... | .... |
| 31 | .... | .... | .... | .... | ... | 10 | .... | 4½ | 5½ | 2½ | .... | .... | .... | .... | ... | .... | .... | .... | .... | .... |
| | 150 | 10 | 65½ | 74½ | 32½ | 270 | 27 | 139 | 104 | 53 | 260 | 6 | 148½ | 110½ | 62½ | 125 | 31 | 50 | 44 | 25½ |

One row contains 11 tons. Average production per hour, June, 4.8 tons; July, 5.6; August, 6.2; September, 6.4.

Total produced, about 1,900 tons.

TABLE II.—OPERATING COSTS, ALFRED BOG.

| Labour Capacity | Plant No. 1 | | | Plant No. 2 | | |
|---|---|---|---|---|---|---|
| | No. Men | Rate Per Hour | Amount | No. Men | Rate Per Hour | Amount |
| Excavator | | | | | | |
| Engineer | 1 | 60c. | $6.00 | 1 | 60c. | $6.00 |
| Fireman | 1 | $130/mo. | 5.00 | 1 | 35c. | 3.50 |
| Runner | 1 | 35c. | 3.50 | 1 | 40c. | 4.00 |
| Attendant | 1 | 30c. | 3.00 | 2 | 30c. | 6.00 |
| Spreading | | | | | | |
| Load Cars | 3 | 30c. | 9.00 | .......... | none | .......... |
| Attend. Spreader | 3 | 30c. | 9.00 | 1 | 30c. | 3.00 |
| More rails | 2 | 30c. | 6.00 | .......... | none | .......... |
| Extra Men | | | | | | |
| Clear in front of spreader and steer | 1 | 30c. | 3.00 | .......... | none | .......... |
| Repair cars, etc.[1] | 1 | 35c. | 3.50 | .......... | none | .......... |
| Water boy | ½ | 17½c. | .90 | .......... | .......... | .90 |
| Totals | .......... | .......... | 48.90 | .......... | .......... | 23.40 |
| Fuel—1½ tons coal, 3 tons peat, each place | .......... | .......... | 12.00 | .......... | .......... | 12.00 |
| Gasoline, 3 gals., No. 1 | .......... | .......... | 1.25 | .......... | .......... | .......... |
| Oil (estimated) | .......... | .......... | 1.00 | .......... | .......... | 1.00 |
| Totals | .......... | .......... | $63.15 | .......... | .......... | $36.40 |
| Av. actual capacity to date | .......... | .......... | 60 tons | .......... | .......... | 60 tons |
| Cost per ton | .......... | .......... | 1.05 | .......... | .......... | .60 |

[1] This man to be dispensed with.

TABLE III.—EXPENDITURE STATEMENT.

NOTE:—Amounts below are approximate. Accurate figures cannot be obtained until all expenditures are distributed.

| Item. | Approx. Actual Cost. | Est. Cost to Replace. |
|---|---|---|
| Machines— | | |
| No. 1 | $32,000 00 | $25,000 00 |
| No. 2 | 26,000 00 | 20,000 00 |
| Harvesting Equipment and Siding— | | |
| Track, Cars, Locomotive, Loading Platform, Siding | 13,000 00 | 13,000 00 |
| Office Tools, Phone, etc. | 1,500 00 | 1,500 00 |
| Experimenting | 5,000 00 | |
| Making Fuel | 9,000 00 | |
| Committee Expenses— | | |
| Salaries | 12,600 00 | |
| Other expenses | 10,400 00 | |
| Miscellaneous | 5,000 00 | |
| Total | $114,500 00 | Say—$60,000 00 |

## TABLE IV.

### Overhead Cost.

| | | |
|---|---|---|
| Capital expenditure, estimated | | $60,000 00 |
| Working capital, estimated | | 25,000 00 |
| Depreciation, say 10 per cent. on $60,000.00 | $6,000 00 | |
| Amortization, say 10 per cent. on $60,000.00 | 6,000 00 | |
| Superintendent and mechanic | 4,000 00 | |
| Office and stenographer | 1,500 00 | |
| Incidentals, insurance, taxes, etc. | 1,500 00 | |
| | $19,000 00 | |

### Estimated Production.

Two plants—day and night, 100 days.
Capacity, average 125 tons per day of 24 hours each per unit.
Total estimated production, say 20,000 tons.
Overhead, say $1.00 per ton.

### Total Cost per Ton.

| | No. 1. | No. 2. |
|---|---|---|
| Cost raw material, per ton | $0 05 | $0 05 |
| Production cost | 1 05 | 60 |
| Cubing and turning | 30 | 30 |
| Loading on cars or to store | 60 | 30 |
| Overhead | 1 00 | 1 00 |
| Total per ton | $3 00 | $2 25 |

| | | |
|---|---|---|
| Average cost f.o.b. cars or in storage | $2 62½ | per ton. |
| Add for loading one-half fuel second time from storage to pile, 25c. per ton average | 12½ | " |
| Average cost, season output, f.o.b. cars | $2 75 | " |

TABLE V.—TROUBLE SHEET—PLANT NO. 1, 1919.

| Items in order of importance. | Remarks. |
|---|---|
| Item. | |
| 1. Supporting caterpillars.<br>Driving mechanism broken.<br>Difficulty with clutches.<br>124 chain broken.<br>Excavator out of line. | These difficulties were practically entirely eliminated when the driving mechanism was rebuilt, and latterly a differential drive installed. |
| 2. Spreader.<br>Chain broken.<br>Spreader sill broken.<br>Spreader clutches slipping.<br>Sprocket broken.<br>Trouble with engine.<br>Delay in turning. | The No. 1 spreader is being rebuilt, with special attention to the weaknesses disclosed. Trouble with the engine was almost entirely due to stopping and starting so frequently, due to the clutches, which never worked satisfactorily. The drive chain will be replaced with a much stronger one, and provision made so two men can turn the spreader in half the time it took five or six to do it in 1919. |
| 3. Spreader cars driving mechanism.<br>Cable slipping.<br>Cable broken.<br>Grips worn out. | Due almost entirely to original cable being too small. This was replaced by a larger cable and specially hardened grips procured, when this trouble practically disappeared. |
| 4. Spreader cars system.<br>No cars available to load. | Four new cars are ordered, which should materially increase capacity of plant. |
| Cars off track. | Mostly at joints in track on spreading side of rectangle. An extra tie will be put in at these joints which will overcome this. |
| Station car off track.<br>Station car anchor pulled. | The original scheme of holding the station car was defective. This was changed by bracing it direct from the excavator, and the trouble disappeared entirely. |
| 5. Excavator chain and pins. | The original pins holding the excavator chain together were poorly designed and wore so that occasionally a pin came out. New pins of better design have been secured and put in place. |
| 6. Soft ground.<br>Caterpillars in a hole.<br>Pivot castings No. 4 caterpillar broken. | The south end of No. 1 drying field was never cross drained and was very soft in places even along the face. Drains have been put in to remedy this, and the carrying ties on two of the caterpillars will be increased 50% in length, which should prevent further trouble from this cause. |
| 7. Ordinary delays.<br>Iron in macerator.<br>Roots in conveyor.<br>Wait for fuel.<br>Wash boiler.<br>Piston rod loose.<br>Heater tube blew out.<br>Pump gland played out.<br>Repair dry pipe.<br>Weather. | Delays from iron in macerator were few, and coupled with delays from roots in conveyor were not very important. Care on the part of the attendants will remedy to an extent. Delays for fuel should disappear when a regular supply of peat is arranged for. Washing boiler should be done on Sundays. The next four items are not important, and are the ordinary hazards of running machinery of this kind. Delays due to weather are not as serious as might be imagined, as the men will work through any ordinary rain, and fuel may be laid out, although the drying, of course, is interfered with. |

TABLE VI.—TROUBLE SHEET—PLANT NO. 2, 1919.

| Items in order of importance. | Remarks. |
|---|---|
| Item. | |
| 1. Supporting caterpillars.<br>Driving mechanism broken.<br>Difficulties with clutches.<br>124 chain broken.<br>EC62 chain broken.<br>Steering. | Difficulty with driving mechanism overcome when this was rebuilt. Difficulty with clutches and steering overcome by use of line to steer by and introduction of differential drive. Driving mechanism has also been raised so chains and sprocket wheels all run clear of moss. When work was commenced several drivers were down in the peat most of the time. |
| 2. Conveyor bridge.<br>Caught on moss.<br>Driving mechanism stalled in moss.<br>Universal joint broken.<br>Trouble with chain drives. | Practically all trouble with the bridge was due to it being too low. This has been raised one foot, and a new connection with the platform made in the centre instead of at one end, which will eliminate these troubles. |
| 3. Machine sinking in bog. | Until working face was cut down sufficient to get some drainage, the bog was all very soft and many delays and breaks occurred. As the working face became deeper these gradually disappeared, but to eliminate this trouble entirely the supporting caterpillars have been increased 50% in supporting area, which should eliminate this trouble even under such conditions as were met at the start. |
| 4. Feed belt insufficient. | The feeding mechanism to the belt conveyor at no time during the season had enough capacity to take the material away from the macerator. This has been altered to eliminate the trouble entirely. |
| 5. Macerator repairs. | Due to running macerator light when the cut was first started some of the knives froze in their bearings. Some delays were due to this cause, but they disappeared as soon as a normal supply of raw peat was available. |
| 6. Excavator element.<br>Pins worn.<br>Gutters broken.<br>Supporting frame and driving shaft bent. | In the early part of the operations when the dry top surface of the bog was being excavated the excavator was subject to abnormal wear. The ends of the pins in the chain wore off and the pins came out from time to time. These have been replaced with new pins of much better design. Many roots were also encountered at the first and a number of cutters broken, and due to inexperience excavator was permitted to stall on a root and the machine to move ahead, which strained it badly. A new brace has been added which will prevent this happening again, and spare cutters provided, although the experience with No. 1 working on a proper face shows only a couple of cutters broken in the season. |
| 7. Clutch controls. | Owing to this plant being so new no attempt was made to put in proper clutch controls until it was found where would be the best place to locate them. These will be put in for the 1920 season. |

TABLE VI.—TROUBLE SHEET—PLANT NO. 2, 1919—*Continued.*

| Items in order of importance. | Remarks. |
| --- | --- |
| 8. Delay turning spreader. | Serious delay in this operation was encountered at the start. Conditions gradually became better, but a new method of handling it has been worked out, which should reduce the time for this operation from several hours to possibly 20 minutes. |
| 9. Sundry delays.<br>Wait for fuel.<br>Wait for water.<br>Iron in macerator.<br>Belt slipping.<br>Adjust engines.<br>Excavator caught on roots.<br>Roots in spreader.<br>Weather. | The delays under this heading were mainly due to starting up on the new face with no proper organization. A lot of delay was caused from trouble in getting water to the boiler, which disappeared as the working ditch became deeper. The belt slipping was due to the bridge being too low, preventing proper adjustment of the parts. Roots in spreader was a minor trouble, which should be eliminated by changes in the spreader which have been made. |

TABLE VII.—COMMITTEE BUSINESS.

| | | |
| --- | --- | --- |
| Salaries:— | | |
| E. V. Moore, engineering and management | $11,180 65 | |
| F. O. Orr, inspection | 1,800 00 | |
| superintendence | 2,000 00 | |
| Rd. Morley, drawing and designing | 1,265 60 | |
| | | $16,246 25 |
| Travelling Expenses:— | | |
| Committee members | $1,191 63 | |
| E. V. Moore | 2,406 25 | |
| F. O. Orr | 790 21 | |
| A, Arnep | 268 24 | |
| A. Leverin | 370 00 | |
| | | 5,026 33 |
| Rent | | 1,140 00 |
| Office Expenses:— | | |
| Telephone and telegrams, installation of Bell phone at Alfred. | $345 81 | |
| Stamps | 91 57 | |
| Stationery, drawing supplies, etc. | 271 25 | |
| General | 94 55 | |
| | | 803 18 |
| Total | | $23,215 76 |

TABLE VIII.—PLANT AND EQUIPMENT.

| | | |
| --- | --- | --- |
| Plant No. 1:— | | |
| Original cost | $28,373 16 | |
| Unload and install | 895 05 | |
| Experimental work and alterations, materials | 1,548 46 | |
| Labour | 731 36 | |
| | | $31,548 03 |
| Plant No. 2:— | | |
| Original cost | $21,747 04 | |
| Unload and install | 59 57 | |
| Experimental work and alterations, materials | 1,044 03 | |
| Labour | 2,596 93 | |
| | | 26,047 57 |
| Harvesting and Loading Equipment:— | | |
| Materials | $11,127 87 | |
| Labour and install. | 1,526 94 | |
| | | 12,654 81 |

| | | | |
|---|---|---|---|
| Buildings and Telephone:— | | | |
| Materials | | $869 09 | |
| Labour on buildings | | 359 20 | |
| Labour install. telephone | | 26 35 | |
| | | | 1,254 64 |
| Tools | | | 583 77 |
| Freight and expenses | | | 1,738 71 |
| Total | | | $73,827 53 |

TABLE IX.—OPERATION EXPENSES.

| | | | |
|---|---|---|---|
| Plant No. 1:— | | | |
| Labour in excavation | $169 80 | | |
| Operate excavator | 251 17 | | |
| Moving track | 554 70 | | |
| Operate boiler and engine | 955 20 | | |
| Spreading | 1,119 90 | | |
| | | $3,050 77 | |
| Turn and cube contract | $403 90 | | |
| Straight time | 503 21 | | |
| | | 907 11 | |
| Repairs | 672 72 | | |
| | | 672 72 | |
| | | | $4,630 60 |
| Plant No. 2:— | | | |
| Labour in excavation | $12 60 | | |
| Operate excavator | 154 68 | | |
| Operate boiler and engine | 709 07 | | |
| Spreading | 110 60 | | |
| | | $986 95 | |
| Turn and cube | | 24 40 | |
| Repairs | | 211 06 | |
| | | | $1,222 41 |
| Supplies:— | | | |
| Coal | $1,223 28 | | |
| Gasoline and oil | 173 44 | | |
| Sundries | 447 11 | | |
| Spare parts | 395 24 | | |
| | | | 2,239 07 |
| Harvesting and loading | | | 868 68 |
| Sundry repairs | | | 170 00 |
| Total | | | $9,130 76 |

TABLE X.—OTHER EXPENSES.

| | | |
|---|---|---|
| Preparing field for No. 1 Plant | $255 46 | |
| Preparing field for No. 2 Plant | 894 60 | |
| | | $1,150 06 |
| Water boy and general work | | 483 81 |
| Cleaning up property | | 401 86 |
| Moving old plant | | 215 55 |
| Sundries | | 1,225 74 |
| Total | | $3,477 02 |

TABLE XI.—SUMMARY OF EXPENDITURES TO 31st DECEMBER, 1919.

| | |
|---|---|
| Committee expenses | $23,215 76 |
| Plant and equipment | 73,827 53 |
| Operation | 9,130 76 |
| Other expenses | 3,477 02 |
| Cash advance to E. V. M. | 254 04 |
| Cash on hand, Alfred account | 354 42 |
| Total | $110,250 53 |

# A GEOLOGICAL RECONNAISSANCE INTO PATRICIA[1]

### Including Part of Sixth Meridian Line, and Wenasaga, Birch Lake and Trout Lake Rivers

By

E. M. Burwash

## Introduction

The field-work on which this report is based was carried out during the summer of 1919 under directions received from T. W. Gibson, Deputy Minister of Mines for Ontario. The writer left Toronto on June 7th accompanied by A. H. Dingman and R. C. Montgomery, both of Toronto, as field-assistants, and reached Sioux Lookout, district of Kenora, on the 9th. Here was secured a 17-foot canvas-covered Peterborough canoe, belonging to the Bureau of Mines, and the party next day arrived at Freda station, which is situated on the sixth meridian where it forms the western boundary of the township of Rowell and intersects the line of the National Transcontinental railway. At Hudson we met T. J. Patten, O.L.S., with his party, to whom had been assigned the duty of extending the sixth meridian line survey northward from the northwest corner of Rowell to a point 120 miles distant in the district of Patricia. On the 11th the combined parties and their supplies were moved three miles north from Freda to the starting point of the survey.

Work was begun on the 12th, and was carried to the southern end of South Cove, an arm of Lac Seul, on the evening of the 28th, a short distance north of the seventeenth mile-post. At this point the geological party left the line temporarily for the purpose of visiting the iron ore deposits at Little Shallow lake, and proceeded thither by way of Pine Ridge Post (at the western end of Lac Seul) and the English and Mattawa rivers. We returned to the main party on July 11th, when we found them encamped at Shanty narrows, Lac Seul. The line had now been completed as far as the north shore of the lake, which was intersected at a point about three miles northwest of the narrows, near the 33rd mile-post.

Here the survey of the line had to be abandoned, owing to the refusal of the Indians employed as packers to continue at work, and Mr. Patten therefore withdrew his party from the field. In order to carry on the geological work independently it was necessary to return to Sioux Lookout to reorganize the party and equipment. The canoe already mentioned, while quite as large as convenient for portaging along the line, was overloaded, slow and dangerous on the larger lakes when burdened with three men, their baggage and supplies for even a short

[1] Literature on the District of Patricia is summarized in Vol. XXI, 1912, Part 2, Ontario Bureau of Mines Report.

journey. We therefore accompanied Mr. Patten's party to the railway at Hudson, and reached Sioux Lookout on July 16th. There we purchased supplies and secured the use of a second canoe through the kindness of Mr. Farlinger of the Farlinger Lumber Company. After some days we also succeeded in engaging the services of George Rowatt as cook and canoeman, in both of which capacities he proved very efficient.

We left Hudson on July 26th by the Hudson Bay Company's launch and arrived at Pine Ridge, at the outlet of Lac Seul, on the 28th. The next day we proceeded up the Wenasaga river, which enters Lac Seul from the north near Pine Ridge and intersects the projected meridian line about fifteen miles from the lake. Near the probable point of intersection the White Mud river enters from the east, and three days were spent in exploring and mapping it. It consists of a chain of lakes connected by narrows which extends about ten miles to the east, receiving two streams on the southern side and another at the eastern end. The second stream on the south side appears to be the principal branch of the system, but time was not taken to explore it. Immediately north of the White Mud river the Wenasaga crosses a schist and greenstone area which was studied to some extent. Attention was also paid to the two succeeding granite areas and the intervening band of schists.

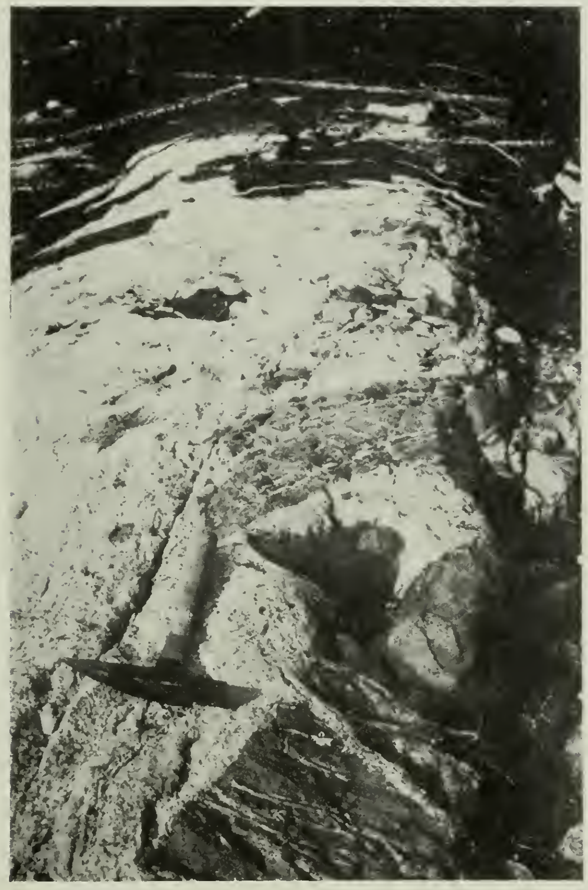
Passing over the Height of Land portage to Big Portage lake the stream which enters from the west was explored and mapped in the expectation that it might prove to be the outlet of Birch lake, but it was found to extend only a few miles westward through two small lakes. On proceeding to the bay which projects westward about the middle of the west side of Gull lake, the Birch lake river was found and ascended westward to Birch lake. A survey of this stream and of the long southwestern bay of Birch lake was made. The southern boundary of the schist and greenstone area, which surrounds Birch lake, was traced for about six miles, and the rocks of the area itself were examined on that part of the route to the south of Birch lake and along its southwestern arm. Leaving Birch lake on August 25th, we followed the Shabumeni river to Shabumeni lake whence the Woman portage leads southward to a small lake which is part of the northerly bend of the Woman river. Passing through Woman lake, Woman river and the Trout Lake river to Pakwash lake and thence by way of the Mattawa and English rivers we reached Pine Ridge on August 30th.

A day or two was spent at Shanty narrows and South Cove in completing the geology of that part of the line which lies across various bays of Lac Seul, and we returned to Hudson on September 7th. After settling some business details at Sioux Lookout we left for Toronto where we arrived on the 11th. In addition to the geology and mineralogy some attention was paid to the waterpower, fish, game, soil and timber resources, and an attempt was made to secure climatic data of sufficient reliability to form the basis of an opinion as to the suitability of the area for agricultural development. For the last mentioned purpose a thermometric record was kept of daily maximum and minimum temperatures, but owing to the difficulty of securing proper shade for the thermometer under all conditions of travel, it is probable that the minima are more reliable than the maxima.

## Geology

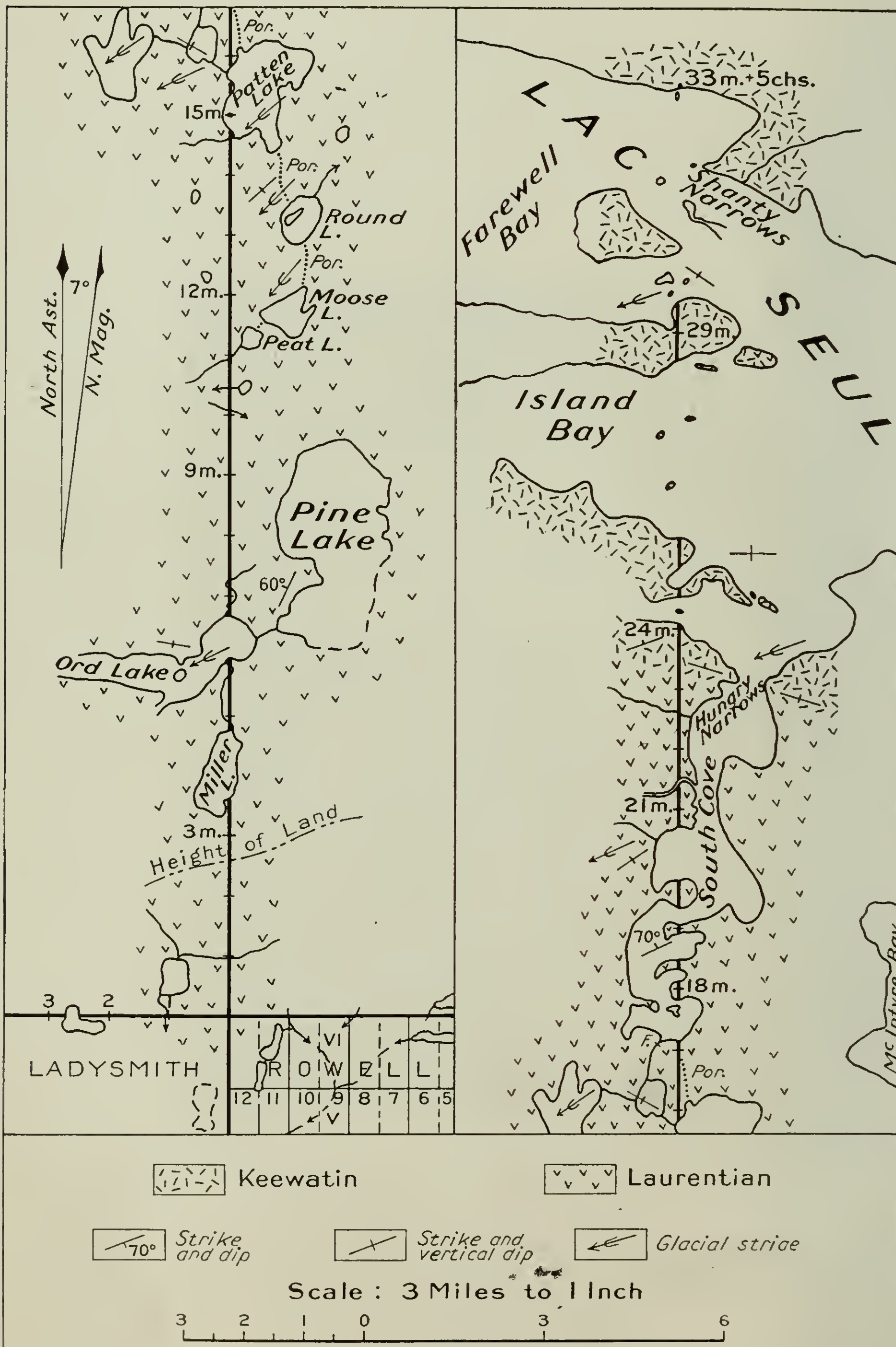
### I.—The Sixth Meridian from Freda to Lac Seul

Topographically, the country traversed by the line from Freda to Lac Seul is rather uniform in type, and consists of rounded hills of gneiss or granite which generally have a N.E.-S.W. trend along their greater axes, and are flat-topped or simply dome-shaped, with a certain accordance of height. In all cases the



Keewatin inclusions in gneiss a short distance north of Freda station, district of Kenora. Note well-preserved angular outlines.

rock surfaces exhibit signs of intense glaciation, the north and east faces being generally rounded, while cliffs are sometimes found facing the west and south. The direction of the ridges corresponds generally to the strike of the gneiss. The direction of the glacial movement was observed in one case to form an angle of 60° with the strike (strike 120°; glacial striæ 60°), but they are in general more nearly parallel, since the average of strikes noted is 82.5° and the average direction of glacial movement 64°. Hence the ridges are glaciated fairly parallel




Geology along sixth meridian surveyed by T. J. Patten, O.L.S., in 1919. The right half of the plan shows the northern extension of the surveyed line on the left half.

to their length, and the intervening valleys having been swept clean by the ice, the deposits now found in them are either in the nature of sandy outwash from the margin of the retreating ice, terminal morainic ridges, or post-glacial lake deposits. Very little till and no continuous till-sheets were observed; the tops of the hills are in general strewn with boulders often of large size, but little finer material is to be seen, though in some places the lower parts of the hillsides and the bottoms of the valleys are covered with earth, which may have been washed down from the hilltops. The morainic ridge which lies in a N.W. to S.E. direction between Peat and Moose lakes, is about half a mile in length and 50 feet above Moose lake at its highest point. It is largely composed of boulders of granite with a smaller proportion of darker rocks and schists; the finer materials are gravel and sand with little clay.

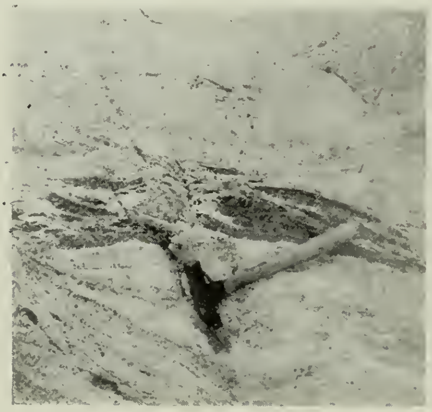
The post-glacial clays which occur in the deeper valleys, especially from Ord lake north, and are largely continuous in the Lac Seul depression, have been described under the heading of Soil and Climate.

The Laurentian formation occupies the whole of the belt traversed by the line until Lac Seul is reached, and its more massive and less gneissoid phases seem in general to form the higher features of the topography. The hills, however, do not exceed 150 feet in height in most cases, and on the average are probably not higher than 100 feet. The most massive granite on this section of the line forms the principal divide, that between Ord and Pine lakes, which drain west toward the Cedar river, and the streams which flow north and east into Lac Seul. On South Cove the gneiss gives way to older soda-rhyolites of Keewatin age, and in these, which are in part somewhat friable, the basin of Lac Seul has been excavated by erosion, of which the latest important phase was the ice action of the Pleistocene period. In the gneiss between Freda and the height of land mentioned, which lies about 16 miles north of the railway, two or three sets of small dikes were observed at different points. The following table indicates their nature and direction. The sets of dikes present are marked 1, 2, and 3 in order of age:

| Place | Strike of Gneiss | 1st Set | 2nd Set | 3rd Set |
|---|---|---|---|---|
| (a) Freda...... | 50° | Contorted: Strike 50° | Straight: about 180° | |
| (b) 1¾ miles N. of Freda.. | 35° | Straight: Strike 25° | Straight: Strike 70° | Epidote veins: Strike about 125° |
| (c) Portage E. of 13th mile (16 miles North of Freda).... | about 40° | Contorted: Strike 20° to 25°. Coarse pegmatitic | Straight: Strike 65° (cuts 1st). Felsitic | Straight: Strike 130°. Cuts 1 and 2. Felsitic |

The strikes of corresponding members of these successive intrusions are accordant enough in the different localities to suggest that in some cases they represent contemporaneous action throughout the area.

At Freda the rock is distinctly granitoid gneiss, containing in parts numerous inclusions of more basic rocks of a gneissic texture but of finer grain than the magma itself. The rock is essentially a biotite gneiss, with little biotite and large quartz-content. It is pinkish in colour to the east of Freda station, and in places shows a porphyritic texture with orthoclase phenocrysts; and in some parts it increases in coarseness to a pegmatitic facies containing anhedrons up to three inches in diameter. To the west of Freda station the inclusions of basic rock are much more numerous, and the magma itself finer-grained and of a greyer colour, probably due to assimilation of basic material or to basic differentiation near the contact with the roof. About a mile northward there are in addition to the basic inclusions others that appear to represent acid rocks, possibly sandstone or quartz porphyry now much altered. The inclusions here show a considerable amount of contortion due to flowage of the gneiss, and are less markedly angular than near Freda. The surface is therefore representative of a lower horizon within the batholith.



1.

2.

1. Inclusions indicating fluidal movements of both inclusions and gneiss together.
2. Rounded inclusion, with granitic intrusions along cracks, and shearing cracks transverse to the lamination of the enclosing gneiss.

Proceeding northward the gneiss becomes gradually more granitic in texture and the inclusions in general fewer as far as Ord and Pine lakes. On the shore of the first-named lake about half a mile west of the point where the line meets the south shore, there is an exposure of quite massive granitoid gneiss without inclusions so far as observed, and the same type of rock was seen on the south-easterly shores of Pine lake, which lies east and north of Ord lake. The gneiss at this latitude is known to extend from Lac Seul on the east to the Cedar river on the west. Proceeding northward from Ord lake there is an outcrop of massive granite with no apparent gneissoid structure at 8 miles 20 chains. The high bluff to the west of the line here is probably also of the same rock, which appears to be a hornblende granite[1], with the ferromagnesian constituent altered to epidote or chlorite. The whole is traversed by small veins of epidote. The direction of the hills here is N. 20°E., more northerly than that of those in the distinctly gneissoid area further south, and the strike of the gneiss on Ord lake (280°) may indicate

[1] Specimens from this locality were unfortunately lost.

that the gneissoid structure parallels the outline of the massive granite area. No inclusions were noted in the granite. On the 10th mile there is still but little evidence of gneissic structure, the texture being coarsely granular, and the inclusions much altered. On the east side of Moose lake ($1\frac{1}{2}$ miles E. of the 12th mile) the rock is a massive hornblende gneiss with graphic pegmatite traversing it in dikes. On the portage to the north of this lake (opposite the 13th mile) the granite is porphyritic, and is traversed by three series of small dikes as described above. It contains a few large xenoliths of a much finer grained rock of gneissic appearance, one of which measured about 50 feet by 8 feet on its exposed surface. The earlier pegmatitic dikes are much contorted by movements or other changes of the rock, involving shrinkage. The later (aplitic) dikes are unchanged as to direction of the fissures.

To the north of Round lake, on the portage leading to Patten lake (E. of 14th mile) the gneissoid structure becomes distinct again, while the texture is still porphyritic. Inclusions occur here of both basic and acid types. Gneiss was also seen on the hills to the northeast of Round lake, and occupies the shores of Patten lake and a small lake to the east of it. On the western shore of Patten lake the greyish gneiss contains many inclusions of dark grey and green rocks, and this increase in the number of inclusions and the more basic appearance of the gneiss are no doubt due to the approach of the present land surface closer to the original roof of the batholith as the line is followed to the north. The inclusions on Patten lake are microscopically seen to be diorite gneiss, consisting of a large amount of fresh green hornblende (about 50 per cent. of the rock) with the remainder of the space occupied by andesine and a few grains of magnetite. In other cases the inclusions are of massive basic rock, diorite or gabbro. In the gneissic inclusions apophyses of the surrounding granitoid gneiss may be observed penetrating fissures formed along the lamination, which serves as evidence that although the gneissoid inclusions are in general oriented parallel to the structure of the enclosing gneiss, they were gneissoid before their inclusion in the batholith, and not merely rendered so by the causes which produced gneissoid structure in the batholith. On the small lake west of the 17th mile the greyish gneiss contains contorted inclusions, while a reddish, somewhat porphyritic type of gneiss seen on the shores of the lake a mile farther west has few or no inclusions. At the south end of South Cove, just north of the 17th mile-post, the gneiss is traversed by a pegmatite dike, which consists almost exclusively of feldspar and quartz, the former of earlier formation than the latter and crystallized in individuals up to three inches in diameter. There are no noticeable ferromagnesian silicates or metallic ores present.

Two miles farther north pegmatitic dikes are again seen, and as we advance northward along the Cove inclusions increase in number and size. The pegmatitic dikes on the point to the west of the 19th mile-post consist of microcline, quartz, orthoclase and biotite (in the order of their abundance) with some accessory iron oxide, apatite and augite in small amounts. The gneissic inclusions in the granite at the same locality are of a soda rhyolite gneiss which contains quartz, albite and biotite with small amounts of iron oxide. The reddish granitoid gneiss along the shore of South Cove in which these inclusions and dikes occur, is a biotite granite gneiss which in general is composed of orthoclase, microcline, quartz, biotite, hornblende and micropegmatite, the last two in small amounts. It is reddish in colour toward the south end of the Cove, but becomes somewhat greyer as Hungry narrows is approached. At this point it is succeeded by a fine-grained, almost felsitic soda-rhyolite gneiss which is markedly stratiform in appearance, and is identical with the inclusions found in the biotite gneiss to the south. The rhyolite is therefore older than the batholithic intrusion which occupies the country from Freda to Lac Seul. It strikes in general east and west, varying somewhat to the north and south of 90°, and dips vertically or steeply toward the north.

Banded rock near Hungry narrows, Lac Seul.

It is exposed from Hungry narrows northward on the islands in Island bay, at Shanty narrows, on the point lying between Island bay and the northwestern arm of Lac Seul, and on the islands in the lake to the northwest of Shanty narrows. The line ends for the present on the north shore of the lake, where no outcrop of rock exists. The rhyolite is penetrated by granite dikes or sills generally parallel to the structure of the rhyolite and in some places in large bodies—especially on the south shore of the bay northwest of Hungry narrows near its mouth, and on an island near the north side of Island bay, just to the south of Shanty narrows.

On the shore between Hungry narrows and the entrance to the unnamed inlet to the northwest there is a series of rocks exposed which is finer grained than the rhyolite, being quite aphanitic, and showing a ribbon-like banding parallel to the strike. It is probably a fine grained hornblende schist like others seen on Slate lake. In some places the rhyolite presents much the appearance of a gneiss of medium grain, but in general its texture is so fine as to resemble a moderately fine-grained yellow sandstone.

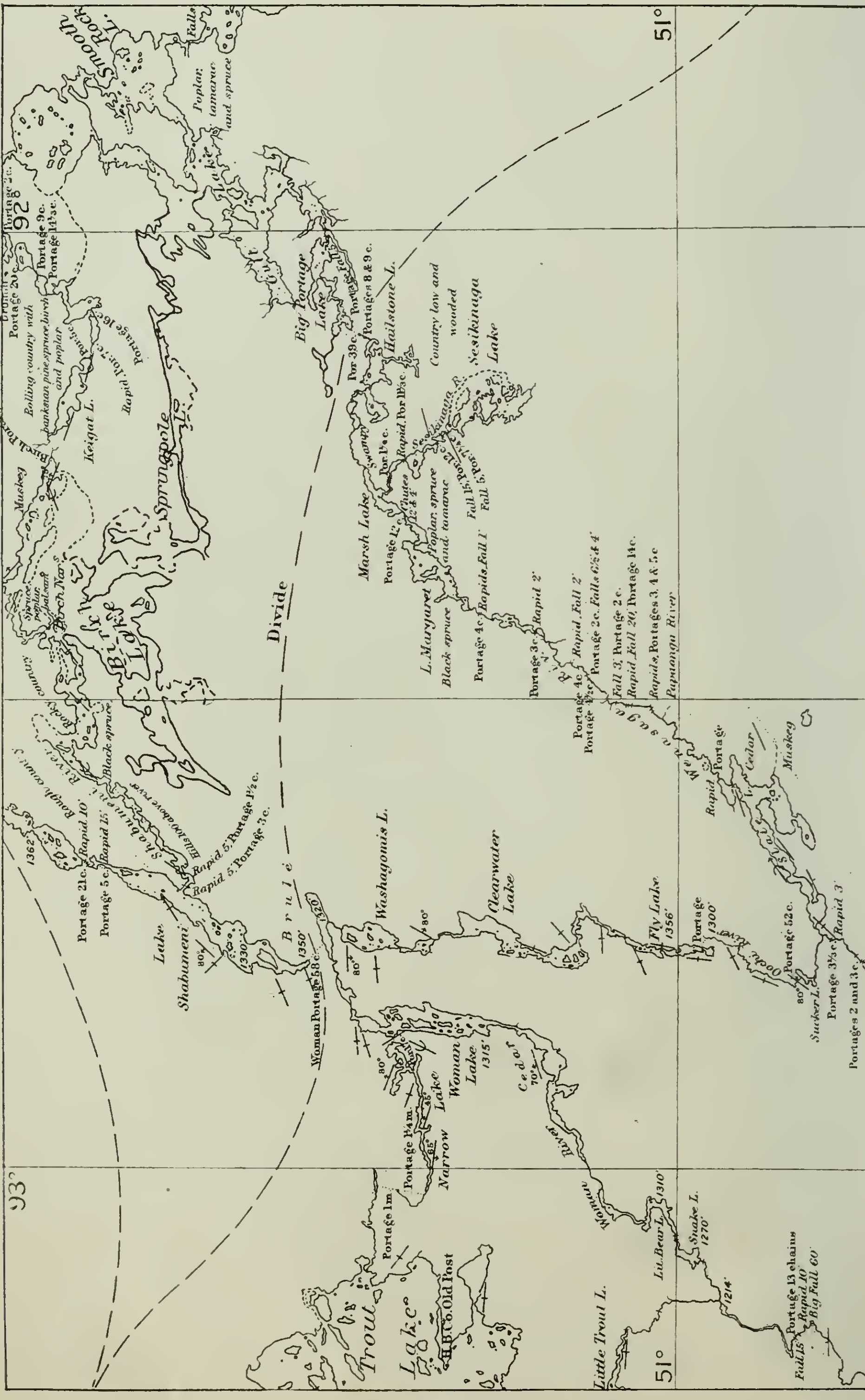
The Laurentian batholith over which the line runs from Freda to mile 23 varies somewhat both in texture and composition. Near the contact of the rhyolite, and at other points where inclusions are numerous, it has a greyish colour, due to a higher proportion of dark minerals, and a distinctly gneissoid texture. Farther from the contact, or where inclusions are more sparsely scattered through it, while still gneissoid it presents a ruddier colour, due to the greater predominance of pink feldspar. Finally in the area from mile 8 to mile 13 the gneissoid texture gives place to the granitic, and the rare inclusions are of large size. This granitic area is not separated from the gneissic part by eruptive contacts so far as observed, but seems to pass into it by an easy gradation. It therefore represents the central part of the same intrusion and in all probability a horizon which lay considerably below its upper surface before the roof was removed by erosion, while the gneissic parts are those nearer the outer surface of the batholith, both at the sides and top.

The soda-rhyolite gneiss consists, as before stated, of quartz, albite or oligoclase-albite, and biotite, in the order given.[1] and contains in many places a considerable amount of garnet and some magnetite and pyrite as accessories. In one or two instances noted the feldspar was in excess of the quartz, but generally the reverse is the case. The garnet is probably almandine (iron-aluminium silicate). Slight amounts of muscovite are also present, probably secondary after anorthoclase or microcline.

### II.—The Wenasaga River

The northwestern arm of Lac Seul is underlain by gneissoid rocks. At its southeastern end these consist of the soda-rhyolites already described. At Pine Ridge post near the outlet of the lake there is a considerable covering of drift, but a small islet in the river just opposite the post is composed of a dark grey banded gneiss, consisting partly of a fine grained granitic type, and partly of narrow aphanitic bands which exhibit transverse shear-cracks. The coarser part is essentially a gneissoid mica-hornblende gabbro, and consists of sericite with kaolin representing the original feldspar (labradorite), hornblende, biotite, and quartz, while the narrow bands are more silicious. The accessory minerals are titaniferous magnetite and pyrite. This island seems to represent an intrusion, largely confined to this locality, whose relations to surrounding rocks were not determined. The gneiss on the island is traversed by dikes of two different kinds, one a hornblende-biotite granite, and the other a mica diorite of coarse grain. The relations of these dikes to one another were not evident, but the granitic dike probably indicates that the older gneiss, which it intrudes, is pre-Laurentian and may be provisionally assigned to the Keewatin series.

[1] Essential mineral constituents of rocks are named throughout this report in the order of their abundance in the rock.



92°
93°
51°
51°
Divide
Birch Lake
Springpole L.
Keigat L.
Big Portage Lake
Hailstone L.
Sesikinaga Lake
Marsh Lake
L. Margaret
Washagomis L.
Clearwater Lake
Fly Lake
Woman Lake
Narrow Lake
Trout Lake
Little Trout L.
Lit. Bear L.
Snake L.
Sucker L.
Lake Shabumeni
Brulé
Cedar
Papaonga River
Country low and wooded
Rolling country with banksian pine, spruce, birch and poplar
Poplar, tamarac and spruce
Poplar, spruce and tamarac
Black spruce
Muskeg
Rough country
H.B.Co.Old Post
Woman Portage 58 c.
Portage 1m.
Portage 1¼ m.
Portage 21c.
Portage 5 c.
Portages 2 and 3 c.
Portage 13 chains
Rapid 10'
Big Fall 60'
Fall 15'


Key plan, scale 8 miles to the inch, showing location of areas examined geologically.

Proceeding up the Wenasaga river, little of the rock is exposed until the first fall is reached. There a reddish grey stratiform gneiss forms the ledge over which the river drops about 10 feet. The gneiss seen on Wenasaga lake appeared also stratiform, and similar in that respect to the soda-rhyolite gneiss near Shanty narrows, Lac Seul. Along the northwest shore of Bluffy lake and at the falls below its outlet, the gneiss is of a more granitoid type, grey in colour, with inclusions showing evidence of having been partly fused and recrystallized. On the fourth small lake-expansion (Brulé lake) of White Mud river, at the south end, the granite gneiss is again replaced by soda-rhyolite gneiss with granitoid apophyses at intervals parallel to the lamination. It is quite possible that the rhyolite occupies the whole district between this point and Lac Seul. On the north shore of the same small lake there is a band of hornblende-magnetite schist very similar in composition to the ferruginous hornblende schist of Little Shallow lake. It consists of a quartz matrix with grains of magnetite and a little hornblende and as estimated by specific gravity contains about 17 per cent. of iron in the specimen which was taken. Along the narrows to the east and on the shores of White Mud lake,[1] the rocks are grey gneisses or mica schists with occasional bodies of intruded granite. The mica schist and gneiss where examined microscopically have proved to be soda-rhyolite, more or less altered, and it is probable therefore that this rock extends northward until it comes in contact with the basic schistose area of which the southern boundary crosses the Wenasaga river on the line of Ogani lake in an east and west direction. On White Mud lake there are massive granitic intrusions exposed at the mouth of the stream which enters the lake about the middle of its south shore, and on the small rock which stands at the end of the sandy point on the northern shore. On the southern shore the rhyolite gneiss has been altered to a muscovite schist with some biotite, having undergone more intense metamorphism here than in the Lac Seul valley. Garnets were not noticed as a constituent at White Mud lake, though common at Lac Seul. On the north shores of White Mud lake near the east end some angular pieces of jasper were seen, which no doubt indicate the presence of iron formation some distance to the east and north (glacial striæ here N.75°E.). Some pieces of vein quartz were also found.

Proceeding northward by the Wenasaga river from Bluffy lake, few outcrops of rock are found before reaching the rapids below the junction of the Ootchi river from the west. At these rapids the rock exposed is schistose in appearance, and on examination is found to consist of biotite in parallel arrangement enclosing grains of plagioclase (probably oligoclase-albite), and secondary quartz. The rock probably represents a sheared soda-trachyte or soda-syenite. The absence of primary quartz and the slightly more basic feldspar distinguish it from the metamorphosed soda-rhyolites to the south, toward which it dips at steep angles (strike 85°; dip S.80°). The contact of the two rocks was not observed and hence their relationship cannot be definitely stated. Near the southwest end of Slate lake A. W. G. Wilson has noted a local variation of the compass[2] which probably indicates the existence in this locality of a magnetite-hornblende rock similar to

[1]See map, p. 172.

[2]Cf. A. W. G. Wilson, G.S.C. Publication No. 1006, republished in Ont. Bur. Mines. Report, 1912 (Vol. XXI, Part II, p. 54 *et seq*).

those which occur on the White Mud and Little Shallow lakes. On entering Slate lake from the south, after passing through the first narrows, there is an outcrop of sheared conglomerate on the south shore, which contains stones whose maximum observed length is about eight inches, but which are on the average much smaller. They are partly rounded and partly angular. The angular material seems to be chert or possibly jasper, but was not examined microscopically. In most cases the stones have been rendered lenticular by shearing, the direction of which coincides nearly with that of the dip. There are some small quartz veins parallel to the strike, and there is a certain amount of pyrite distributed at intervals through the matrix. The pebbles examined microscopically were:

(1) Rounded pebbles of sugary-textured quartz, which under the microscope shows a granular structure of somewhat interlocking grains, no secondary enlargement of grains, slight amounts of bleached biotite and brown iron oxide, very occasional grains of apatite and magnetite and flecks of kaolin.

(2) A grey slaty rock which consists of rounded grains of feldspar partly sericitized. and quartz grains in smaller amounts in a matrix of bleached biotite, with iron ore, carbonates and some fine granular quartzose and feldspathic material. The feldspar present seems to be partly oligoclase near albite, and some orthoclase or albite.

(3) A squeezed diorite porphyry, which has a groundmass of finely divided plagioclase and bleached biotite, in which are a few grains of ilmenite or titaniferous magnetite altered to leucoxene. The phenocrysts are of oligoclase with much sericite and kaolin. The crystals are much fractured and the cracks filled with unaltered biotite.

(4) A biotite-muscovite gneiss which has the biotite much altered with interstitial fillings of fine grained quartz and feldspar, while through the mass are scattered larger fragments of quartz and plagioclase (probably oligoclase-albite). These would agree very well with derivation of the pebble from the soda rhyolite or soda trachyte gneisses to the southeast.

The matrix in which these pebbles are embedded is seen microscopically to consist of large lenticular grains of quartz surrounded in some cases with sericite envelopes, while in the interstices are fillings of secondary quartz with bleached biotite, which has produced some brown iron oxide. Calcite is also present.

The strike of the rocks at this point is 70° and the dip vertical. The conglomerate bed was traced along the peninsula which divides the main body of Slate lake from its southeastern arm. and across the connecting narrows. It undoubtedly represents a considerable erosion interval between the rocks on each side, and as the materials of the conglomerate agree very well with the rocks to the southeast but do not include the hornblende schists which are found to the northwest, probability appears to favour the idea that the rocks to the southeast, including the soda-rhyolites, are the older series, while those to the northwest are considerably younger.

To the west of the conglomerate band the rocks at first are light grey and yellow banded or ribboned, dipping vertically and composed of sericite in which are fragments of plagioclase (about oligoclase-albite) and automorphic grains of magnetite. They are traversed by quartz veins which are often rusty-coloured through the weathering of their pyrite, and in some cases white and glassy, with numerous tourmaline needles in the quartz. In no case was any indication of gold visible, and two assays failed to disclose even a trace.

The total thickness of schistose rocks which are exposed on Slate lake is about 12,000 feet, and others are crossed in ascending the river above the lake, though few exposures occur until the 6½ foot fall is reached near the northern boundary of the schist area. At the next portage a laminated hornblende rock is seen. The hornblende is in parallel arrangement and automorphic, while between the fibres are large automorphic crystals of magnetite, andesine grains of hypautomorphic form and much quartz, which is mainly secondary in appearance. Part of the hornblende has been altered to chlorite. The rock was probably a quartz diorite, now altered toward hornblende schist.

On Slate lake a mass of boulder-conglomerate was noticed which is probably an erratic. It contains boulders two and a half feet in diameter, some angular and some sub-angular, some exhibiting transverse shear-cracks.

Near the granite contact to the north an irregular dike of pegmatite was observed on the west side of the river. This dike, like some seen earlier in the season at Pakwash lake, has large crystals of tourmaline which lie at right angles to the walls of the dike in its finer marginal parts and is very coarse-grained in the centre, with feldspars 8 x 2½ inches or more on exposed surfaces, and crystals of muscovite about one inch in diameter. There is also much interstitial quartz, and a green mineral which accompanies the mica. The schist in this neighbourhood is much contorted, and large horses of it are included in the pegmatite dike, which has a general direction of about N.35°E. The granite which succeeds, and of which the pegmatite is an apophysis, is of course younger than the schists. It is itself somewhat pegmatitic in texture, and is traversed by pegmatitic dikes of still coarser grain. It is light grey in general appearance and consists of microcline, orthoclase, quartz, biotite and muscovite (in parallel intergrowths, the latter predominating), and a little oligoclase or andesine with accessory zircon and garnet. Tourmaline is developed also along fracture planes. The rock powders easily as if affected by hydrothermal or pneumatolytic action, but most of the feldspar is fresh, only a small part having developed a little kaolin and sericite.

The area occupied by this granite, which extends up the river as far as Hailstone lake, is characterized by rounded hills which are of no great elevation, but contrast notably with the low-lying, flat and largely swampy country to the south which is underlaid by the older schists. In this area of granite hills lie the sources of the Wenasaga, which takes its rise in the Hailstone and Sesikinaga lakes or small streams tributary to them.

### III.—The Cat River Basin

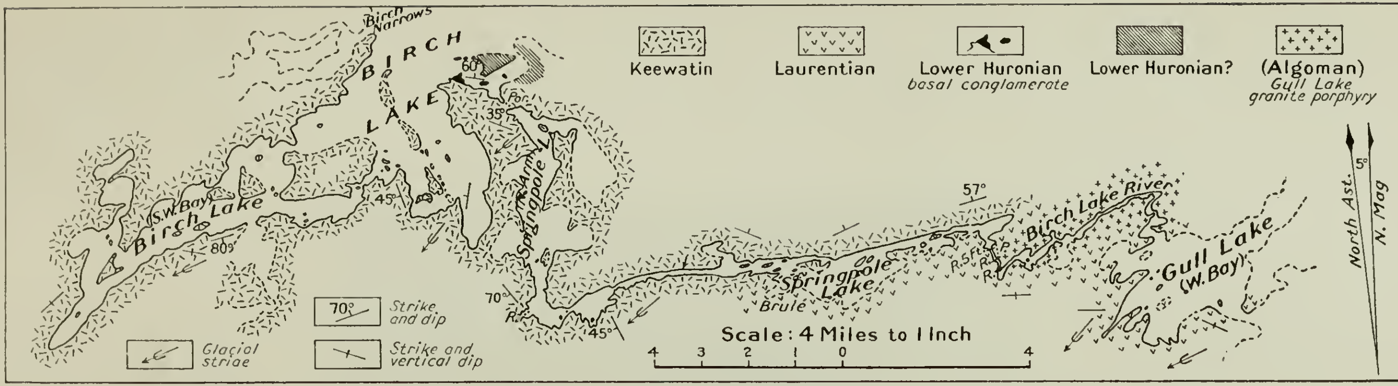
Passing over the portage from Hailstone lake to Big Portage lake, which belongs to the Cat river system, the granite is interrupted by a band of hornblende schist which contains a considerable amount of tourmaline. At the outlet (west end) of the small lake west of Hailstone lake, and on the portage connecting it with Hailstone lake, small bands of dark schist had already been seen, and the southern boundary of the bands which cross the height of land portage was traced some five miles westward by A. W. G. Wilson in 1902.

The width of the last-mentioned bands is about half a mile or less, and at the most southerly of the two small lakes which break the portage they are separated by a strip of gneiss. The schist is dark green in colour, and is intruded by small quartz veins, the strike of which is parallel to the schistosity. It is composed largely of green fibrous hornblende with tourmaline and quartz in about equal proportions, a little accessory magnetite and oligoclase-andesine. The quartz is largely secondary. At the north end of the longer portage leading to Big Portage lake the schist gives way to a grey granitoid gneiss dotted with pseudo-porphyritic

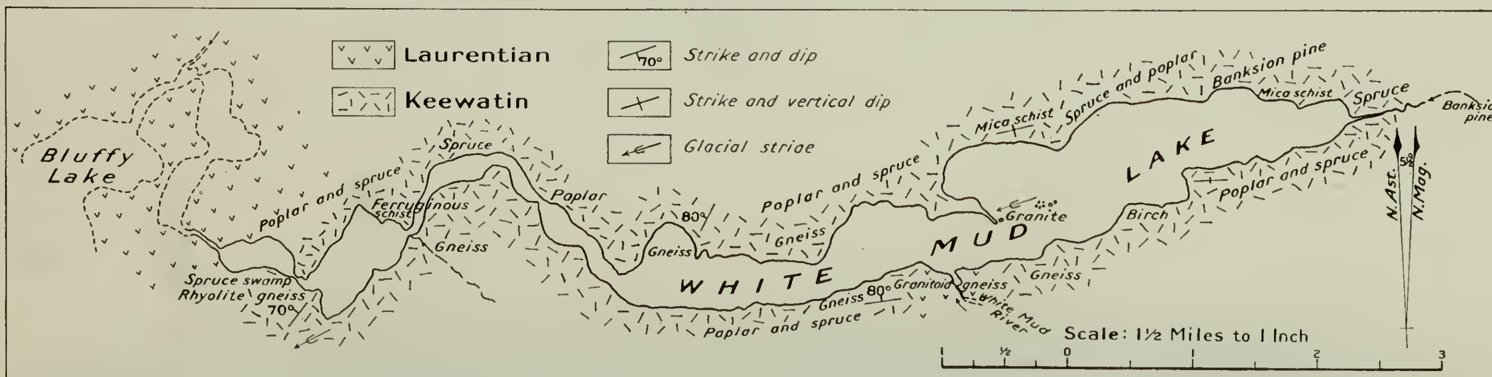
Overhanging (plucked) cliff of granitoid gneiss on the west bay of Gull lake.

pinkish-yellow feldspars which are seen microscopically to be rounded microcline crystals, with both primary and secondary quartz, embedded in green biotite with a little muscovite. The accessories are titanite, zircon and magnetite, and secondary leucoxene; kaolin and sericite are also present. This gneiss contains angular inclusions of the green hornblende schist which are arranged with their greater axes parallel to the lamination. Small quartz veins cut both gneiss and schist across the strike.

In ascending the creek which flows into the western arm of Big Portage lake two small lakes were seen leading to the west, and between these, at a point



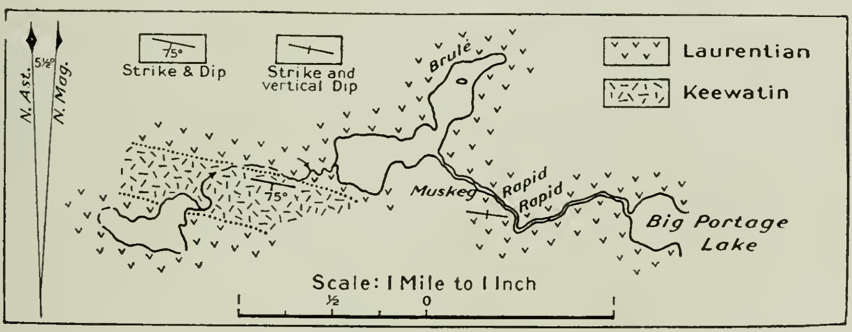

Plan showing survey of southwestern part of Birch lake and geology of route therefrom to Gull lake.




Plan showing geology along the shores of White Mud lake. The large expansion of White Mud lake immediately underneath the legend blocks for "Laurentian" and "Keewatin" is called Brulé lake.

about a mile west of the larger lake, another band of Keewatin schist was found, grey-green in colour and highly ferruginous. It has in part an appearance which suggests that it had originally a pillow structure. Microscopically, it is a hornblende schist in which the quartz mosaic filling the interstices between the hornblende laths carries a large amount of automorphic magnetite. While quite similar in type to the ferruginous schists of White Mud and Little Shallow lakes, the percentage of iron present is considerably less. The schists have a width of about 100 yards and are in contact on both sides with gneiss. The strike of the band is about 103°, dip southerly 75°. It is traversed by pegmatitic apophyses from the gneiss. The isolated bands of schist in this locality probably represent a series of pinched-in folds, and may or may not unite with each other or with the main body of schists farther west.

The stream which enters at the west end of Big Portage lake proved to be not the outlet of Birch lake, as supposed by previous explorers. We therefore proceeded to the bay of Gull lake which lies to the west of the large island occupying the centre of that lake, and after examining its shores discovered the mouth




Geology westerly along supposed route from Big Portage lake to Birch lake.

of the Birch Lake river at the northwest corner of the bay. The rock seen from Big Portage lake to the mouth of Birch Lake river is a granite gneiss composed essentially of orthoclase, microcline, quartz and green biotite. with occasional aplite dikes which have in addition to orthoclase and quartz, a little oligoclase-albite and carry muscovite but no biotite. There are occasional inclusions of Keewatin schist. At the mouth of Birch Lake river this gneiss gives way to a coarse porphyritic granite gneiss which is apparently intrusive in the grey gneiss of the region just passed over. This younger granite consists of orthoclase. quartz, microcline and green biotite, with accessory titanite in rhombs and grains. zircon, and titaniferous magnetite and pyrite. There is only slight alteration observable. which has resulted in a little leucoxene. kaolin and sericite. The groundmass is coarsely granular, and the phenocrysts, which preserve very perfect crystal outlines, are on an average from an inch to an inch and a half in diameter and in some cases as much as four inches in maximum dimensions. They are orthoclase. and are often Carlsbad twins.

This granite is traversed by three distinct types of end-intrusions. which are, in the order of their age: (1) pegmatite in small dikes of an inch or thereabouts in width, which is faulted by (2) aplite dikes six or eight inches across, the latter in turn being faulted by (3) small quartz veins. The aplite is characterized by the presence of green biotite and a little oligoclase.

Following up Birch Lake river this body of granite-porphyry is exposed on the banks as far as the second short rapid below the outlet of Springpole lake. At the rapid below this, where the course of the stream alters from south to northeast, the porphyritic granite can be seen in intrusive contact with grey gneiss similar to that on Gull lake. The distance across the stock of granite porphyry where crossed by the river is about six miles and a half, in a direct line from east to west.

#### Springpole Lake and Birch Lake

The grey gneiss which lies along the south shore of Springpole lake strikes slightly south of west, and the trough occupied by the lake lies along the strike. The north shore of the lake consists of hornblende schists, which rise in a cliff. They are light and dark grey banded rocks which dip to the northward at about 60°, and strike 75°-80°. They are very similar in appearance to those on the northeast side of the conglomerate bed of Slate lake and to others near Hungry narrows on Lac Seul. Microscopically, they are seen to be fine grained hornblende schists with some automorphic magnetite distributed through the laths of green hornblende and the intervening quartz mosaic.

The much greater amount of magnetite and the tourmaline found in some instances farther south may be due to impregnation from the gneissoid granite, as it occurs generally in the narrow bands isolated in the gneiss. The schists on Springpole lake are traversed by bedded veins of quartz, mainly a foot or less in thickness, and there are others which cut both the gneiss and the schist as well as the granite-porphyry gneiss farther south, transversely. Several assays failed to find gold in any of these. They are often rust-stained from the decomposition of pyrite. They appear to be subsequent in age to the younger granite of the neighbourhood, and are probably the latest phase of its intrusion, due to the escape of aqueous solutions along cracks in the cooling rocks. Near the west end of the lake they are of a glassy quartz, and contain needles of tourmaline.

Proceeding westward along the eastern arm of Springpole lake, the cliff of schists thirty or forty feet high forms a remarkably straight shore line on the north side for about five miles in a bearing of about S.85°W., while the gently sloping gneiss forms an irregular shore on the south side. After this there is a slight turn of the shore to a direction nearly due west for about two and a half miles, while the contact between the schist and gneiss continues on the same bearing as before and crosses the lake toward the southwest. After this the strike curves to the northwestward following a broad gentle anticline whose axis runs in that direction, and several massive beds of lava appear underneath the schists. The southern arm of the lake crosses the anticline by a shallow channel, coming to an end at its western limit, where the river enters by a rapid which appears to fall over the lava beds as they again plunge below the surface. The axis of the anticline to the north is occupied by the northern arm of Springpole lake, and by a bay which extends south from Birch lake and lies to the west of the north arm of Springpole lake.

The river was not followed farther west, but crossing the portage at the north bay of Springpole lake we turned west along the south side of Birch lake and examined the shores as far as the end of the southwestern bay, and thence in a cursory manner north-eastward to Birch narrows from which the route leads westward up the Shabumeni river to the lake of the same name. We did not see the actual outlet of Birch lake, which flows from a bay on the south side of the southwest arm.

On the north arm of Springpole lake the rocks noticed were mainly altered pillow lavas lower in the series than the schists seen further east, but brought to the surface by the anticlinal fold as already mentioned. The lavas exposed on the flanks of the anticline are dark grey, fine-grained, somewhat sheared rocks, with grains and streaks of pyrite easily visible to the naked eye. Microscopically, they consist of sheaves of fibrous amphibole with magnetite in grains and aggregates. The altered feldspars which remain are lath-shaped in some cases, which may indicate that the rock was originally a diabase. Secondary quartz and calcite are also present. These rocks appear to represent sills in softer rocks which have developed more marked schistosity. In the central part of the anticline the pillow-lavas have been rendered much more schistose. They were porphyritic in texture; the groundmass was cryptocrystalline or is now devitrified. It consists of small grains of quartz and feldspar with occasional grains of magnetite and ragged leaves of biotite, also secondary chlorite, calcite, kaolin and sericite. The phenocrysts, now much altered, were oligoclase-albite or perhaps a more basic plagioclase, and the rock may have been an andesite porphyry. It is lighter in colour than the diabase last described, and also older, since it lies lower in the series and represents surface extrusion, while the diabase was intruded as a sill. No quartz veins were seen in either of these more massive rocks.

Passing over the portage from the north arm of Springpole lake to Birch lake we descend the northern limb of the anticline. At the mouth of the small bay of Birch lake to which the portage leads, there is a bed of conglomerate exposed on a small island and on the shore thence to the next point westward. This has considerable thickness, possibly 150 feet, with a strike of about 115° (E.25°S.), or roughly parallel to the axis of the anticline as traced in the north arm of Springpole lake.

In constitution this conglomerate is practically the equivalent of that seen on Slate lake some thirty-six or thirty-seven miles distant. It contains rounded quartz pebbles almost identical in composition with those on Slate lake, the difference being that the rock has not undergone such intense shearing as at Slate lake, and the scattered individuals of biotite and feldspar are fresher, while magnetite grains are present in both cases, and the rock as a whole consists of a mosaic of quartz grains which has a fine "sugary" appearance. There are also pebbles of porphyrite in both localities in which the phenocrysts are oligoclase, or oligoclase-albite, representing the andesite lavas of the series below. At Slate lake the ferromagnesian constituent is mainly biotite, while at Birch lake it is hornblende, some of which appears also as inclusions in the feldspar phenocrysts. The phenocrysts at Slate lake are frequently fragmented, and the biotite leaves form fillings of the fractures to which they are parallel. The appearance is therefore that of a mashed rock, while at Birch lake the original granular condition of the groundmass is more evident, though the pebbles have suffered a considerable amount of weathering. It is probable that the mashed condition in the first case may be attributed solely to a shearing of the conglomerate as a whole in the Slate lake region, which has not taken place at Birch lake. Other pebbles show less similarity than the two already described, but the evidence seems sufficient to warrant at least a hypothetical judgment that the denudation to which the conglomerates owed their origin extended throughout the entire area covered by the schists in the Wenasaga, upper Cat River and Woman River valleys. It is therefore necessary to infer that we have here a widespread unconformity, and that the rocks above the conglomerate must be assigned to much later age than those below.

No examination was made of the upper series on Birch lake, as time did not permit, and we proceeded, as already said, to examine the southwestern part of the lake as far as Birch narrows without coming in contact with the conglomerate again. Camsell[1] speaks of meeting with it to the west of Birch lake, but in the short time which remained after reaching Birch narrows we did not attempt to duplicate his work or that of Dowling[2], both of whom have reported on the route from here to Mattawa on the English river, in whole or in part. Dowling also mentions a similar conglomerate north of the Wolf narrows on Red lake "with occasional pebbles of red banded jasper and others of a light yellowish quartzite, but the majority of the pebbles are of a dark purplish grey to green with a matrix of the same colour." This and the associated rocks agree quite perfectly with the appearance of the conglomerate and adjacent rocks on Slate lake, and also with the conglomerate on Birch lake, which was observed at a point about 80 miles from the occurrence at Wolf narrows.

Passing westward a gneissic rock is exposed on a point in the bay just west of the north arm of Springpole lake, whose macroscopic appearance suggests greywacké. It consists of large grains of oligoclase which have been in some cases rounded off by cataclastic action, or have undergone fracturing and slight alteration. There is also a considerable quantity of biotite with magnetite crystals sometimes included in the mica. The interstices are filled largely with calcite and quartz-mosaic. The rock is therefore crushed andesite porphyry or diorite.

Extending along the south shore of the southwestern arm of the lake from the bay just mentioned, rocks are exposed which in general present a schistose appearance macroscopically, and sometimes have also a bedded or parallel jointed structure striking at a small angle across the schistosity. Microscopically, they are seen to contain grains of acid plagioclase, sometimes also fragmental quartzes in a matrix of parallel muscovite and chlorite, with more or less magnetite in grains, secondary calcite and quartz-mosaic. These still represent the dioritic types of rock common in the Keewatin formation farther south and east, and possibly in some cases the soda-rhyolites which are so abundant in the Lac Seul region.

[1] Camsell, Chas., Geol. Sur. Can., Vol. VI, N.S., 149A, quoted in Rep. Bur. Min., Vol. XXI, Part II, p. 91.

[2] Dowling, D. B., G. S. C., Vol. VII, Part F, quoted in "District of Patricia," Rep Bur. Min., Vol. XXI, Part II, p. 19-48. (See p. 43 for conglomerate beds.)

Toward the southwestern end of the bay where it forks there is a crescent-shaped island on which a number of claims have been staked. The rocks on the island and adjacent shores include a talcose schist, a green quartzose rock which appears macroscopically to be partly serpentine, and a banded jaspilyte consisting of granular quartz with a rhombic mineral, probably siderite, arranged in bands appearing red to the eye, though the colour is scarcely noticeable under the microscope, The talcose rock under the microscope proves to be an altered porphyrite traversed by talcose shear-planes. The groundmass is granular and consists partly, at least, of small plagioclase laths with idiomorphic (rhombic) carbonate and talc or sericite, and some earthy-looking iron ore. The phenocrysts are of oligoclase. The green rock was also found microscopically to be a porphyrite, the groundmass of which may have been originally glassy with feldspar microliths, but is now much sericitized, the sericite being in parallel or net-like arrangement. The phenocrysts are small laths of plagioclase (andesine or more basic) and larger quartz individuals, sometimes with well marked crystal outlines, often rounded and containing lath-shaped inclusions of feldspar. The rocks would therefore appear to have been quartz-andesite or quartz-diorite porphyries, and their peculiar difference from similar rocks in the locality is no doubt attributable to hydrothermal action or more intense effect of regional metamorphism in this locality. The green rock has a width of 20 or 30 feet across the strike.

On the bay which extends to the north from this locality another altered porphyrite was found, in which the groundmass consists of small grains of quartz (?) surrounded by colourless mica with areas of calcite and titaniferous magnetite and leucoxene alteration products. The phenocrysts are of labradorite. None of the rocks staked or excavated contain gold so far as seen. The jaspilyte is more or less brecciated, and the fissures are filled with ferruginous material, but no body of ore was seen. It contains about 54 per cent. of siderite equivalent to 26 per cent. of iron. The exposure is a small one.

On the north channel of the southwest arm on the way from the southwestern end to Birch narrows, a schistose rock was seen which an examination proved to be a much altered hornblende schist with large amounts of calcite, the weathering out of which produces a pitted surface, in which the depressions are as much as two inches deep.

Proceeding westward up the Shabumeni river a number of quartz veins were noted, which on assay proved to be barren of gold or silver. They run in a N.E.-S.W. direction and the widest are three or four feet across. The country rock in which they occur is a greenstone largely altered to chlorite; the feldspars recognizable were albite or a more basic plagioclase; accessory titaniferous iron ores are also present, and the secondary minerals are chlorite, calcite and leucoxene.

On Shabumeni lake the greenstones continue to be the principal Keewatin rocks.

### IV.—The Trout Lake River Basin

On Woman lake the presence of pyrite in the rocks becomes noticeable before reaching the long narrows. The rock examined is a diorite porphyrite having a cryptocrystalline groundmass, in which some sericite and titaniferous magnetite are distinguishable. The feldspar phenocrysts are completely altered to sericite and kaolin, and the ferromagnesian phenocrysts to chlorite. In some parts aggregates of automorphic pyrite occur surrounded by borders of fibrous silica.[1] On the southwest arm of the lake are " dark, fine-grained, thin bedded rocks, of which some are thoroughly filled with pyrite and magnetite. Medicine rock, just out of water in the centre of the channel is apparently a mass of ore, while the weathered pyrite supplies the Indians with 'medicine.' "[2] A re-examination of this outcrop shows that it consists of verticallly dipping bands, which were recognized from east and west as (1) finely contorted ferruginous schist, (2) a fairly

Pegmatite dike in Keewatin rocks, west shore of Pakwash lake. Note flat topography in the background toward Little Shallow lake and the valley of the Trout Lake river.

coarse quartz-mosaic with occasional grains of pyrite and small laths and aggregates of automorphic hornblende, (3) cryptocrystalline granular quartz with minute hornblende aggregates at intervals, through which are distributed crystals and granular aggregates of pyrite, (4) crystals, grains and aggregates of pyrite filling about 75 per cent. of the rock with interstitial cryptocrystalline quartz mosaic and a few needles of ferromagnesian minerals, probably hornblende, (5)

[1] For rocks of this neighbourhood see D. B. Dowling, Geol. Sur. Can., N.S., Vol. VII, 1894, p. 43F, quoted in Ont. Bur. Min. Rep. 1912, Vol. XXI, Part II, pp. 41-42.
[2] D. B. Dowling, op. cit.

quartzose rock. The pyritous band is about six feet in width, and on assay it proved to contain no valuable metallic ingredients. The whole outcrop would be about 20 feet wide and strikes in a S.W. by S. direction. It affects the compass, and therefore contains magnetite or pyrrhotite. By following its strike to the N.E. the continuation of the pyritous deposit is found, about a quarter of a mile distant, on the north shore of the lake, but much reduced in dimensions. The country rock is a chlorite-sericite schist with some titaniferous iron ore. It is penetrated near the vein by a dike of quartz-porphyry with some andesine and hornblende in the granular groundmass, and zircon, magnetite and titanite accessories. The phenocrysts are orthoclase and quartz; the former sometimes microperthitic, the latter generally eroded and irregular in outline. A similar dike about nine feet wide occurs on the east side of the lake just south of the long narrows. The dike near the "medicine rock" cuts a quartz vein, which probably indicates that the veins of the neighbourhood do not owe their origin to the porphyry intrusion. In the same neighbourhood a five-foot vein well charged with pyrite and carrying also some value in gold was found. Its strike is 80°. It occurs in a mica diorite porphyry which has a groundmass of cryptocrystalline quartz (?) and feldspar with phenocrysts of hornblende, biotite and oligoclase. It contains angular inclusions of similar rock, but finer grained and with a larger proportion of hornblende, but little biotite. Titaniferous magnetite occurs in both the rock and inclusions as an accessory. The rock seems therefore an andesitic lava containing fragments of those parts of the flow which were more quickly cooled than the main mass, and afterwards broken up by its motion and included in the portion which was still liquid.

Passing out of Woman lake into Woman river a gneissoid granite area is entered. The rock contains inclusions of the dioritic rocks of the Keewatin area to the northeast, and is itself composed of rounded feldspars (microcline, orthoclase, and some oligoclase-albite and microcline-albite-microperthite), with biotite and quartz. The Woman and Trout Lake rivers flow over no other rocks, with the exception of some narrow folds of Keewatin age on Trout Lake river from above Manitou fall to Whitefish fall.

On Pakwash and Little Shallow lakes the Keewatin formation again appears, occupying the west shore of each lake from its northern part to near the southern end, but a tongue of grey syenite gneiss separates the areas exposed on the two lakes and underlies the narrows which connect them, and the land for a short distance on each side. Along the western shore of Little Shallow lake from the second point south of the outlet to Pakwash lake as far as the narrows formed by the long point which projects from the east shore, there is a belt of ferruginous hornblende schist consisting of idiomorphic magnetite and hornblende (in small amounts) with quartz-mosaic filling the interstices, and a little apatite. It is reported to carry as much as 20 per cent. of iron in some samples and has been prospected by a number of persons, one of whom went so far as to take in a drilling outfit, but the writer was unable to find that any drilling was actually done. At the northern extremity the compass is strongly affected by a belt about 25 feet in width, which displays a banded appearance and some seams of quartz parallel to the strike, but these are veins or secondary lenses and not merely iron-free bands of the original rock. It is not, therefore, an exposure of "iron formation", but simply a belt of ferruginous hornblende schist similar to those seen on the White Mud lakes and to the west of Big Portage lake. Farther south the width of the iron-bearing rocks increases. At its southern end the strike abruptly changes, and the rocks show a great deal of contortion and fracturing. At this point a claim has been staked, but whether there is any greater concentration of iron oxide in the ore here the writer is unable to say. The strike which is west of south at the north end of the deposit, curves to east of south at the southern end before reaching the point where the abrupt change toward the west occurs. On the high island crossed from end to end by the ferruginous schist half a mile north of the narrows, the eastern edge of the schist is seen in contact with a grey gneissoid rock like that which occurs on Pakwash lake, so that the band of schist is apparently only a pinched-in fold in the gneiss, which also penetrates it in dikes. These dikes cut the quartz veins already mentioned, and the quartz is also found to be contorted with the schists wherever contortions occur. The ferruginous part of the schist band therefore lies along its eastern margin, close to the gneiss. There is a total width of half a mile or more of schist on the point between the lakes, flanked on each side by gneiss. Near the south end of Little Shallow lake the strike of the schist curves to the west, as already noted, and appears on the east shore of Pakwash lake at its widest part. It probably crosses the lake and connects with the schists on the west side. No ferruginous belt was observed in the schists on Pakwash lake, but the examination made was somewhat cursory.

#### A Mica Prospect

On the west side of Pakwash lake a pegmatite dike was seen penetrating the schist in a direction 70° east of north. It is about three feet wide, has coarse textured margins with prisms of tourmaline up to six inches long arranged perpendicularly to the walls. These are followed by quartzose bands about two inches wide on each side while the central part is of a finer textured pegmatite with little or no tourmaline. The other minerals present are orthoclase, quartz and muscovite, with some green chlorite or epidote. On the southwestern arm of this lake a claim has been staked, from which muscovite in sheets up to 3 x 4 inches in size has been obtained. The vein is said to be about 14 inches wide, and to contain approximately two-thirds muscovite. The granite from which these apophyses extend, and which has also possibly been responsible for the injection of iron into the schists, is a grey gneissoid rock. It contains darker inclusions of the neighbouring schists, which in places show a tendency to alignment along the strike of the gneiss. The strike is in general parallel to that of the schists where the two are in contact. Microscopically, the gneissoid granite has a hypautomorphic granular appearance, and its essential minerals are: orthoclase (60 per cent.), a little plagioclase, hornblende, biotite and a few grains of augite and quartz, with accessory magnetite and apatite. There is some secondary calcite and kaolin. The rock is a syenite rather than a granite.

A syenite apophysis which cuts the ferruginous schists of Little Shallow lake transversely has a gneissoid structure which runs across the apophysis and parallel to the banding of the schists. At the same time the banding, which is due to layers of more or less quartzose material, seems to have been primary, as the bands of differing hardness project differentially on the fracture line at the edge of the dike. This would militate against the theory, elsewhere expressed, that the iron in these rocks is due to impregnation from the grey gneissoid granites.

The syenite itself is traversed by darker dikes of hypautomorphic mica-diorite, which consists in one instance of automorphic hornblende and biotite laths with feldspar filling the interstices, which is probably andesine with some orthoclase and quartz. There is a very small amount of iron ore present, a little titanite being included in the biotite, and some secondary epidote, due to the alteration of hornblende. These dikes have a possible relationship to the diorite dikes seen on the English river on an island opposite the Hudson Bay Company's post at Pine Ridge. At Pakwash lake these dikes may well be basic differentiation-rocks allied to the syenite.

## Summary

The rocks in the area traversed during the summer appear to fall under the following sub-divisions:

RECENT.

Stratified clays, sands, lake and river terraces.

PLEISTOCENE.

Boulder-deposits, some morainic ridges, slight amounts of till.

ALGOMAN (?)

Younger granite porphyry of Birch Lake river.

LOWER HURONIAN [1] (?)

Upper schist series, above the conglomerate of Slate and Birch lakes—including conglomerate, hornblende schist, quartzite and limestone. The last two were observed by Dowling on the north shores of Birch lake, but were not seen by the writer.

*Erosional Unconformity.*

LAURENTIAN.

Older gneisses including (*a*) The reddish biotite gneiss on the 6th meridian line south of Lac Seul. (*b*) The grey muscovite-biotite gneiss of the Upper Wenasaga River valley and Gull Lake area. (*c*) The biotite-hornblende syenite gneiss of Pakwash lake and English river. The last two are characterized by the presence of much tourmaline in their pegmatitic and other end-facies.

KEEWATIN.

The soda-rhyolite of the Lac Seul basin, altered andesitic and dioritic volcanics, altered diabase, hornblende schists in part ferruginous, and the jaspilyte of Birch lake, assigned with some confidence to the Keewatin.

The above table must be taken with some reservation as yet. The young granite (Algoman?) was not seen in contact with any rocks except the Laurentian, and may therefore be older than the upper schistose series so far as local evidence goes. It is placed above the Lower Huronian only tentatively, and in conformity with the position which has been proven for the younger granites of the Laurentian complex in other parts of the Province.

[1] The fragmental rocks here classed as Lower Huronian probably represent the Timiskaming series that occur elsewhere in Ontario.—(W. G. M.)

Secondly, while the granite on both sides of the schist area on the lower Wenasaga is intrusive in the schists, the conglomerate was seen on only one line crossing the area, and hence the rocks above the conglomerate should be older than the granite with which they are in contact, as well as those below. In that case the grey granite of the Lake Margaret area would be post-Lower Huronian, and possibly also the granite of Pakwash lake which seems to be related to it in composition. The granite of Big Portage and Gull lakes may well differ in age from the Lake Margaret granite to the south of the narrow schist band on the Height of Land portage. On the other hand, the great apparent thickness of the rocks on Slate lake may be due to faulting, or a second outcrop of the folded-in conglomerate may have escaped observation. Another possibility is that the upper schists may be pre-Laurentian, perhaps corresponding in age to the Grenville. A fact which suggests this is the absence of granitic pebbles from the basal conglomerate.

The porphyry dikes which cut the Keewatin rocks of Woman lake are also probably younger than the older Laurentian, and perhaps younger than the younger granite, but their relations were not definitely determined except as regards the Keewatin.

### Table of Glacial Striae

(Astronomic bearing E. of N.)

| | | |
|---|---|---|
| 1. | ¾ mile E. of Freda Station | 231° |
| 2. | N. side of Ord lake, E. of 5th mile | 246° |
| 3. | Portage, Moose L. to Round L., 13th mile | 221° |
| 4. | N.E. point of island on Round L. | 221° |
| 5. | Portage, Round L. to Patten L. | 225° |
| 6. | Patten L., W. side, point S.E. of 15th mile-post | 230° |
| 7. | Small lake, 1 mile S. of South Cove (17th mile) | 245° |
| 8. | Lake, 1 mile W. of the above | 235° |
| 9. | Island in Lac Seul, W. of 20 miles 70 chains | 250° |
| 10. | White Mud river, S. end of second small lake above outlet | 240° |
| 11. | White Mud lake, rock at end of sandy point | 255° |
| 12. | Slate L., S. shore, just E. of first narrows above outlet | 250° |
| 13. | Second set of striæ at the same point | 280° |
| 14. | Hailstone portage (connecting with Wenasaga and Cat L. rivers) | 233° |
| 15. | N. end of narrows, Big Portake lake | 245° |
| 16. | W. bay of Gull L., S. shore, near S.W. point of large island | 250° |
| 17. | W. bay of Gull L., southwestern part | 227° |
| 18. | S. side Springpole L., 1½ miles E. of W. end | 239° |
| 19. | Channel leading to N. arm of Springpole L. | 227° |
| 20. | N. arm Springpole L., near portage at N. end. | 238° |
| 21. | Point on S. bay of Birch L., just W. of Springpole L. | 223° |
| 22. | S.W. Bay, Birch L., on crescent-shaped island | 255° |
| 23. | Shabumeni L., shore opposite outlet | 238° |
| 24. | W. side Little Shallow L., bay just N. of the narrows | [1]215° |
| 25. | W. side Pakwash L., 4 miles from S. end | 250° |
| 26. | E. side Pakwash L., 2 miles N. of outlet | [1]270° |
| 27. | Point on Mattawa river, 3 miles from Pakwash L. | 250° |
| 28. | English river, about four miles below Ear Falls | 256° |
| 29. | English river at Ear Falls | 254° |

## Soil

### Freda Station to Lac Seul

The valley in which Freda station stands is underlain by a sandy till. Proceeding northward, the line lies for a mile or more over a succession of sandy

[1] These bearings may be affected by local attraction of the compass.

ridges and flats bounded to the east and west by hills of bare gneiss. From a point a mile and a quarter north of the station there are alternate ridges of gneiss with little or no covering and swampy flats intervening, wooded with spruce, and in part with red cedar, balsam, birch, birch alder, etc. On the hills poplar and Banksian pine are the prevailing trees, while birch-alder fringes the water courses and lake shores. The soil underlying the valley-flats appears in some cases sandy, while in others it consists of a grey loam, and there are also deep deposits of black peaty muck which conceal the subsoil. Sandy deposits sometimes extend up the hillsides, which are in that case wooded with Banksian pine.

On the east side of Miller lake there is a considerable sand flat, which is followed by clay soil clothed with large poplars on the portage to the north. This portage leads nearly a mile N. by W. to Ord lake, round the shores of which stratified clay is to be seen at some points, especially between Ord and Pine lakes, but most of the shores consist of high bluffs of gneiss.

On the lake to the northwest of Ord lake clay banks were also reported. The western shores of Pine lake are low and composed of a loamy or sandy deposit, while sand and boulders cover the lower slopes of the hills for some distance north of Ord lake and west of Pine lake.

From this point northward the granite hills increase in height and form the watershed between the streams flowing into Ord lake and thence westerly toward the Cedar river, and those which flow into the south side of Lake Seul. Among these hills lie a few peaty lakes, and a morainic ridge about half a mile in length and fifty feet high at the highest point separates two such lakes to the east of the 12th mile.

To the east of the 14th and 15th miles an area of clay land extends for a mile or more, through which the outlet of the small round lake east of the 14th mile finds its way to the northeastward. The valleys to the west of the 17th mile are floored with swampy flats, and the small lake half a mile south of South Cove is connected with a larger one to the west by a creek three-quarters of a mile long, which flows through a deposit of stratified clay.

Following the line along the western side of South Cove, clay banks appear on the 21st mile, and from thence to Island bay there is a continuous clay area with occasional projecting rocks. On the point between Island bay and the western arm of the lake the same conditions exist, and the end of the line at the north side of the lake is on a sandy shore, beyond which there seems to be a considerable area of level land.

Along Lac Seul to the east and west of the line clay cut-banks are of frequent occurrence, and in fact this part of the valley of the English river and that which lies to the west is largely covered by a deposit of fine stratified silt or sandy clay, which extends also for some distance up the valleys of the tributaries, running out into more sandy deposits at the upper ends. It appears therefore that a post-glacial lake or an arm of such a body, probably Lake Agassiz, filled the valley of the English river and its tributaries as far as the basin now occupied by Lac Seul. At Hudson and Sioux Lookout there are well marked terraces above the levels of Lost and Pelican lakes, which may also be explained as old beach levels, but no effort could be made to trace the shore lines. The Indian reserve between Hudson and Lac Seul is largely covered with arable land which undoubtedly formed a part of the lacrustine deposit.

Till sheets are of very small extent in the area which was examined during the summer. At Pine Ridge post there is a good area of tillable land, and the official in charge, Robert Young, maintains a vegetable garden near the post.

### The Wenasaga Valley

Ascending the Wenasaga river, clay land is seen on both sides as far as the first fall, and a cut-bank on the east side of Wenasaga lake exposes a deposit of stratified clay about 35 feet thick. This clay contains a few small stones which probably indicate the presence of floating ice in the depositing waters. A few small concretions were also noted in the clay, which have a septate structure internally and are formed by the growth of crystalline calcite as a cement between the particles of the clay. The level clay surface appears to extend about half a mile east from the lake, when it is interrupted by a hill. The west side of Wenasaga lake shows no clay on the shores. Above the lake the river seems to have cut a channel down to a temporary grade through a level deposit of sand, and has also developed some meanders with flat flood-plains in their loops. This extends as far as the falls below the outlet of Bluffy lake, when a gneissic ridge is encountered, and the shores of the lake above show little soil of value. On the White Mud river, which enters from the east at the northern end of Bluffy lake, there are some spruce swamps on either hand in the lower reaches, and the stream which enters at the northeast corner of the fourth small lake was followed for about a mile through low flat land timbered with spruce and some large poplar. The stream that enters at the east end of the large lake (White Mud lake) also flows in its lower reaches through spruce flats, but as we ascend the banks increase in height to 30 or 40 feet and are composed of grey sandy clay, mainly forested with Banksian pine. The stream itself by its brown muddy waters seems to indicate that it flows over a drift area of the same type higher up. The remainder of the country surrounding White Mud lake and river is hilly, and while in places thinly covered with drift, is largely rocky.

Proceeding northeastward, the Wenasaga river above Ogani lake meanders through a valley floored with grey stratified clay. On the northwest side of Slate lake some sandy terraces rise about 30 or 35 feet; the lowest one is about 15 feet above the water, while the trail which leads for half a mile southeastward from the southern bay of this lake lies over low clay-covered hills and ends at a small lake surrounded by an area of muskeg a mile or more in width.

Above Slate lake the valley of the Wenasaga is floored with silty sediments whose level surface is wooded with spruce and in some places with poplar, balm of Gilead and occasional ash, tamarack and Banksian pine. The river meanders through the flat which seems to be of considerable width. Some fine areas of spruce were observed here. This general condition continues, and few outcrops of rock are seen until the boundary between the Keewatin and the succeeding granite is nearly reached. At some points high banks of sand also occur.

### The Granite Area

After passing into the granite area, the small lakes as far as the Hailstone portage are surrounded by rocky hills, and very little incoherent material was seen except a few deposits of sand and swampy land along the creeks. The same statement is true of Big Portage and Gull lakes and connecting waters; a few muskegs lying between the bare gneissic hills are the only superficial deposits to be seen. Ascending Birch Lake river, a deposit of sand occurs on the west side of the river, just before Springpole lake is reached, and more is to be seen along the channel near the southwest end of the lake. With these exceptions nothing approaching soil was met with on Birch lake, Shabumeni river or Shabumeni lake until we reached Woman portage, where the trail passes over a thin superficial covering of soil and a terrace-like sand-flat largely covered with muskeg above the small lake at the south end of the portage. The lake itself and the river below are underlain with a deposit of stratified white clay.

### Trout Lake River Valley

Descending Woman river no soil is met with until the portage just above Snake lake, on which the rock is overlain by a thin coating of clay. After passing the canyon below Snake lake, which marks the descent of the river to the wide valley occupied by Trout Lake river, banks of clay and marshes apparently underlain by alluvium appear on both sides of the river, and these clay lands are continuous as far as Little Shallow lake. Near Manitou falls the river has cut through them a channel about thirty feet deep, which in places displays a well-marked terrace. This is generally about 15 feet above the river, while a higher bank bounds its upper surface 100 yards or thereabouts farther back. Apparently two stages of erosion are thus indicated, the first having developed a fairly mature valley before a subsequent rise of the land or the cutting through of drainage barriers below caused the lower cutting of the present river channel.

The successive deposits of clay at different levels along these rivers, with alternating sandy deposits, probably represent stages of recession of the large glacial lake already mentioned. The clays become thicker and more continuous in the lower reaches of the valleys, where deposition was continued longer, as one would expect under such circumstances.

The deposit consists of a grey sandy stratified clay with some, but only a few, stones, the whole nearly identical with that seen on Wenasaga lake, except that no concretions were observed on Trout Lake river. Approaching Little Shallow lake, the level of the land gradually falls to that of the river, and the lake is entered through extensive marshes. The waters of the lake are extremely shallow, and the clay deposit forms the bottom at least of the northern half of the lake. Along Trout Lake river this clay forms an important area of cultivable land, which probably extends for some miles on either side of the river, though its width could not be determined from the river owing to lack of time. The narrows between Little Shallow lake and Pakwash lake are bordered by several hundred acres of marsh land which with a little improvement might produce fine crops of hay.

At points along the Mattawa river and continuously along the English river from the mouth of the Mattawa to the Ear falls, there are banks of stratified clay which bear abundant grasses, among which red-top and timothy were noticed.

The agricultural value of the clays of the Trout Lake river basin may be to some extent inferred from the following partial analysis which has been kindly furnished by Professor R. Harcourt of the Ontario Agricultural College, Guelph:

| | Per cent. |
|---|---|
| Nitrogen (N) | 0.14 |
| Lime (CaO) | 2.42 |
| Magnesia (MgO) | 1.10 |
| Potash ($K_2O$) | 2.58 |
| Phosphoric Acid ($P_2O_5$) | 0.225 |

This represents the total amounts of the various constituents determined from a fused sample, a method which Professor Harcourt states has been found most satisfactory in his experience.

## Climate

Of seventy-seven days on which records were kept during the summer between June 11th and September 8th, rain fell on 26, the temperature fell to 32° or below that twice (August 8th and 28th), and the mean of the daily mean temperatures observed was 63.86°. The record which was not taken from July 16th to 30th, would no doubt have made the mean somewhat higher. On the other hand the maxima are probably in some cases high owing to the difficulty of avoiding the direct rays of the sun on some days. Great accuracy cannot therefore be claimed for these observations, but the result is probably not very far from the mean summer temperature of the region as a whole.

The places at which the readings were taken have a north and south range of about 95 miles, and an east and west range of about 65 miles; the result can therefore only be considered as a very general statement of summer climate for the region north of the National Transcontinental (Canadian National) railway, and including the country which surrounds Lac Seul, the Wenasaga and Trout Lake river valleys, and a part of the Cat Lake river valley from Big Portage lake to Shabumeni lake.

Table of meteorological data collected during the field season of 1919, on the sixth meridian line from Freda to Lac Seul, and thence on canoe routes as far north as Birch lake.

| Date. | Place. | Temperature. Minimum. | Temperature. Maximum. | Wind and Sky. |
|---|---|---|---|---|
| June 11.. | Freda | 54° | 82° | |
| " 12.. | Mile 1 (3 miles N. of Freda) | 62° | 77.5° | |
| " 13.. | " " | 62° | 79.5° | |
| " 14.. | " 2 (1 M. 40 ch.) | 50° | 80° | Cloudy; fair. |
| " 15.. | " 2 " | 56° | 87° | Fair. |
| " 16.. | " 2 " | 52° | — | |
| " 17.. | N. end Miller lake (5th mile) | 60.5° | 80° | Fair; breezy; thunderstorms. |
| " 18.. | " " " " | 64° | 77° | S.W.; clearing. |
| " 19.. | N. shore Ord lake (7th mile) | 54° | 73° | Fair. |
| " 20.. | Mile 8 (spring) | 46.5° | 80.°5 | Fair. |
| " 21.. | " 10 9 m. 16 ch.) | 52.5° | 80° | S.W.; fair. |
| " 22.. | " 11 | 62° | 70° | Cloudy; rain. |
| " 23.. | " 11 | 60.5° | 76° | Showery. |
| " 24.. | " 12 (S. side Moose L.) | 59.5° | 80° | Fair. |
| " 25.. | " 13 (N. end Moose L.) | 70° | 83° | Fair; thunderstorms. |
| " 26.. | " 15 (S. end Patten L.) | 47° | 66° | Cloudy. |
| " 27.. | " 15 " " L.) | 46.5° | — | |
| " 28.. | " 17 (N. end Patten L.) | 55° | 73° | Cloudy; clear. |
| " 29.. | " 18 S. end S. Cove, Lac Seul) | 57° | 79° | Fair. |
| " 30.. | " 18 " " " | 63° | 88° | W.; fair; thunderstorms. |
| July 1.. | Island bay to Pine Ridge | 66° | 73° | Thunderstorms. |
| " 2.. | Pine Ridge | 62° | 75° | Fair; rain. |
| " 3.. | Pine Ridge to Mattawa river | 63° | 75° | W.; clearing. |
| " 4.. | Mattawa R. to N. end Pakwash L. | 54.5° | 75° | Fair. |
| " 5.. | N. end Pakwash L. | 50° | 83° | Fair. |
| " 6.. | N. end Pakwash L. | 51° | 81° | N.E.; fair; cloudy; |
| " 7.. | N. end to S. end Pakwash L. | 60° | — | N.E.; fair; stormy; rain. |
| " 8.. | S.E. part Pakwash L. | 56.5° | 72° | S.W.-W.;fair;windy. |
| " 9.. | " " " | 62° | 63° | W., N.W.; rain; squalls. |
| " 10.. | Pakwash L. to Pine Ridge | 50° | 74.5° | N.W., fair. |
| " 11.. | Pine Ridge to Shanty Narrows | 50° | 73° | Fair. |
| " 12.. | Shanty Narrows to Lac Seul Post | 53° | 77° | N.W., fair. |
| " 13.. | Lac Seul Post, H.B.Co. | 62.5° | 77.5° | S., cloudy; fair. |
| " 14.. | Lac Seul Post to Hudson | 65.5° | 67.5° | W., strong; fair. |
| " 15.. | Hudson | 46° | 74° | W., fair. |
| " 16.. | Hudson to Sioux Lookout | 56° | — | W., fair; showers. |
| (Interval without observation while at Sioux Lookout.) | | | | |
| " 30.. | N. end Wenasaga L. to Bluffy L. | 63° | 72° | Fair to cloudy. |
| " 31.. | N. end Bluffy L. to White Mud L. | 39° | 77° | Fair. |
| Aug. 1.. | White Mud lake | 48° | 76° | Fair. |
| " 2.. | " " " | 48° | 78° | S.W., fair. |
| " 3.. | Bluffy lake, N. end | 63° | 82° | Fair; thunderstorms in afternoon. |
| " 4.. | Bluffy L. to near Ootchi R. | 59° | 75° | E., cloudy; rain. |
| " 5.. | Ootchi R. to W. end Slate L. | 65° | 76° | S.W., clearing. |
| " 6.. | W. end Slate L. to E. end | 63° | 72° | Rain; fair. |
| " 7.. | Slate L. to 6½ ft. fall | 54° | 66.5° | Cloudy to fair. |
| " 8.. | 6½ ft. fall N. end L. Margaret | 29° | 72° | Fair; no wind. |
| " 9.. | L. Margaret to Hailstone L. | 42° | 73° | Fair. |
| " 10.. | Hailstone L. | 42° | 70+° | Fair; rain. |
| " 11.. | Big Portage to Big Portage L. | 60° | 75.5° | S., rain; clearing. |

Table of meteorological data.—*Continued.*

| Date. | Place. | Temperature. Minimum. | Temperature. Maximum. | Wind and Sky. |
|---|---|---|---|---|
| Aug. 12.. | Big Portage lake | 61° | 74.5° | Thunderstorms. |
| " 13.. | Big Portage lake | — | 66° | Rain; clearing. |
| " 14.. | Big Portage L. to Gull lake | 56° | 75.5° | Fair. |
| " 15.. | Gull lake | 59° | 76° | Thunderstorms; fair |
| " 16.. | Gull lake—Birch Lake river | 59° | 70° | Fair. |
| " 17.. | Springpole lake, W. end | 60° | 73° | N.W., rain; clearing. |
| " 18.. | Springpole lake | 52° | 75.5° | Fair. |
| " 19.. | " " | 52° | 78° | Fair; thunderstorms. |
| " 20.. | N. arm Springpole L. to Birch L. | 68° | 71° | N.W., clearing. |
| " 21.. | S. side Birch lake | 58° | — | W.,strong, rain; fair |
| " 22.. | " " " | 53.5° | 74.5° | Fair. |
| " 23.. | S.E. bay, Birch lake | 58° | 68° | W., rain; fair. |
| " 24.. | N.W. end Shabumeni R. | 49° | 59° | W., cloudy. |
| " 25.. | Shabumeni R. to Woman Portage | 50° | — | W., fair. |
| " 26.. | Woman Portage to Woman R. | 37° | 68° | W., fair. |
| " 27.. | Woman R. to Manitou Falls | 49.5° | 63.5° | W., cloudy; fair. |
| " 28.. | Manitou Falls to Pakwash lake | 32° | 76° | Fair. |
| " 29.. | N. end Pakwash L. to S.E. shore | 51° | 56° | N., rain. |
| " 30.. | Pakwash L. to Pine Ridge | 51.5° | 71° | N.W., fair. |
| " 31.. | Pine Ridge | 44° | 64.5° | W., fair. |
| Sept. 1.. | Pine Ridge to Shanty Narrows | 56° | 69° | E., cloudy; rain. |
| " 2.. | Shanty Narrows to South Cove | 48° | 68° | S.W., fair. |
| " 3.. | South Cove to Shanty Narrows | 38° | 63° | W., cloudy. |
| " 4.. | Shanty Narrows to Poplar Narrows | 40° | 69° | W.byS., fair; cloudy. |
| " 5.. | 6 M. W. of Lac Seul Post to S.E. arm, main steamer route | 47° | 70+° | Fair. |
| " 6.. | S.E. arm Lac Seul to Grassy lake | 53° | 70° | S.E., cloudy. |
| " 7.. | Grassy lake to Hudson | 54° | 62° | E., thunderstorms. |
| " 8.. | Hudson | 44° | — | E., rain; clearing. |

## Timber, Game and Fish

*Timber.*—A timber expert with an assistant accompanied the party as far as the line was run and afterwards ascended the Wenasaga river as far as Slate lake. It is therefore unnecessary to describe here the forest conditions of the part of the area which was examined by them. A few notes were made on other parts of our route, the substance of which is as follows:

On White Mud river and lakes there are a number of areas covered by well grown spruce, bordering on the waterway, but in general the shores are backed by low rounded hills wooded with a mixture of spruce (*Picea nigra*) and poplar (*Populus tremuloides*) or in a few spots with Banksian pine (*Pinus Banksiana*) and white birch (*Betula papyrifera*). At the east end of White Mud lake the low flats are covered with black spruce, which gives way to Banksian pine as the banks of the stream become higher. The area of this timber which was seen extends up-stream for several miles, but the width is unknown.

Above Slate lake the banks of the Wenasaga are heavily clothed with black spruce of good size. Intermingled with it are occasional Banksian pines, poplars (*P. tremuloides*), balsam poplar (*P. balsamifera*), ash (*Fraxinus sambucifolia*) (?) in wet places, and tamarack (*Laryx Americana*). Some burnt spots were observed, but on the whole there is a large amount of spruce on this part of the river as the valley appears to be wide. The granitic area to the north is largely occupied by an old burn until the neighbourhood of Marsh lake is reached, when the hilly shores are well clothed with spruce, which extends with some burnt areas as far as Hailstone lake. Much of the country surrounding this lake, Big Portage lake, and the southwestern part of Gull lake has been burnt within the last few years. It was formerly covered with spruce.

On ascending Birch Lake river from the west bay of Gull lake, the rocky banks were found well wooded with mature spruce, diversified just below the outlet of Springpole lake by sandy clay terraces, which are covered with large poplars and Banksian pine. The northern arm of Springpole lake and the southwestern part of Birch lake are well timbered with mixed spruce, birch and poplar, which is unburned except at the end of the southwest bay of Birch lake, where there is a freshly burned area surrounding some claims staked in the summer of 1917. The shores of Shabumeni lake and river are also well wooded, but the country surrounding Woman lake was burnt a few years ago. The same brulé extends down Woman river practically as far as the junction of Trout Lake river. Below this point the flat lands on each side are in general heavily timbered with spruce and large poplar. The shores of Pakwash and Little Shallow lakes and the southwestern part of the connecting narrows are well wooded with poplar and spruce. The Mattawa river and the English river below Ear falls are also bordered with similar forests of good size.

White cedar (*Thuja occidentalis*) and rowan or mountain ash (*Pyrus Americana*), the latter in fruit, were seen as far north as Birch lake at intervals. Black ash (*Fraxinus sambucifolia*) was not seen so far north, but is found with the balsam poplar or "balm of Gilead" (*Populus balsamifera*) on the clay lands of the lower Wenasaga and Trout Lake rivers. Red raspberries were found in considerable numbers on the east side of Pakwash lake, while the blueberry is fairly common in burnt country throughout the area visited. Wild strawberries occur on sandy spots to the south of Lac Seul, but were not seen farther north. Small specimens of white oak (*Quercus alba*) were seen on Pakwash lake and a few red and white pines (*Pinus resinosa* and *P. alba*) occur in the vicinity of Pine Ridge post at the northwest end of Lac Seul, but none were observed farther north. White birch is found throughout the district as well as several species of willow. Vetches are of common occurrence on the clay lands. The "pin" cherry and wild rose were seen near the south end of South Cove, Lac Seul.

*Game.*—Moose (*Alces Americanus*) is extremely common throughout the whole area traversed during the summer, so much so that we encountered specimens almost every day while travelling on the rivers and smaller lakes. "Red deer" or more properly the white-tailed deer (*Odocoileus Virginianus borealis*) was found as far north as the small lake below Lake Margaret on the Wenasaga river, where a doe with two fawns was seen. About the same locality a woodland caribou (*Rangifer caribou*) was met with, and another individual was met a little farther north.

Black bear (*Ursus Americanus*) were plentiful in the valley of the English river and the lower waters of the Wenasaga and Trout Lake rivers. They were not seen by us in the vicinity of Birch lake, but traps set for them by the Indians were found at Springpole lake, and no doubt their seemingly greater abundance in the clay country farther south is due to better food supply during the summer, rather than climate. The same appears to be true of beaver, which apparently thrive better where mud is available for dams and lodges or banks for burrowing. In such places also their chief food, the poplar, grows in greater size and abundance. Evidences of beaver were abundant to the south of Lac Seul, but none were observed to the north of the clay-bordered parts of the Wenasaga. They had been present in considerable numbers on the White Mud river in recent years, but apparently had been hunted to extermination, as no fresh cuttings were seen.

At a hunting lodge on Birch lake near Birch narrows, the skulls observed were those of fox, (*Vulpes vulgaris*), lynx (*Lynx Canadensis*) and bear (*Ursus Americanus*). The fox seemed to be the most numerous.

Wild ducks, including the black duck (*Anas obscura*), and others were observed in considerable numbers and breed throughout the whole region traversed.

Upper Ear falls, descent about ten feet, English river just below the outlet of Lac Seul.

*Fish.*—Whitefish and pickerel are abundant in Lac Seul and its tributaries up to a certain distance from the main stream. Pike are also extremely common. The whitefish seemingly have no ability to ascend rapids or falls, and the pickerel comparatively little, but pike are found up to the headwaters in all streams. Perch were observed in the streams which flow into Lac Seul from the south.

## Drainage Basins and Waterpower

In passing along the line from Freda station to Lac Seul, not much could be done apart from determining the boundaries of the several minor drainage-basins which were crossed. The waters south of the second mile post appear to flow to the southward toward the Wabigoon river; and from the middle of the third mile to about the 10th mile post, including Pine lake to the east, they flow into Ord lake and thence to Cedar river, a branch of English river which joins it between Duck and Barnston lakes to the west of Lac Seul. Moose lake and Round lake appear to drain to the northeast, perhaps into McIntyre bay, while the three small lakes to the north unite their waters in the creek which falls into the south end of South Cove. This latter stream has a drainage basin of about 13 or 14 square miles, which should provide an average flow, for this district, of about three or four cubic feet per second.[1] The fall at the mouth of the creek is about 45 feet, which would yield about 14 shaft horse power. The flow on June 30th when we visited the falls appeared to be at least 20 or more cubic feet per second.

### Wenasaga Basin

The Wenasaga river drains an area which is estimated conservatively at 1,000 square miles. Its tributaries, the Ootchi, White Mud, Papaonga, Sesikinaga and smaller streams have not yet been traced to their sources. The total fall from Hailstone lake to the outlet at Lac Seul is estimated by Wilson[2] at 178 feet, which would give a total horse power of roughly 2,000, or slightly more if the total descent could be utilized. About 37 per cent. of the fall occurs below Bluffy lake, where the stream has practically reached its full volume. Below Wenasaga lake there are two rapids and a fall of 4, 3 and 10 feet descent respectively, which could be combined at the lower fall into a single head of 17 feet or a little more by damming so as to raise the level of Wenasaga lake very slightly. This would furnish power at the lower falls equivalent to about 385 h.p. The fifty-foot fall at the outlet of Bluffy lake should develop about 1,025 h.p. The steepest part of the river's course above these points is at the series of rapids in the schist area northeast of Slate lake, where a descent of 35 or 40 feet occurs within four or five miles, most of which could probably be concentrated at one point by the construction of a dam. The amount of power here would probably not exceed 275 h.p.[3]

### The Cat River Basin

The upper part of the Cat River basin, which drains into Gull lake by Birch Lake river is 500 square miles in area. It belongs to the headwaters of the system, however, where, as often occurs on the Laurentian peneplain, the gradient is more gentle than farther down stream. The total descent from Birch lake to Gull lake, as far as known, does not exceed 15 feet. This might, it is true, be rendered available at one point on the lower part of the river, where the banks are high, and if this were possible would yield an estimated total of 170 horse power. This river basin, however, includes a large area of lake surface, and would probably offer facilities for the storage of considerable quantities of water by means of one or more dams. The two chutes on the Shabumeni river

[1] The Ontario Hydro-Electric Commission estimate gives the minimum mean monthly flow of English river as .31 cubic foot seconds (or "second feet") per square mile of drainage basin. The Dominion Water Power Branch gives .15 C.F.S.; .20 or .25, allowing for storage, would be reasonable for the district (40 C.F.S. has been used as a general average for the Province). Estimates of actual horse power are based on the formula $P = \frac{Qh}{11}$, where Q is the flow in cubic foot seconds, $h$ the head in feet. The result P is expressed in shaft horse power, allowing for 80 per cent. efficiency in the machine.

[2] G.S.C. Publication 1006. (Rep. Bur. Min., Vol. XXI, 1912, Pt. II, p. 54.)

[3] For the physiography of the Woman river above Woman portage see Ont. Bur. Mines Report, Vol. XXI, Part II, 1912, p. 42.

have a combined fall of 10 feet, but the volume of water is inconsiderable. A dam might be built at the lower chute to raise the level of Shabumeni lake by several feet.

### The Trout Lake River Basin

The Woman river drains an area of about 350 square miles, and the total drainage basin of the Trout Lake river may be placed at 930 square miles. Above Little Bear lake the Woman river has no large rapids and consists of a series of lakes connected by short river stretches, which have a total fall of about 46 feet. From Woman lake to the foot of Little Bear lake there is only five feet of descent. The canyon below Little Bear lake has a fall of 35 feet and would probably yield 285 h.p. The preglacial canyon below Snake lake has a total fall of 65 feet, which would furnish 530 h.p. at the mouth of the canyon, where the construction of a dam appears feasible.

The volume of the stream is about doubled by the addition of Trout Lake river, and a few miles below the junction there is a series of three falls involving a descent of 85 feet in about two miles. The total power theoretically available here would be about 1,740 h.p. There is a further descent of about five feet at the Whitefish rapid. At this point the river practically reaches the level of Pakwash lake and the English river at Mattawa.

The aggregate available horse power of the streams examined might therefore be estimated at 4,424, were all the sites within a reasonable distance of transportation facilities, and installation not too costly. On the latter point the writer does not presume to speak definitely, although most of the sites mentioned appear capable of fairly cheap development.

The figures for power given above are calculated on the basis of a mean monthly flow of .25 cubic foot seconds per square mile of drainage basin. On the basis of the figures supplied by the Dominion Water Power Branch, however, the amount of power available would be only 60 per cent. of that given, or a total of 2,650 shaft horse power.

# WINDY LAKE AND OTHER NICKEL AREAS

By

Cyril W. Knight

## Introduction

The nickel deposits, or areas, described in the following pages are prospects which must yet be proved to be of economic value. No work was being done on any of the properties in the fall of 1919. The report deals with five areas, namely:

(1) The Windy lake nickel area, district of Sudbury.
(2) The Cedar and Net lakes nickel area, Strathy township, district of Nipissing.
(3) The Munro nickel area, township of Munro, district of Timiskaming.
(4) A reported nickel area in Fox township, about 15 miles east of Cochrane, district of Timiskaming.
(5) The Lake Shebandowan nickel area, district of Thunder Bay, by J. G. Cross.

Of these five areas the Lake Shebandowan nickel deposit has the highest grade ore. It is worthy of further prospecting. The property is described by J. G. Cross, of Port Arthur, who is responsible for the development done on the deposit up to the present time. In the fall of 1919 the writer spent two days on the property with Mr. Cross and Roy Emmerson, and he has the pleasure of thanking these two gentlemen for their kindness and trouble in showing him about the deposit.

The Lake Shebandowan ore body is noteworthy on account of the fact that it contains about three tenths of one per cent. of cobalt.

The Windy lake nickel area in the Sudbury nickel field may possibly prove to be the most important of any of the prospects described in this report. Although practically no ore is exposed around the shores of the lake, yet it will be recalled by those familiar with the Sudbury area that the contact between the norite and granite-gneiss passes below the water, and that it is along this contact elsewhere in the Sudbury nickel area that most of the ore deposits are found. Diamond-drilling, properly directed, might demonstrate the presence of an enormous ore body. Located as it is on the main line of the Canadian Pacific railway, it presents no problems in respect to transportation.

The Cedar lake nickel deposit is a low-grade body of nickel and copper ore about two and a half miles west of the Temiskaming and Northern Ontario railway, in Strathy township. The ore body has been sampled by at least two companies, and was found to be of low grade, except certain small veins, less than a foot wide, of pure sulphides. There is also a body of pyrrhotite on Net lake, on claim W.D. 269, about three-quarters of a mile east of the Temiskaming and Northern Ontario railway. About a dozen pits have been sunk on this property and some diamond-drilling has also been done. The pyrrhotite in the Net lake deposit is "pockety" and would be difficult to mine even if it were high-grade, whereas the Cedar lake deposit is more uniformly mineralized. There are also auriferous mispickel deposits in the area, known as the Big Dan and Little Dan. These are described.

In the Munro nickel area there are two deposits of pyrrhotite which were reported to contain nickel, only one of which, however, showed the presence of this metal, one sample having been taken from each property. The one containing nickel is on the west boundary of the township and is known as the Mickle claim. Both occurrences are small.

The reported discovery of nickel in Fox township, 15 miles east of Cochrane, was examined and a sample of pyrrhotite taken. An assay of this sample showed the presence of neither nickel nor copper.

A word may be added regarding the geological character of the deposits. The Lake Shebandowan, Cedar lake and Munro occurrences are associated with serpentine rock, and are in that respect similar to the Alexo nickel deposit near Porcupine. The Fox township pyrrhotite occurs in a complex of rocks consisting of granite-gneiss, mica-gneiss and garnet-gneiss, the whole cut by coarse-grained pegmatites. There are no intrusions of serpentine or gabbro associated with the Fox township pyrrhotite. Regarding the Windy lake occurrence it may be said that if a deposit of nickel ore is eventually discovered below its waters, it will be of the same character as the well-known Sudbury occurrences, which need not be described here.

### Acknowledgments

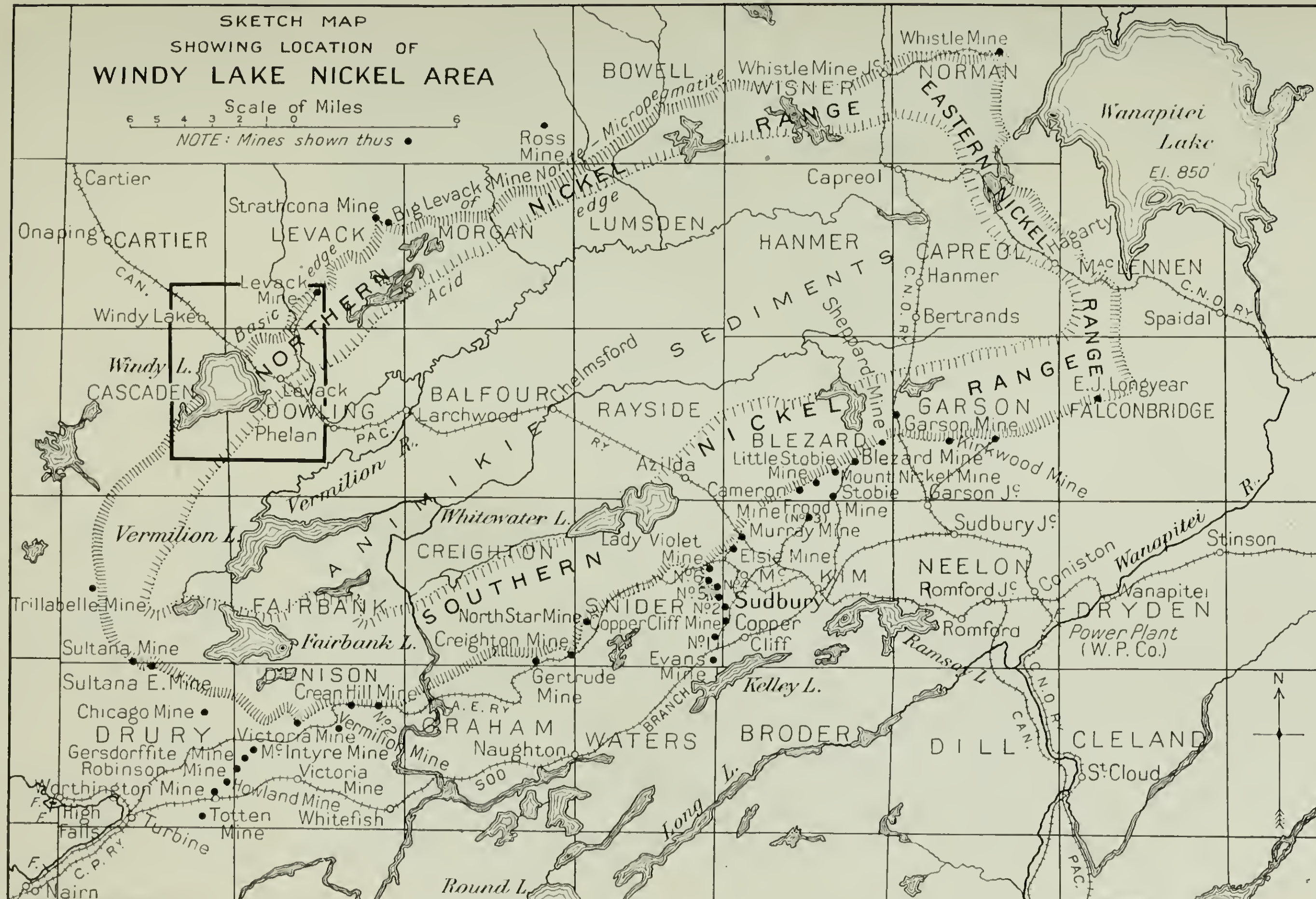
The assays of nickel and copper from Strathy township, Munro township and Fox township were made by W. K. McNeill, Provincial Assayer. Some of the assays of the ore from the Lake Shebandowan nickel deposit were also made by Mr. McNeill, but most of the assays from this property were obtained through the kindness of private individuals who had sampled the property. The writer is indebted to J. G. Dickenson for his kindness in giving information regarding the grade of ore at the Cedar lake nickel deposit.

## WINDY LAKE[1]

Windy lake is in the Sudbury nickel area, in that part of the field known as the "northern nickel range." The lake is about 24 miles by rail west of the town of Sudbury and the main double-track line of the Canadian Pacific railway passes along the northeastern shore. The mining rights to the land under Windy lake are still owned by the province of Ontario.

It has been a common assumption for many years among prospectors, mining men and geologists that a deposit of nickel ore might occur under the lake. This assumption is based mainly on the fact that the contact between a rock called norite and the granite-gneiss crosses the lake and is hidden below its waters. It is well known that most of the nickel deposits in the Sudbury area occur along this

[1] The original name of Windy lake, according to Robert Bell, was Ma-ko-ping, meaning, in Indian language, Bear lake. (Geol. Sur. Can., Vol. 5, 1890-91, p. 92.)




Key plan showing location of the Windy Lake Nickel Area, district of Sudbury.

contact, and hence the assumption that a valuable ore body of nickel may exist under the lake. The Levack nickel mine, with its immense ore reserves of 4,500,000 tons,[1] lies four miles to the northeast of the lake. Furthermore, Windy lake occupies a marked depression in the rocks, the depth of the water being in places 175 feet along the approximate line of contact between the norite and the granite-gneiss. This depression is suggestive of a deposit of nickel ore, since it is known that the sulphide ore weathers readily, and would give the glaciers an opportunity to gouge out the soft, weathered ore and thus form a valley or other depression.

The country surrounding Windy lake, which has an elevation of 1,107 feet above the sea, is rugged, particularly on the south side of the lake. The rocks are well exposed along the shore, except on the northwest part where there are deposits of gravel, sand and boulder clay. The gravel has been used by the Canadian Pacific railway for ballast on their roadbed.

## Geology

The general geology of the area immediately surrounding the lake is well known.[2] The rocks are all pre-Cambrian in age. The Keewatin lavas and the sediments of the Sudbury series are not exposed. The oldest rocks consist of red granite and banded granite-gneiss, pink or grey in colour. It is not known whether this granite-gneiss is Laurentian or Algoman in age. The next youngest series of rocks exposed is of Animikean age, and consists of conglomerate, slate, tuff and sandstone. These sediments were deposited, it is believed, on the surface of the granite and granite-gneiss and are found in the Sudbury basin. After the deposition of the Animikean sediments there followed the intrusion of the norite-micropegmatite; this event constitutes the most important phase, economically, of the geological history of the area. The norite micropegmatite has a width of two and a quarter miles in this part of the Sudbury area, and it strikes in a northeast-southwest direction. The intrusion is the dividing line between the granite-gneiss and the Animikean sediments, the former lying to the northwest and the latter to the southeast. The intrusion of the norite-micropegmatite was followed by dikes of green-coloured diabase, fine or medium in grain; and shortly after that by dikes of coarse-grained diabase, similar to the olivine diabase dikes which everywhere cut the rock formations in the Sudbury area.

## Evidence of Ore Body

As a matter of fact there is very little actual evidence of the presence of ore to be seen along the shores of the lake. In the long bay, however, at the southwest end of the lake, a patch of granite-gneiss near the norite is a little rusty owing to the decomposition of sulphides. There are also a few rusty boulders of granite-gneiss along the north shore of the lake.

[1] Royal Ont. Nickel Commission Report, 1917, p. xxx. Descriptions of this important ore body will be found in the Commission's report, pages 163-167.

[2] See reports of A. P. Coleman, T. L. Walker, and other writers.

### Re-mapping of Windy Lake

The possibility of a valuable ore body occurring under the lake encouraged the Bureau of Mines to remap the Windy lake area. Accordingly a somewhat close study of the contact between the norite and granite-gneiss was made for about six miles along its course. This work was done in June, 1919, about three weeks being devoted to the mapping. The four previous maps which had been made of the Sudbury area, one by Robt. Bell,[1] and three by A. P. Coleman,[2] were eminently useful, but were general in character and did not show the drift along the contact. Map No. 29 *b.*, accompanying this report has been made on a scale of one-half mile to the inch. In this work the writer had the assistance of C. R.

Granite-gneiss, Windy lake.

Elliot and R. Presgrave, who rendered efficient service. The drift-covered areas along the contact are shown, and also some of the diabase dikes. The roads and buildings were also mapped. The lake itself was carefully surveyed on the ice by McAusland and Anderson, Ontario Land Surveyors, in March, 1919, so that their map was available when the geological work was being done about three months later. McAusland and Anderson also took a great number of soundings, particularly along the approximate line of contact between the norite-micropegmatite and the granite-gneiss.

[1] Geol. Sur. Can., Vol. 5, 1890-91, Robt. Bell.

[2] Ont. Bur. Mines, Vol. XIV, 1905, Part III, A. P. Coleman; also Vol. XIII, 1904, Part I, and The Nickel Industry, Dept. Mines, Ottawa, 1913.

### Contact of Norite and Granite-Gneiss

The map of Windy lake accompanying this report shows the contact between the norite and granite-gneiss for about six miles. Along the whole of this distance the contact is hidden by the lake or by drift deposits, except at one place about a quarter of a mile southwest of the lake.

At this point the actual contact is well exposed on a hillside bordering on the southeast side of an old winter road used for lumbering purposes. The dip of the contact plane between granite and norite shown by a surface exposure is 76° to the southeast—a somewhat high dip compared to that at the Levack mine seven and a half miles to the northeast. At the Levack mine extensive diamond-drilling and underground workings have proved that the norite dips to the southeast at an average angle of 45°, flattening somewhat at the deeper parts.

The transition zone between the norite and micropegmatite is about 600 feet in width, and its location is shown on the accompanying geological map.

### Ore below lake suggested by A. P. Coleman

The possibility of a deposit of nickel and copper ore below Windy lake was suggested by A. P. Coleman in 1913.[1] Regarding the matter Coleman wrote as follows:

> Windy lake itself cuts out two miles of the basic edge, the only example of a large body of water occurring on the circumference of the basic edge. A promontory stretching out from its northwestern shore is crossed by the norite margin, but here it is obscured by moraines and esker ridges, and a small bay pushing north from the end of the lake forms another interruption followed by wide swamps to the southwest in the direction of Mink lake.
>
> Including the water stretch of Windy lake, there is a gap of about nine miles between the last outcrops of ore in Levack [township] and the one just referred to in Cascaden [on Ministique and Mosquito lakes], the longest blank known on the basic margin of the nickel eruptive. The next longest blank is in Morgan township to the northeast, where the eruptive is narrower than anywhere else. The Windy lake part of the eruptive is not unusually narrow, so that some different explanation must be looked for in this case; it may simply be that ore bodies exist but are under the water of the lake, or are covered by the widespread drift and swamp which hide the solid rock over much of the region.

### Calcite Veins and Felsite Dikes

In the deep bay at the southwest end of the lake there are several calcite veins and fine-grained, pink felsitic dikes cutting the nickel eruptive along the cliffs at the water's edge. These occurrences are found immediately north of the two large islands in that part of the lake which is situated on the north part of lot 3 in the third concession of Cascaden township. The veins and dikes are as much as 5 inches in width. The felsite dikes are older than the calcite veins, since the latter have been found cutting the former. The calcite veins contain also some quartz. Possibly if a systematic search were made for these calcite veins some of them might be found to contain smaltite or native silver. It is doubtful if much prospecting has been carried on along the nickel eruptive with a view to finding argentiferous veins. The nickel eruptive is very similar to the Nipissing diabase at Cobalt and elsewhere and probably of the same age.

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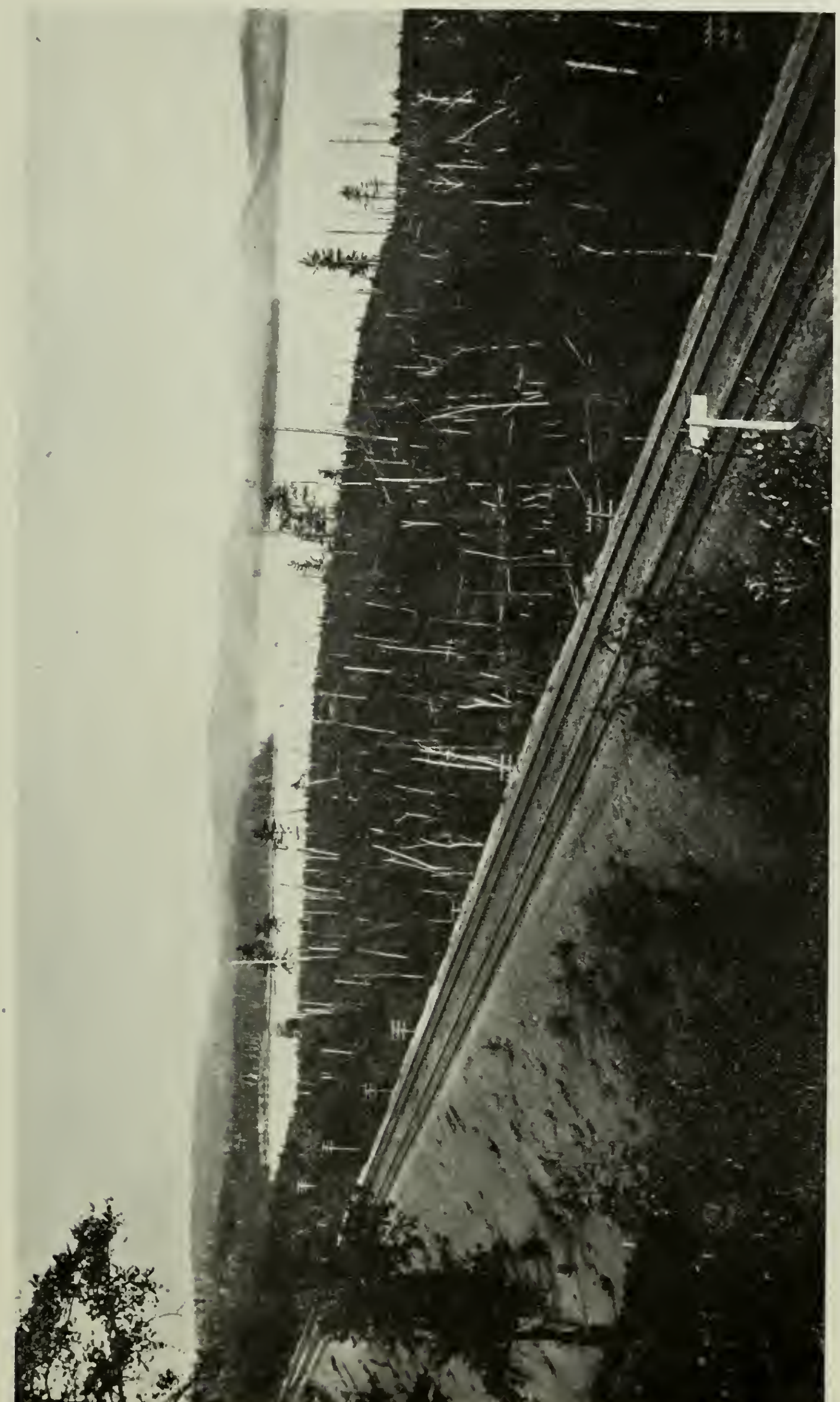
[1] The Nickel Industry, pp. 93-94, Dept. of Mines, Ottawa, 1913, A. P. Coleman.



WINDY LAKE, ON THE MAIN LINE OF THE CANADIAN PACIFIC RAILWAY, 24 MILES NORTHWEST OF SUDBURY.

The contact between the norite and granite-gneiss passes below the lake, suggesting the presence of a body of nickel and copper ore under the lake. Most of the ore bodies of the Sudbury nickel area occur along the contact between the norite and granite-gneiss.

The felsitic dikes and calcite veins were found in that part of the nickel eruptive showing the transition between the norite and micropegmatite. This transition zone is about 600 feet wide.

### Magnetic Survey by A. H. A. Robinson

In March, 1919, while the ice was still on Windy lake, A. H. A. Robinson [1] made a careful survey of the lake for the Ontario Bureau of Mines with a magnetometer in order to ascertain if there were indications of a body of pyrrhotite below the water. The results of Mr. Robinson's work were disappointing.

It may be added that the experience of the Mond Nickel Company has shown that negative results, except over areas very deeply covered with drift or water, may be accepted as practically conclusive evidence that no pyrrhotite of any consequence exists. This is the statement made by C. V. Corless, manager of the Mond Nickel Company, before the Royal Ontario Nickel Commission in October, 1916.[2] It will be noted, however, that Mr. Corless says that where the deposit is deeply covered with water or drift then negative results with the magnetometer do not necessarily prove the absence of an ore body.

Mr. Robinson's report on his magnetometer survey of the lake is given below:

Magnetic observations were made at intervals over all that portion of the lake lying northwest—that is, on the granite side—of the assumed line of contact of the norite and the granite, together with a strip, of varying width, along the southeast—norite side—of the same contact. The maximum distance between the points at which observations were taken over this area was about ten chains (660 feet) ; most of the intervals, however, were shorter than this.

. . . . . . . . . . . . . . .

No local magnetic attraction, such as would indicate the possible presence of a magnetic ore body, was observed in any part of the area examined; neither did the needle afford any indication that would aid in definitely locating the granite-norite contact. Dip-needle readings were taken at all the observation points and, as a check, frequent observations were made to detect any variation from the normal declination of the compass; but no evidence of any appreciable magnetic disturbance could be found, and it can, I think, be safely concluded that, if ore bodies exist under the area examined, no help in locating them can be looked for from the magnetic needle. If any considerable local magnetic attraction existed in the area in question some trace of it should have been detected.

When C. W. Knight was at Windy lake [in March, 1919] I told him that I thought there might possibly be some slight magnetic attraction in the vicinity of the islands in the southwest corner of the lake. A second series of check readings, taken subsequently in this locality under more favourable weather conditions failed to confirm this hope; no attraction was found to exist.

As regards any conclusions to be drawn, an examination of the original plan and field notes of E. Lindeman's magnetometric survey of the pyrrhotite deposits at the Frood, or No. 3 mine, of the Canadian Copper Co., where the outcrops of the ore appear to have been covered with little or nothing but gossan, shows that even under these conditions only slight magnetic attraction was found over very much the greater part of the area underlain by the outcrops. It seems, therefore, a fair inference that very considerable bodies of ore may possibly occur under the waters of Windy lake, even though there may be no magnetic indication of their presence at the surface; in other words, that the failure to find any appreciable local magnetic attraction cannot, in the present case, be regarded as evidence of the unlikelihood of the occurrence of ore even at moderate depths.

### Levack Mine

The Levack mine is four miles northeast of Windy lake. Descriptions of this immense ore body will be found in the Report of the Royal Ontario Nickel Commission and in the reports by A. P. Coleman in the Ontario Bureau of Mines Reports.

[1] Mining Engineer, Mines Branch, Dept. of Mines, Ottawa.
[2] Report of the Royal Ontario Nickel Commission, 1917, Appendix, p. 25.

*Photograph by F. J. Eager.*

Levack nickel mine, four miles northeast of Windy lake.

*Photograph by F. J. Eager.*

View of Levack mine, showing valley along contact between granite-gneiss and norite.

## Literature

While no reports dealing exclusively with the Windy lake area have been written, nevertheless the numerous reports on the Sudbury nickel area which have been published during the last thirty years contain descriptions of the geology of this locality. The reports of Bell, Walker, Barlow, Coleman and others contain accounts of the geology of the area. Although Windy lake is merely a prospective place in which a valuable ore deposit may be discovered, it was felt that a compilation of the literature which has been written might be convenient for anyone who wishes to diamond-drill or otherwise prospect the lake.

The first mention of the norite (then called diabase) in the Windy lake area was made by Robert Bell in 1890 in a report of the Canadian Geological Survey.[1] Bell's description of the rocks and of the area is as follows:

> The whole breadth of concession I of Levack [township] on the course of the [Onaping] river—upwards of a mile—is occupied by a transverse section of a great belt of rather coarsely crystalline grey diabase, which we have traced from the northeast corner of this township, southwestward into Trill, a distance of about eighteen miles. This belt is widest where it is crossed by the Onaping river, and gradually diminishes to a point at either extremity. To the northeastward its course is marked by a straight valley, down which the lower part of the Kinniwabik river flows, but between the Onaping and Windy lake it is covered by a great accumulation of sand, gravel and boulder earth, forming hills in that direction. Windy lake lies about midway on its course and, from this circumstance, it might be called for distinction, the Windy lake belt. The southeastern boundary of this belt and the southern town-line of Levack intersect the river almost together, but at an angle with each other. Below this intersection the red hornblende-granite [micropegmatite] continues to be met with along the river for two miles, or to the junction of Windy creek, below which the river enters upon the belt of dark silicious volcanic breccia and its underlying quartzite conglomerate.

The micropegmatite of this belt was first described in 1890 by George R. Williams in an article attached to Bell's report.[2] The specimen examined was taken from near the west end of Eagle Rock lake, now known as Moose lake, in the southeast corner of Levack township. Williams' description is as follows:

> A dark rock of medium grain with reddish feldspar.
>
> The microscope shows this to be a biotite-granite or granitite whose quartz and feldspar are minutely intergrown as they are in graphic granite, thus producing the structure called micropegmatite or granophyre. This structure exists in this specimen in an unusual degree of perfection. It composes most of the rock-mass, and is usually developed as a delicate network surrounding and radiating from a central rectangular orthoclase crystal (generally a Carlsbad twin). The quartz exists for the most part intergrown with the feldspar, but a few separate and individual grains may also be found. The ferro-magnesian silicate is biotite, now considerably altered. A little light green hornblende is also present, but this, like the chlorite, seems to be of secondary origin. Apatite is abundant in sharp acicular crystals, some of which have attained an extraordinary length.

In the same report[3] Bell again refers briefly to this belt:

> The other large belt of this variety has been traced from the northeast portion of Levack [township] southwestward across Windy lake, nearly to Hyman [township], a distance of about eighteen miles.

In 1891 Bell has minor references to Windy lake in the First Report of the Ontario Bureau of Mines.[4]

[1] Can. Geol. Sur., Vol 5, 1890-91, p. 38 F., Robt. Bell.
[2] Ibid., p. 78 F., George R. Williams
[3] Geol. Sur. Can., Vol. 5, 1890-91, p. 44 F., Robt. Bell.
[4] Ont. Bur. Mines, Vol. 1, 1891, pp. 75, 76, 84.

The first detailed account of the norite-micropegmatite of the Windy lake area was written by T. L. Walker in 1897. Walker found that the norite passed gradually into the micropegmatite—one of the most important discoveries in the geology of the Sudbury area. His description of the Windy lake section along the railway is quoted in following paragraphs:[1]

On travelling eastward a few hundred feet along the low margin of Windy lake no rocks are observed, but a little farther east there are exposures of a medium grained rock, in which the unaided eye distinguishes a black mineral occurring as separate grains, and a much more abundant white mineral forming the groundmass for the dark mineral. Though a norite, this rock differs in appearance from the Whitson lake eruptives in being coarser grained and of a much lighter colour.

The microscope shows that here the hypersthene, though often quite fresh, is more frequently changed partly or entirely to bastite or secondary hornblende. The plagioclase crystals are quite free from the dusty brown inclusions observed in the plagioclase of the Whitson lake norite. This difference is largely responsible for the comparatively light colour of the Windy lake norite as contrasted with the dark colour of the Whitson lake norite.

A specimen collected one-half mile east differs from the last in being slightly more altered and of somewhat more acid character. Some crystals of plagioclase exhibit in an unusual degree zonal structure and wandering extinction. In some cases there is a difference of 38° between the extinction of the central and marginal portions of the same individual. Such plagioclase crystals generally border on small areas of quartz and micropegmatite, and appear to have continued their growth till all the constituents except the quartz and micropegmatite had crystallized. The central portion is therefore composed of one of the most basic plagioclases, while the marginal portion represents one of the most acid of the series.

Eastward the rock becomes coarser in grain, and the greyish norite gives place to what might be taken macroscopically for a hornblende-syenite. A specimen collected two and a quarter miles west of Onaping station[2] when examined microscopically, shows that a secondary hornblende is the only bisilicate present. Micropegmatite and quartz are abundant; the feldspar of the micropegmatite is well twinned plagioclase. There are a few grains of a yellowish pleochroic mineral, which has strong polarization colours and a high index of refraction. As this mineral becomes much more abundant near Onaping station, it will be more fully dealt with later; it seems to alter to radiating aggregates of pale lemon-yellow hornblende.

Towards Onaping station there is a marked increase in the quantity of micropegmatite, which forms about half the rock. Well-defined feldspar crystals form the centres for radiating micropegmatite axes. Taking into consideration the prominent part played by micropegmatite and the porphyritic nature of the rock, it may be called a hornblende-porphyry with a micropegmatitic groundmass.

There is, moreover, another important constituent. This occurs commonly in groups of irregular grains, and is distinctly pleochroic—lemon, yellowish-green, and colourless. The index of refraction is high, and the surface appears to be quite rough when seen under the microscope. The double refraction is high, so that it polarizes in orange, green and red tints when quartz of the same thickness polarizes in grey. It is always associated with the radiating aggregates of secondary hornblende above mentioned. This mineral appears to have occupied a prominent place in the original rock, when it largely replaced the bisilicates. Having crystallized later than the quartz, it presents very seldom idiomorphic forms. The same mineral is a very frequent accessory in the Norwegian zircon syenite, though the secondary products are not so well developed there as in the Onaping rock. This mineral has been identified in the zircon-syenites as wöhlerite, and it is possible that the associates of wöhlerite may be found in the Sudbury nickel-bearing rocks. A mechanical or chemical separation of this mineral was impossible.

The reddish granite at Onaping station is composed of micropegmatite, orthoclase with a little free quartz, and about equal quantities of wöhlerite and secondary hornblende, which was probably derived from the former. Orthoclase has replaced plagioclase in the micropegmatite, which constitutes about two-thirds of the rock, and has obtained a high degree of perfection. Wöhlerite is present as grains, which at times deserve the name of

[1] Quart. Jour. Geol. Soc., London, 1897, Vol. 53, pp. 40-65, T. L. Walker.

[2] Since Dr. Walker wrote this account, the great curve in the railway at Onaping has been straightened out. Onaping station was about three-quarters of a mile northeast of the present Windy lake station. Part of this great curve is now used as a spur line into the Levack mine about four miles to the northeast. There is no longer a station known as Onaping. (C.W.K., 1920).

crystals, and may be seen to be optically biaxial, with a very large optic angle. The secondary hornblende derived from it contains numerous delicate feathery crystals of biotite, which are also probably of a secondary nature.

Southeastward from Onaping, near the contact, the granite becomes fine grained and darker in colour, while the microscope shows a slight increase in plagioclase and iron ores, and a decrease in free quartz.

Some of the most important deposits of nickeliferous pyrrhotite discovered in the Sudbury district are situated along the northwestern border of the Windy lake eruptives. We have here to deal with an eruptive whose length is unknown, and whose width is nearly four miles. The gradual transition, from typical pyrrhotite-norite on the one hand to hornblende-granite on the other, shows that in most respects it is identical with the Whitson lake eruptive.

About three years after Walker had published his important thesis A. E. Barlow refers to the norite at Windy lake as follows:[1]

According to present information, this band starts about lot 12 in the third concession of the township of Trill, extends north and northeast through the township into Cascaden. and crossing under Windy lake, goes on uninterruptedly through the northwest corner of Dowling to lot 2 in the fourth concession of Levack township.

The reports of A. P. Coleman contain descriptions of the geology of the Windy lake area. In 1903 Coleman described the rocks of the area and referred particularly to the rocks along a great curve on the railway on lots 8 and 9 in the fourth and fifth concessions of Dowling township. Since that time this great curve has been done away with and the railway now follows an almost straight course southeastward through lots 8 and 9 in the fourth concession of the township.

Part of this old curve—the west part—is now used for the spur line which runs into the Levack mine. The spur begins at Levack station. Onaping station. referred to in the following quotations, was located about three-quarters of a mile northeast of Levack station. Coleman's description is as follows:[2]

On Windy lake itself the northwest shore, where not drift-covered, is Laurentian also, of the usual kind in the region, consisting of reddish or grayish bands with darker gray layers of finer grained schist. The islands off shore and the large peninsula projecting from that shore are of norite. On the peninsula the boundary is largely hidden by morainic and esker ridges, but it is distinctly seen on the shore of the southwest bay. The rest of the shores of this beautiful lake are of norite or the intermediate rock between the basic and acid phases.

Much the best section of the nickel-bearing eruptive is provided by the railway cuttings to the west and east of the little station Onaping; and a number of rock specimens from these cuttings have been described by Prof. Walker.[3]

Beginning on the northwest near Windy Lake station, which is some distance west of the lake, Laurentian granite and gneiss with darker schistose inclusions is found until the shore of the lake is reached, when gray dioritic-looking norite is found, the actual contact, however, being hidden by drift. The rock remains the same in appearance for one hundred yards, but soon changes to a reddish syenitic phase of fine or coarse grain, which continues to Onaping station, and is followed toward the southeast by greenish-gray rock having a peculiar ophitic-looking structure. The colour and general appearance of the eruptive at the ends of this section are much alike, but the intervening phase of flesh-red syenite-looking rock is very different.

The acid edge of the eruptive rises as very steep hills to a height of three hundred feet above the station, and the railway is forced to follow the valley of Onaping river in a sharp curve in order to cross the range of hills. The southeast side of these hills consists of hardened sediments, at first a gray, fine-grained graywacké conglomerate with pebbles and a few boulders of quartzite and granite, and sometimes also of gray chert, extending along the railway for about one thousand feet; and followed by characteristic black vitrophyre tuff, often crowded with small fragments of gray material.

[1] Geol. Sur. Can., Vol. 14, 1901, p. 87H., A. E. Barlow.
Ibid, Vol. 15, 1902-3, p. 267A., A. E. Barlow.

[2] Ont. Bur. Mines, Vol. 13, Part I, pp. 196-7;
Ibid., Vol. 14, Part III, p. 64.

[3] Quar. Jour. Geol. Soc., Vol. 53, 1897, pp. 56-9.

A few pages farther on in the report Coleman described the area more fully in the following words: [1]

The best section for the study of the northern side of the nickel-bearing eruptive is undoubtedly that along the Canadian Pacific railway between Phelan and Windy lake sidings, where numerous small rock cuttings expose the tuffs with their underlying conglomerate, the acid edge of the eruptive, its basic edge, and the Laurentian gneisses beyond. Taken at right angles to the strike of the belt of eruptive rock, its width is nearly three miles. Rocks collected at different points on the section have been studied and described by Prof. Walker,[2] but it is worth while to refer to this section more in detail.

Going eastwards along the railway from Windy lake siding, Laurentian is seen for a quarter of a mile, when drift and an esker ridge cover the rock for a distance. At the northwest end of Windy lake gray dioritic-looking norite crops out, rather coarse and speckled in appearance, consisting, as seen under the microscope, mainly of plagioclase, hypersthene and augite, with a little quartz, biotite and hornblende, many prisms of apatite and some magnetite. The plagioclase, which is clear and colourless and makes up about half of the rock, has extinction angles corresponding to andesine or labradorite, and it is generally hypidiomorphic, while the hypersthene is idiomorphic. This mineral presents some anomalies, since some crystals showing the usual pleochroism, red, brown, pale brownish green and pale yellowish, have parallel extinction, while others extinguish at various angles up to 28 degrees. Diallage, brown and fibrous-looking, non-pleochroic, and with an

Sand beach on northeast shore of Windy lake.

extinction angle of about 45 degrees, occurs in small quantities also; the small amount of hornblende present forms margins about the minerals just mentioned; and the brown biotite is present only in trifling quantities.

A specimen from a cutting a hundred yards east is coarser grained and not quite so fresh, but does not differ greatly in composition. An analysis of this rock, given later, shows 56.80 per cent. of silica, considerably more than Professor Walker found in norite from Blezard mine on the southern range.

Fifty yards farther east coarse red syenitic-looking rock begins and lasts to Onaping station, showing in various cuttings. Thin sections prove, however, that the rock contains a large amount of quartz mostly pegmatitically intergrown with feldspar, but partly as fairly large clear spaces, so that it is too acid for syenite, and an analysis given later confirms this by showing 68.48 per cent. of silica. The feldspars are very badly weathered, but the well formed crystals making the starting point for micropegmatite seem to be all plagioclase, though the analysis proves that potash and soda are present in about equal amounts ($K_2O$-3.36 and $Na_2O$-3.72), so that the feldspar in the pegmatite must be chiefly orthoclase. The dark minerals incltde secondary-looking hornblende and the mineral

[1] Ont. Bur. Mines, Vol. 13, Part I, 1904, pp. 210-211; see also, Vol. 14, Part III, 1905, pp. 109-110.

[2] Quar. Jour. Geol. Soc., Vol. 53, pp. 56-59.

resembling epidote named by Professor Walker woehlerite. The last specimen collected to the west of Onaping station has extraordinarily slender prisms of feldspar, which strike the eye immediately on fresh surfaces.

To the east of the station the appearance of the rock changes and it becomes greenish gray and finer grained; though the microscope shows little difference except the presence of more hornblende. An analysis proves that this rock is less acid than the red variety west of Onaping, since it contains only 61.03 per cent. of silica.

At the margin of the eruptive against the basal conglomerate beneath the tuffs, it becomes finer grained, though still green and dioritic-looking; and thin sections show short, stout crystals and little micropegmatite, the quartz, which is present in considerable amount, being mostly granular.

Two miles north of Onaping, at the outlet of Moose creek into Onaping river, there is an interesting slope of gray rather coarse-grained norite, rapidly weathering into boulder-like forms, the loose sandy and gravelly débris sometimes still supporting the round boulders of less decayed rock. Thin sections show the typical norite of the nickel range, consisting of a small amount of quartz, partly pegmatitic, much labradorite, a little apparent orthoclase, and a large amount of pleochroic augite very like hypersthene, but seemingly monoclinic with various extinction angles. Secondary hornblende and a small amount of biotite and magnetite complete the dark minerals. The plagioclase is largely idiomorphic and is sometimes partly enclosed by the augite, which also tends to idiomorphy, so that the order of succession is plagioclase, augite, quartz and pegmatite, the plagioclase and augite overlapping.

A rock found at the basic edge of the nickel-bearing eruptive a little east of the big Levack mine on the eastern side of Levack township is very similar, except that the pyroxenes are almost completely changed to dull-green fibrous hornblende, and that biotite is present in larger quantities.

A specimen from about a mile and a half southeast of the last locality nearer the acid than the basic edge is coarse-grained and flesh-red in colour, and consists as shown by the microscope mainly of micropegmatite and a little hornblende and biotite.

### Chemical Composition of Norite-Micropegmatite at Windy Lake

The chemical composition of the norite-micropegmatite at Windy lake as given by A. P. Coleman [1] is shown in the following table. No. 1 is from near the basic edge west of old Onaping station. No. 2 is from the middle of the eruptive, where the rock is flesh-coloured. No. 3 from the greenish-grey, acid edge. These specimens were obtained along the railway.

| | No. 1 | No. 2 | No. 3 |
|---|---|---|---|
| $SiO_2$ | 56.89 | 68.48 | 61.93 |
| $Al_2O_3$ | 19.39 | 12.70 | 13.03 |
| $Fe_2O_3$ | .38 | 2.41 | .56 |
| FeO | 7.11 | 4.50 | 8.00 |
| MgO | 2.11 | .74 | 1.76 |
| CaO | 8.11 | 1.41 | 4.02 |
| $Na_2O$ | 3.31 | 3.72 | 3.18 |
| $K_2O$ | 1.04 | 3.36 | 2.80 |
| $H_2O$ | 1.35 | 1.13 | 1.95 |
| $T_1O_2$ | .43 | .61 | .84 |
| $P_2O_5$ | .11 | .20 | .32 |
| MnO | .30 | .05 | .18 |
| S | .... | .... | .19 |
| | 100.53 | 99.31 | 98.76 |

Referring to the gossan at Windy lake, Coleman, in 1905, says:[2]

Ore bodies are not found everywhere along the basic edge, though one may walk for miles along that edge in places without an important break in the rusty band. There are, however, a few places along the circumference near Windy lake and toward the northeast of Morgan township, in the northern range, where no gossan or only a few of the pock marks are found, so that the distribution of ore is evidently very unequal. It will, of course, be understood that gossan does not everywhere mean an ore deposit of workable size, though a large area of gossan has nearly always been found to indicate an ore body worth developing.

[1] Ont. Bur. Mines, Vol. 13, 1904, Part I, p. 12, A. P. Coleman.

[2] Ont. Bur. Mines, Vol. 14, 1905, Part III, p. 16.

### Pleistocene

A. P. Coleman refers to the drift deposits in the Windy lake area as follows:[1]

> Morainic ridges and kettle ponds occur to the southwest of Windy lake, and a long esker, beginning on the peninsula which projects into the lake on its southwest corner, runs northeast along the basic edge of the nickel-bearing eruptive for about six miles toward the valley of Onaping river.

Farther on in the same report Coleman says:

> Gravel plains, or flats of sand and gravel, extend between the Archean pre-Cambrian hills far to the northwest of the Sudbury district, and have been put to use by the Canadian Pacific railway, which always locates its sidings and stations on such plains, if possible. Within the limits of our map such plains exist near Geneva lake, at Cartier, at Windy lake siding and at Phelan, the last point being within the basin here described. The gravel plains around Phelan and Onaping extend northwards along the Onaping valley to the mouth of Moose Creek.

Brief reference is also made to the rocks at Windy lake in Guide Book No. 7, published in 1913 by the Ontario Bureau of Mines in connection with the International Geological Congress. A short description of the rocks is given by A. P. Coleman.[2]

## CEDAR AND NET LAKES

### Location

Cedar and Net lakes are in the township of Strathy, district of Nipissing, in the Timagami forest reserve. The locality is quite easy to enter, as the Timiskaming and Northern Ontario railway passes through Strathy township. The most convenient point to leave the railway is about three miles north of Timagami station at mile post No. 76 on Net lake, which is 76 miles north of North Bay. Although there is neither station nor siding at this point, the local trains of the Temiskaming and Northern Ontario railway sometimes stop here. There is a portage a few chains in length from Net to Cedar lakes. If, however, arrangements cannot be made with the railway to stop the local train at mile post No. 76, then Owaissa siding just north of mile post No. 78 may be used. From Owaissa siding to Net lake is less than a quarter of a mile. The only building at Owaissa siding is that used by the section-man working on this part of the railway.

Timagami station, about three miles south of mile post No. 76 is also a convenient point to leave the railway, as provisions may be purchased at this place. From Timagami, Net lake is reached by canoe, through Cariboo, Snake Island, and White Bear lakes, with two or more portages according to the height of the water.

### Maps

Geological map No. 29c., accompanying the report, covers about 18 square miles. This area is included in a map, scale four miles to an inch, of parts of the districts of Nipissing and Timiskaming in Ontario, and Pontiac county in Quebec.

[1] Ont. Bur. Mines, Vol. XIV, 1905, Part III, p. 102, A. P. Coleman.

[2] Guide Book No. 7, pp. 43-44, 1913, International Geological Congress, published by Ont. Bur. Mines.

published by the Geological Survey of Canada in 1908.[1] There is also another map published by the Geological Survey of Canada which takes in the lower part of the Cedar and Net lakes area as far north as the extreme south end of Cedar lake. This map is on a scale of one mile to an inch and is by A. E. Barlow and G. A. Young.[2]

Although the two geological maps referred to above were very useful, they did not show the serpentine intrusion south of Cedar lake, or the gabbro or diabase


Key plan showing location of Cedar and Net Lakes Area.

on Net lake with which the nickel deposits are associated. Certain areas of quartz-porphyry and Nipissing diabase were also not shown. It was therefore decided to remap the area in which the nickel occurrences are found, and in doing so it was found necessary to resurvey the lakes by means of the micrometer.

The work connected with the mapping and examination of the rocks took about three weeks during July, 1919.

[1] Map No. 599, Can. Geol. Sur.

[2] Geological map of the area between Timagami and Rabbit Lakes, by A. E. Barlow and G. A. Young. No. 944, Can. Geol. Sur., 1907.

### Acknowledgments

During the course of the work Jas. E. Hunnisett. C. R. Elliot and R. Presgrave were attached to the party and rendered efficient assistance. The topographic mapping of the lakes, portages, and so forth, was done by Messrs. Elliot and Presgrave, while Mr. Hunnisett and the writer worked out the geology.

### Geology

The rocks of the area are pre-Cambrian in age and may be included in the following classification, the youngest rocks being shown at the top of the column.

| | |
|---|---|
| KEWEENAWAN | Olivine diabase dikes. |
| | *Intrusive Contact.* |
| | Nipissing diabase. |
| | *Intrusive Contact.* |
| ALGOMAN | Granite. |
| ALGOMAN (?) | Quartz-porphyry, quartz-porphyry schist. |
| PRE-ALGOMAN | Serpentine rock, peridotite, diabase. |
| KEEWATIN | Basalt, pillow lava, amygdaloid, together with subordinate areas of quartz-porphyry, grey schist and allied rocks intricately intermingled with the Keewatin. Ankerite and iron formation also occur. |

#### Keewatin

The Keewatin series consists of green, basic lavas, at times schistose, showing pillow structure and amygdaloidal textures, and is similar to Keewatin areas elsewhere in Ontario. The lavas are basalts, or some closely related type. The pillow structure is well known on Arsenic lake, and amygdaloidal textures are developed on claim T.R. 1623 and on the north arm of Cedar lake on the west shore, and also in other parts of the Keewatin. Fragmental rocks, made up of fragments of basic lavas up to six inches in length were noted at the southwest corner of the map. Whether this fragmental material represents the top of a lava flow, or whether it is formed by crushing was not determined.

Ankerite rocks, or other rusty carbonates, are developed in the southwest corner of the area on claims T.R. 1877 and W.D. 267. Outcrops of cherty iron formation occur on claims W.D. 265 and J.S. 62, and also on T.R. 1623.

Here and there in the Keewatin are small, irregular masses or dikes of quartz-porphyry or quartz-porphyry schist, and felsite, apparently intrusive into the Keewatin. These porphyries will be referred to again under the heading Algoman. It may be stated here, however, that it was not possible to map the smaller occurrences on the scale adopted for the accompanying geological map.

#### Pre-Algoman

*Serpentine, Peridotite, Diabase.*—The rocks of this series are of economic interest because the deposits of nickel are associated with and probably owe their origin to them.

These serpentine, peridotite and diabase rocks are shown on the map in dark green colour. There are two main occurrences, one in the southwest part and one at the northeast corner of the area. The former has a length of about three-quarters of a mile and is oval in outline, except at the north end, where a neck of the rock projects to the northward. This intrusion may be called serpentine rock although it passes in places into a diabase. It is fine to medium in grain. Thin sections examined under the microscope show that some of it, at any rate, is an altered peridotite; the outlines of the original olivine crystals are readily recognized, now altered to serpentine. A little calcite or dolomite, or some similar carbonate, is present. Thin sections also show that in places much of the rock is made up of fibrous hornblende. The serpentine rock is somewhat similar to that at the Alexo nickel mine near Porcupine.

The other intrusive rock belonging to this series is at the northeast corner of the area, and differs from the serpentine rock just described. It occupies a long narrow fringe bordering on the east side of Net lake, east of the Temiskaming and Northern Ontario railway. It consists of a coarse-grained diabase and gabbro. The dark green coloured constituents are in places segregated into very coarse-grained masses, in which the pyrrhotite is found. Thin sections of these segregated masses of dark-coloured minerals show that they are composed chiefly of hornblende in crystals as long as an inch or more.

Although the two intrusions of basic rock described above are separated by a distance of two and three-quarters miles, it is believed that they are of the same age. The diabase or gabbro intrusion on the shores of Net lake is cut by dikes from the granite, and is therefore older than the granite. These granite dikes cutting the diabase or gabbro are well seen along the shores of the lake.

There are other smaller masses of basic intrusions belonging to this series, two of which intrusions are shown on the map, one at the Big Dan (claim W.D. 271) and the other east of Net lake on claims H.F. 27 and R.S.C. 172.

#### Algoman (?)

*Quartz-Porphyry, Quartz-Porphyry Schist.*—The quartz-porphyry and quartz-porphyry schist are tentatively classed with the Algoman. They resemble the grey porphyries and porphyry schist in Porcupine and elsewhere. There is one large mass, coloured deep red on the geological map, at the southwest end of the area. The rock is grey in colour, and occurs both massive and altered to a schist. The outlines shown on the map must be considered to be approximate, as there was not sufficient time to work out the contacts in detail.

In addition to this large area of quartz-porphyry there are many small dikes, or irregular masses of the rock, which evidently are intrusive into the Keewatin series. One of these dikes occurs on W.D. 271, a claim known as the Big Dan. There are also dikes of felsite or quartz-porphyry cutting the Keewatin at the entrance to the deep south arm of Cedar lake; these dikes are very irregular in outline, and show rounded eyes of quartz phenocrysts as much as one-quarter of an inch in diameter.

It is not known whether the quartz-porphyry intrusions are connected with, and are of the same age, as the great intrusions of granite at the northeast end of the area.

Rocks similar to these occur in the Timagami lake area and have been well described in the notes printed on the geological map published by the Canadian Geological Survey, which covered an area between Lake Timagami and Rabbit lake.

The map is by A. E. Barlow and G. A. Young, and their description of the quartz-porphyry and quartz-porphyry schist is quoted below.[1]

The schistose rocks of the Keewatin may be divided into the paler coloured and more acid varieties, which are deformed quartz-porphyries or porphyrites, and the more deeply coloured or basic schists resulting from the shearing of hornblende-porphyrites, basalts and diabases. The extreme deformation of the more acid types produces sericite schists, which reveal little or no trace of their original structure. In places, however, the hand specimens secured showed clearly that they have resulted from the shearing and alteration of quartz-porphyries and quartz-porphyrites. In colour they are generally pale yellowish green, although occasionally mottled with purplish, reddish or yellow tints. In some cases the original phenocrysts are still macroscopically apparent, chiefly feldspar in yellowish, reddish or more rarely pale greyish colours. The least altered variety of these porphyries shows the usual more or less rounded phenocrysts of quartz, together with orthoclase and oligoclase, embedded in a groundmass which varies considerably in texture from being finely crypto-crystalline to moderately coarse-grained micro-granitic. The quartz phenocrysts exhibit characteristic invasions and inclusions of the groundmass. By progressive steps this structure is gradually effaced until in the extreme schistose varieties nothing remains but a comparatively coarsely granular mosaic of quartz, sericite and calcite. Some of the more massive types have undergone considerable decomposition, and the original phenocrysts of feldspar can with difficulty be separated from the equally weathered groundmass. These more acid types pass into porphyrites which contain little or no quartz.

#### Algoman

The Algoman series consists of a great intrusion of pink granite which cuts the Keewatin series and the pre-Algoman diabase or gabbro on the east shore of Net lake. It is not necessary to describe this rock in detail.

#### Keweenawan

Belonging to the Keweenawan series are diabase intrusions of two ages, namely, the Nipissing diabase, which occurs in the form of a sill at Cobalt and elsewhere, and the olivine diabase dikes which intersect the Nipissing diabase and all other pre-Cambrian rocks in the region. The olivine diabase dikes are the youngest pre-Cambrian rocks in the region.

North of Cedar lake the Nipissing diabase is well exposed, while the olivine diabase dikes are developed on claims T.R. 3187, W.D. 271, and elsewhere.

#### Cobalt Series

It may be added that sedimentary rocks of the Cobalt series, consisting of conglomerate, greywacké and quartzite, do not occur in the area shown on the accompanying map, but are found over wide areas in the surrounding region. They are younger than the Algoman granite, but older than the Nipissing diabase.

### Cedar Lake Nickel Deposit

The Cedar Lake nickel deposit occurs at the southwest corner of the area on claims T.R. 1623 and T.R. 3187. It is found at the north end of an intrusion of serpentine, the latter being about three-quarters of a mile long and of oval outline. The ore body occurs at the north end of the intrusion on a neck of serpentine which protrudes northward from the main mass of the rock. The

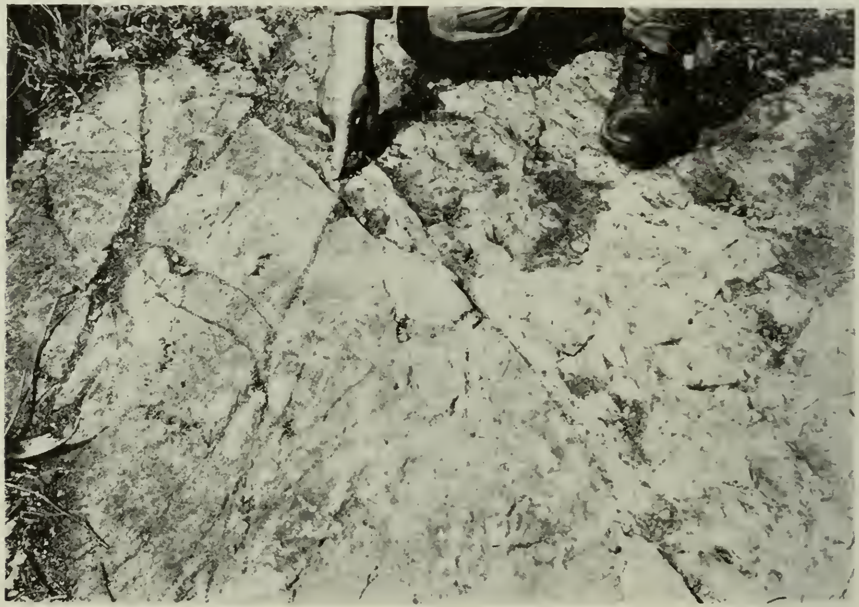
[1] Geological map of the area between Timagami and Rabbit lakes, by A. E. Barlow and G. A. Young. No. 944, Can. Geol. Sur., 1907. A description of the geology of the area is printed on the notes accompanying this map.

outlines of the main mass of the serpentine and of this neck at the north end are shown on the geological map accompanying the report.

The ore body occurs on a low hill just west of a pond. This hill is stained a brown colour by the gossan that covers it. The gossan is made up of iron oxides, which are the decomposition products of the sulphides composing the ore body.

The gossan-covered area has a length of about 300 feet in a north and south direction by a width of about 125 feet in an east and west direction. The gossan is almost wholly in the serpentine, though a little occurs in the banded cherty rocks in the Keewatin near the blacksmith shop at the east side of claim T.R. 1623.

The minerals constituting this ore body are pyrrhotite, copper pyrites, and pentlandite, the last mentioned being the nickel-bearing mineral and carrying



Contact of serpentine and Keewatin, Cedar lake nickel deposit, Strathy township.

theoretically 22 per cent. of nickel. The sulphides are rather uniformly disseminated through the serpentine, and the ore, which is simply a mixture of serpentine and sulphides, resembles the disseminated ore at the Alexo nickel deposit near Porcupine, the quantity of sulphides being smaller at Cedar lake.

While the main deposit is made up essentially of this disseminated ore, it may be noted that there are a few irregular veins of pure sulphides less than a foot wide cutting the disseminated ore. These small veins, although rich, have no economic significance because they are too narrow for profitable work. There are also a few small calcite veins which carry some ore.

There are several trenches across the deposit, and the ore body has been well sampled by private individuals. At least two companies have had options on the property and have sampled the deposit. The results of the channel sampling, however, were not available for publication in this report. Grab samples taken by the writer were analysed by W. K. McNeill and found to contain:

| | Low grade disseminated ore. Per cent. | High grade ore in vein about one foot wide. Per cent. |
|---|---|---|
| Nickel | 1.00 | 6.54 |
| Copper | .52 | 6.40 |

Two shafts have been sunk in connection with development work, one near the west boundary of T.R. 3187, and the other near the east boundary of T.R. 1623. Both shafts were full of water at the time of examination, but the rocks on the dump were seen to consist of serpentine. The dump from the shaft on claim T.R. 1623 was not gossan-stained and contained little ore. The dump from the other shaft was gossan-stained.

There is very little mineralization in the serpentine, except that just described at the north end of the serpentine intrusion.

In connection with the development work which has been done at the property about half a dozen buildings have been erected, and a winter road built from Cedar lake south to the deposit, a distance of about a mile.

Some diamond-drilling has been done in connection with the exploration of the deposit.

### Other Pyrrhotite Deposits

On the shores of Net lake, on claim W.S. 269, considerable work has been done on a coarse-grained diabase or gabbro. This basic rock becomes more basic in places by a segregation of the dark green minerals into isolated masses. Thin sections show that the dark green mineral in these segregated masses is chiefly hornblende. The ore, which is mainly pyrrhotite and a little copper pyrites, occurs generally in these segregated masses of hornblende. At least ten pits, mostly shallow, have been sunk on various parts of the intrusive mass, the largest pit noted being about 30 feet long, 10 feet wide and 6 feet or less in depth. This large pit is at the north end of the claim, at the water's edge. Two diamond-drill holes have been put down at this pit, one at an angle of 45° and the other vertically. There are also other diamond-drill holes on the hillside. The texture of the hornblende rock varies from fine-grained to very coarse-grained, the crystals being as long as one inch in places. The sulphides appear to cut and ramify through the hornblende, suggesting that the sulphides crystallized later and are younger than the hornblende. On the other hand, there is a granite dike two or three feet wide cutting the ore and hornblende rock; the dike has little or no sulphide in it. The inference is that the granite is later than the hornblende rock and the sulphides.

A grab sample of the ore, from the occurrence described in the above paragraph, gave only traces of nickel.

On the shore of Net lake west of the railway, on claim W.D. 264, there is a gossan-stained zone two or three hundred yards long. The gossan area is ten feet or more in width. A pit about eight feet deep and ten feet square has been sunk on the deposit, revealing fresh ore and disclosing pyrite, copper pyrites and pyrrhotite. The ore occurs at the contact of Keewatin lavas and an "old"-looking diabase intrusion. The sulphides impregnate the Keewatin at the contact with the diabase. There are hardly any pure sulphide masses, and the deposit appears to be too low-grade to work.

Copper and nickel claims[1] in the Net lake area have been referred to by A. P. Coleman, in 1899, as follows:[2]

> The other claims of the region have been taken up for copper and nickel, and generally resemble those of the Sudbury region. The Canadian Copper Company has a camp on the west shore of Net lake with four log houses and other buildings, but they had just closed for the season on November 1, so that we saw little of their work. The Mukwa claim on the west side of the lake belongs to them, and is said to contain a large body of copper-nickel ore like that of Sudbury; and the Friday No. 1 and 2 claims appear to be similar. On Friday No. 2 there are two openings, displaying heavy masses of pyrrhotite and chalcopyrite, and the dusty rock surface can be traced for a long distance on a hill top.
>
> The Red Hill claim seems to be of a different character, copper pyrites and some pyrrhotite occurring with quartz, in veins sometimes four feet wide, the ore looking like the copper ore of the Bruce mines, though said to contain important amounts of gold.
>
> On the east side of Net lake two claims were visited, the Fairview and the Pike, the former about a mile and a half north of the openings on the Big Dan. On the Fairview there are two small pits and some stripping on a country rock of green slate with gabbro, a little quartzite cropping out near by. The ore is pyrite, pyrrhotite and chalcopyrite with a little arsenopyrite, and except for the pyrite resembles the Sudbury ore in many respects. The amount to be seen is not great, however. The Pike claim is a quarter of a mile farther north, and shows considerable extent of gossan, but the only working is a small pit. The materials on the dump contain pyrrhotite and chalcopyrite like the Sudbury ores, but mixed with a large amount of barren rock.

## Other Mineral Occurrences in Cedar and Net Lakes Area

In the past twenty-five years, before and after the construction of the Temiskaming and Northern Ontario railway, a good deal of mining and prospecting has been carried on in the Cedar and Net lake area. Daniel O'Connor, a well-known prospector, was engaged in prospecting and mining during part of the period mentioned. He was particularly interested in the immense deposits of low-grade iron ores which occur a mile or two south of the area covered by this report.

Aside from the Cedar lake nickel deposit, probably the most interesting of the other mineral occurrences in the area are the gold-bearing mispickel ore bodies known as Big Dan and Little Dan. On these two deposits considerable work has been done and buildings erected.

### Big Dan Auriferous Mispickel Deposit

The Big Dan mispickel deposit occurs on claim W.D. 271, near milepost 74 on the Timiskaming railway about two miles north of Timagami station. A siding some 250 yards in length was built into the property, but the rails have since been taken up. The siding was at one time known as Grey's siding; trains, however, do not stop at this point now. A mill and other mining buildings were erected some years ago, but a fire has made a clean sweep of the plant and not a building now remains.

The ore body occurs in a sheared and brecciated zone in basalt of Keewatin age. The basalt in the neighbourhood is massive except along the shear zone. The ore occurs in small veinlets and in grains disseminated through the rock.

[1] It is difficult to locate these claims from the descriptions given.
[2] Ont. Bur. Mines, Vol. IX, 1899, p. 173.

Big Dan mispickel deposit, Strathy township, Timagami Forest Reserve.

There is also some pure ore containing many angular fragments of rock, showing that the country rock has been brecciated and that the ore has subsequently filled in the interstices between the fragments.

The ore consists of mispickel, iron pyrites, copper pyrites and pyrrhotite. Some quartz and calcite also occur.

The shear zone in which the ore is found strikes about north and south, with a steep dip to the west. This zone is gossan-stained on the surface, and has a width, at the tunnel, of about 50 feet and a length of about 1,000 feet. There is a shaft at the north end of the deposit and one near the south end, and there is also a tunnel and open cut about midway between the two shafts. The open cut is about 18 feet wide. The tunnel referred to leads into a stope from which ore has been removed.

There are at least three dikes on the property, namely, a quartz-porphyry dike, a diabase dike, and a very basic dike. The quartz-porphyry dike occurs from 25 to 200 feet west of the ore body, and strikes a little east of north. It is from 50 to 100 feet in width. To the east of the ore body from 300 to 1,000 feet there is a very basic dike striking northwestward. This dike belongs to the series of pre-Algoman intrusives which have been previously described as consisting of serpentine rocks, diabase or gabbro. The third dike mentioned is a fresh-looking diabase at the south end of the deposit. The location of these three dikes is shown on the geological map accompanying the report.

The origin of the mispickel deposit described above is uncertain.

The Big Dan mine has been described in previous Reports of the Bureau of Mines.[1] Following is an account of the property by A. P. Coleman:[2]

The Big Dan claim, a half mile inland on the southwest shore of the lake [Net], contains a large deposit of auriferous mispickel, the surface of gossan stretching more or less continuously for about a third of a mile in the direction N. 30° E., as disclosed by stripping, with a width running in places up to 100 yards. A number of test pits have been sunk upon it, two of them of considerable dimensions. The most southerly pit is 27 feet long, 4 feet wide and 3 feet deep; and the ore pile beside it consists of altered slate as country rock, mixed with a large amount of pyrite, chalcopyrite and arsenopyrite (mispickel). The next large opening to the north is a trench on the side of a steep hill, disclosing a band of nearly solid mispickel, 59 feet long and a foot thick on the average, running down at least 10 feet as shown in the trench, but having no distinct walls. Assays show this ore to run $3.70 in gold, $2.52 in silver and 14.4 per cent. of arsenic per ton. At the foot of the hill and a little northwest of the trench there is another large pit yielding ore rich in mispickel and containing considerable quantities of copper pyrites, but running low in gold and silver. A hundred yards to the north there is another large pit showing a band of ore rich in mispickel, a sample of which assayed $9.30 in gold and $1.32 in silver. The assays made on these ores run from less than $1.00 to $31.20 in gold and silver, with an average of $5.75; and all the samples of ore contain more or less arsenic, so that their treatment by ordinary methods would be difficult. It is probable, however, that the arsenic from carefully selected ore may be an object of importance, since white arsenic is now quoted at 4½ to 5 cents per pound. It is hard to estimate at present the amount of ore likely to be found in the deposit, but it is probably very great. Although an arsenical ore, it differs greatly from the well known ore of Deloro, since it is largely mixed with other sulphides, is associated with little or no quartz, and does not occur in distinct veins, but rather in shear zones or fahlbands in slate, penetrated by dikes and masses of diabase.

Another deposit of arsenical ore with copper pyrites is said to occur not far to the west, and has been taken in hand by the Canadian Copper Company of Sudbury, two shafts having been sunk, one 30 and the other 15 feet deep; but we were unable to visit the claim.

[1] Brief references to the arsenic deposits of the area will be found in the notes printed on Map No. 944, by A. E. Barlow and G. A. Young, 1907, Can. Geol. Sur. See also Map No. 599, Can. Geol. Sur., 1908.

[2] Ont. Bur. Mines, Vol. IX, 1900, p. 173.

The deposit is mentioned by W. G. Miller in 1900 as follows:[1]

A mispickel deposit known as the "Big Dan" lies a short distance south of Net lake. This mispickel is fine grained and massive in appearance, and occurs under different conditions from the well known deposits of Hastings county, in the eastern part of the Province. Like that of the latter deposits, however, the mispickel of Nipissing is auriferous. As this deposit was described by Dr. Coleman in the last Report of the Bureau, p. 173, it is not necessary to refer further to it here. Mispickel is, as already stated, found in close association with the iron-bearing band at Austin bay, lake Timagami.

Miller again refers to the ore body in the following words in 1903:[2]

It is of interest to note that a deposit of sulpharsenide of iron, mispickel, was discovered a few years ago near Net lake, which lies about 25 miles to the south-westward of the Haileybury deposits. The mispickel, however, does not carry appreciable amounts of nickel, cobalt or silver.

In 1906, Thos. W. Gibson, referring to the mispickel deposits in the Net lake area, remarks:[3]

A mill and concentrating plant were installed at the Big Dan mine, Net lake, but the success of the process has not yet been determined. Other promising mispickel locations in the same neighbourhood are being developed by Major R. G. Leckie.

In the same year E. T. Corkill describes the Big Dan as follows:[4]

On mining location W.D. 271 at Grey's siding, in the Timagami Forest Reserve, and about three miles north of Timagami station, the Timagami Mining and Milling Company have put up a concentrating mill for treating the ore from the Big Dan mine. Very little mining or development work has been done, the ore milled having been taken out of an open cut 18 feet wide, about 30 to 35 feet high and 20 feet long. The ore is arsenopyrite, and outside the veins is disseminated through the country rock, which is milled.

The ore is hoisted from the open cut by a skip and dumped into a Blake jaw crusher. The product is then dried, and is passed through rolls and elevated to trommels for sizing. The oversize passes down through a fine roll. The sized product is then put through Kriem air separators, of which there are three in the mill. The concentrates from these separators are drawn off and bagged for shipping. It is the intention of the management to do away with dry concentration and put in a plant using the wet process. Mr. Albert Smith is general manager, employing, when operating, a small gang of men.

### Little Dan Auriferous Mispickel Deposit

The Little Dan auriferous mispickel deposit is on claims W.S. 14 and W.S. 13 at the east end of Arsenic lake. The property is reached by a wagon road which begins at the Big Dan mine, near milepost 74 on the Temiskaming and Northern Ontario railway. It is only a mile and a quarter in a straight line west of the railway, but the winding wagon road makes the trip much longer. The Little Dan may also be reached by following a good trail which begins 150 feet south of milepost 75 on the railway.

The occurrence is somewhat similar to the Big Dan. The ore is found in a shear zone, and a little quartz may be seen in the deposit. The country rock is Keewatin basalt, showing pillow structure well developed at the east end of the lake about 150 feet east of the office.

The property has been worked by a shaft and open cut just south of the east end of the lake. The shaft was full of water at the time of examination. The

[1] Ont. Bur. Mines, Vol. X, 1900, p. 179.
[2] Ont. Bur. Mines, Vol. XIII, 1903, p. 101.
[3] Ont. Bur. Mines, Vol. XV, Part I, p. 23.
[4] Ibid pp. 87-88.

open cut is about 40 feet long by 20 feet deep by 15 feet wide. The rock on the dump is somewhat schistose. Near the ore body the basalt is in places bleached to a light grey colour.

The shear zone along which the deposit occurs strikes north 15° east and is about vertical. The dump shows the ore body to be made up of mispickel, pyrite and copper pyrites. The ore occurs in disseminated grains in the country rock and in pure masses holding rock fragments. Mr. John E. Hardman, who was associated with the property some years ago when it was being worked, has informed the writer that there were lenses of pure mispickel encountered from one to 18 inches wide. About 270 tons of mispickel were shipped, and the gold and arsenic contents were paid for.

There are several buildings on the property including one with a boiler and an Ingersoll rock drill compressor, No. 12, size 16 by 24.

In 1905 W. E. H. Carter described the Little Dan property in the following paragraph:[1]

Locations W.S. 13 and 14 are also owned by Major R. G. Leckie, who has had them under development for a year or more, with a force of about seven miners. They lie on a small pond known as Arsenic lake, which is one and one-half miles by road northwest of milepost 74 on the Temiskaming and Northern Ontario Railway two miles north of Timagami. So far tents have sufficed, but a substantial log camp is to be built at once. The ore found here is mispickel—arsenical pyrites—filling a shear zone about eight feet wide in the green schist of the area. Two solid, clean bands of ore, aggregating three to four feet in width, lie on each side of a central lower grade somewhat wider portion, having a strike about south-southwest by north-northeast. The ore will probably be sorted into two grades when mined, on account of its irregular outline and composition, the greatest width of solid ore so far explored being only three feet, whereas a safe average of the whole merchantable body is about eight feet. The clean ore carries, according to assay, $16.63 per ton gold and silver, and 30 per cent. arsenic, and the second grade not over 10 per cent. arsenic. Copper and iron pyrites are also present, the percentage of copper running from 0.5 to 1.5 per cent. Stripping with open cuts has laid bare a length of 60 feet by a width of 20 feet along the ore body.

The number of arsenic deposits already discovered and opened up in this immediate area may warrant the erection of an arsenic refinery in their midst. On this same road, but much nearer to the railway, lies the Big Dan arsenic location, found a number of years ago, but only this year explored to any extent.

E. T. Corkill mentions the Little Dan mine in 1909. His description is as follows:[2]

About three miles west of Grey's siding, T. & N. O. railway near Arsenic lake, on what was formerly known as the Little Dan, the Grey's Siding Development Company, Limited, are working chalcopyrite and mispickel. Mr. John McMartin is president of the company, Mr. Wm. Marshall managing director, and Mr. J. E. Wilson superintendent.

Two pits are worked, the ore being taken out by open cutwork. The ore in the pit to the east of the lake is mispickel, and that in the pit north of the lake is chalcopyrite, carrying values in gold. At the former a shaft has been sunk to a depth of sixty feet, but the work at present is being done by carrying an open cut from the shaft south into the hill. At the latter a hole has been sunk about fifteen feet. About four cars of ore were being shipped per day at the time of inspection.

### Minor Occurrences

In the deep south bay of Cedar lake, about halfway south on the east side, there is a shaft some seven feet deep at the water's edge. The shaft was sunk on an irregular calcite vein from one inch to two feet wide and about one hundred

[1] Ont. Bur. Mines, Vol. XIV, 1905, Part I, pp. 73-74.

[2] Ont. Bur. Mines, Vol. XVIII, 1909, Part I, pp. 132-3.

feet, or more, long. The vein has a very irregular strike. The calcite or dolomite vein carries considerable iron pyrites, some of it in cubes. The occurrence is in Keewatin.

Ankerite, or rusty iron carbonate, occurs in considerable volume in the south-west corner of the map on W.D. 267 and T.R. 1877. On the latter claim it has attracted the attention of prospectors, and two shafts were sunk on the rusty rocks. The dump from the shafts shows that the carbonate is plentifully impregnated with cubes of iron pyrites.

In the same vicinity, on the north shore of Cooke lake, at the end of the portage, there is also some rusty carbonate carrying iron pyrites and small veinlets of quartz. This association of rusty carbonate rocks intersected by veinlets of quartz is not unlike similar occurrences in Larder lake, Porcupine and elsewhere in northern Ontario. In the Cedar lake area these carbonate rocks were seen to carry a green mineral resembling chrome mica.

Mr. A. L. Parsons in 1917 refers to a molybdenite property on Net lake in the following paragraph:[1]

> About four miles north of Timagami station on the Temiskaming and Northern Ontario railway, and about a quarter of a mile east of the track, a deposit of molybdenite was opened up about ten years ago. The main ore body, upon which a shaft has been sunk, is about fifty feet wide, and consists of a series of gash veins of quartz carrying chalcopyrite and molybdenite in greenstone. The molybdenite is present in radiating nodules which when broken across give the appearance of a rosette.
>
> The shaft is said to be about fifty feet deep, and about 200 tons of rock and ore are upon the dump. The molybdenite is well distributed in the quartz, and although it did not appear to be rich when compared with other ores, the nodular character of the molybdenite renders the appearance somewhat deceptive, and it is probably richer than it appears to be. The writer would estimate that about one-fifth of the dump consisted of quartz which would run 1 per cent. of $MoS_2$. Openings were seen in two other places on the property where the veins, although of high grade, are not more than a foot wide. At the time when the work was done good camps were erected. Some of these have, however, been burned, but the boiler house is in fairly good shape, and is provided with hoist and pump.

## MUNRO TOWNSHIP

The Munro nickel area is in the township of Munro in the district of Timiskaming. The area is entered from Matheson, on the Temiskaming and Northern Ontario railway, by a good wagon road leading to the Croesus gold mine, a distance of about twelve miles from Matheson.

The township of Munro, which has been completely swept by a devastating fire, is chiefly known on account of the celebrated Croesus gold mine, which produced some phenomenally rich native gold in quartz veins. The gold deposits in the township were described by A. G. Burrows in 1912 in notes accompanying his geological map of Munro and Guibord townships.[2] Later, in 1915, P. E. Hopkins enlarged this map and wrote a more detailed report on the area.[3]

The nickel in Munro township occurs on lot 12 in the third concession, on the west part of the lot at the township boundary, a little of the gossan extending into Beatty township. The deposit occurs at the contact of an intrusive mass

[1] Ont. Bur. Mines, Vol. XXVI, 1917, p. 308.
[2] Ont. Bur. Mines, Map No. 21 c, 1912, A. G. Burrows.
[3] Ibid, Vol. XXIV, 1915, Part I, pp. 171-184, P. E. Hopkins.

of serpentine rock and pillow lava, the latter Keewatin in age. There is some diabase associated with the serpentine and the contact between the two rocks is rather sharp, but it would appear that the serpentine and diabase form part of the same intrusive mass. There is a well-marked depression along the contact between the serpentine and basalt, the serpentine forming the lower ground. The serpentine has a brown colour and is streaked by seams of light grey material. The contact of serpentine and pillow lava strikes northwestward and has a steep

Vein at Croesus gold mine, Munro township.

dip to the northeast. The ore consists of pyrrhotite, and is found here and there from point to point, not continuously, for a distance of three or four hundred yards. Several shallow pits have been sunk along the contact, but very little ore is to be seen on the dumps from these small pits. Mineralization has taken place in the serpentine and the adjacent basalt, but on account of the presence of much drift along the contact, and the pits being full of water, it was not possible to find out in which rock most mineralization has taken place.

A piece of the best ore was taken from the largest pit and submitted to W. K. McNeill, Provincial Assayer, for analysis. Mr. McNeill found it to contain 0.83 per cent. of nickel and no copper.

P. E. Hopkins, in his report on the Beatty-Munro gold area in 1915, also sampled this deposit. Mr. Hopkins reports as follows:

Nickel occurs in a five-foot pyrrhotite vein on the boundary line between Beatty and Munro townships in concession III. The pyrrhotite sample gave nickel 1 per cent., gold none, platinum none.[1]

Contact of what appear to be two lava flows, near Croesus gold mine, Munro township.

Later, in 1919, Mr. Hopkins refers again to the same deposit as follows:[2]

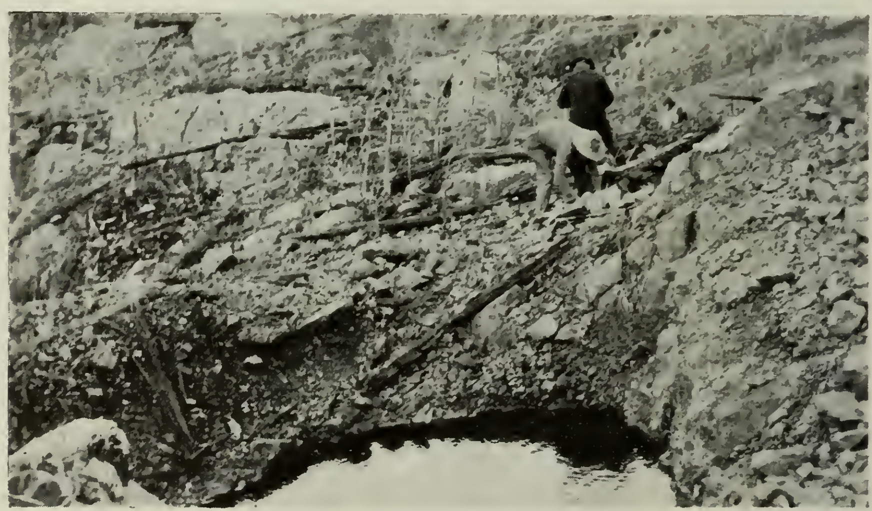
In lot 12, concession III, Munro township, Chas. Mickle has sunk a fifty-foot shaft on a massive pyrrhotite deposit five feet wide, a sample of which yielded on assay, nickel 1 per cent., gold none, platinum none. Like most deposits it occurs at the contact of a pillow lava and an altered diabase or serpentine.

Nickel was also reported to occur at the north end of Munro township on a claim known as the Copper Queen on lot 5 in the fifth concession. The writer took a sample from a small pit of the richest part of the ore consisting of pyrrhotite and copper pyrites and submitted it to W. K. McNeill, Provincial Assayer, for analysis, who reported that it contained no nickel but a high per cent. of copper, namely 5.34 per cent. The sample was taken from one pit only, and it may be that elsewhere along the deposit, which appears to be small, the ore may contain some nickel.

[1] Ont. Bur. Mines, Vol. XXIV, 1915, Part I, p. 181.
[2] Ibid., Vol. XXVIII, 1919, Part II, p. 64.

The geological conditions, however, under which the deposit occurs are interesting and worth describing, since there are no reports on the character of the occurrence. The ore is associated with a great intrusion of diabase covering an area of about eight square miles.[1] This mass was mapped by A. G. Burrows[2] in 1912, and later by P. E. Hopkins in 1915 and 1919.[3]

The ore occurs at the foot of the hill of diabase, on the south side. The diabase mass rises to a height of 100 to 150 feet above the surrounding sand plains. At the foot of the diabase hill there is a belt of serpentine rock of unknown width, since it disappears below the sand plains to the south. Between this serpentine and the diabase there is a belt of Keewatin (?) rock about 100 feet, more or less, in width, and extending at least half a mile along the foot of the diabase hill. This belt of Keewatin rock constitutes the ore body. It is, on the whole, but slightly impregnated with pyrrhotite and copper pyrites, but the decomposition of



Prospect known as Copper Queen, lot 5 in the fifth concession of Munro township. The ore body is associated with serpentine rock and diabase.

the sulphides forms a prominent gossan which exaggerates the intensity of the mineralization. This Keewatin belt strikes about north 60° west magnetic, and dips steeply to the southwest; it consists of fragmental material, mainly of basalt and chert. It also contains beds of banded cherty material a few inches wide and several feet long, dipping steeply to the southwestward and lying parallel to the general strike of the belt.

Cutting at right angles across the belt are several fresh diabase dikes 100 to 150 feet wide. It is where one of these dikes cuts across the deposit that most ore was developed; a pit was sunk at this point. The sample submitted to Mr. McNeill for analysis, mentioned above, was obtained here. The ore from this

[1] Ont. Bur. Mines, Vol. XXVIII, 1919, Part II, p. 24.
[2] Ibid., Map No. 21 c, Vol. XXI, 1912, A. G. Burrows.
[3] Ibid., Map No. 24 a, Vol. XXIV, 1915, P. E. Hopkins.
Ibid., Map No. 28 b, Vol. XXVIII, 1919, Part II.

pit consists of pyrrhotite, chalcopyrite and a little pyrite. Whether the intrusion of the diabase dike caused an enrichment of the ore is not known. It can be said, however, that at Sudbury, where similar diabase dikes cut the immense ore bodies, no enrichment has taken place which can be traced to diabase dikes.

The contact of the serpentine and diabase was not observed, since the belt of Keewatin (?) rock lies between these two rocks.

The occurrence of the serpentine rock at the foot of the diabase belt is suggestive of the occurrence at Ghost mountain, where the rock consists of diabase with a belt of serpentine rocks encircling it at the base.

It may be added that the diabase in Munro has also some serpentine at the north side, which was mapped by P. E. Hopkins.[1]

Croesus gold mine, Munro township.

## FOX TOWNSHIP

It was reported to the writer that there was a deposit of nickel ore in Fox township a few miles east of Cochrane, in the district of Timiskaming. Accordingly the writer spent a day in October, 1919, investigating the reported discovery.

The occurrence is easily reached by leaving the National railway at Norembega station, fifteen miles east of the town of Cochrane. A rough road, beginning a few hundred yards west of Norembega, runs north along the boundary between lots four and five. A few primitive log cabins owned by pioneer settlers are found along this road, and there is a store at the railway station. The deposit is a mile and a half north of the railway, and is on the north half of lot 5 in the third concession of Fox township at the east side of the lot.

The township is a flat, drift-covered, agricultural locality, and the deposit occurs on a low hill which rises some forty feet above the surrounding swamps

[1] Map No. 28 *b*, Ont. Bur. Mines, Vol. XXVIII, 1919.

and flat clay land. The hill is about one-third of a mile long in an east and west direction and a quarter of a mile wide.

The rock on this hill consists of various banded gneisses, such as mica-gneiss garnet-gneiss and granite-gneiss. These gneisses resemble certain rocks in southeastern Ontario known as the Grenville series.

The rocks in Fox township are intersected by coarse-grained, granite pegmatite dikes, which cut across the strike of the gneiss or lie parallel to it. The gneisses strike north 65° to 70° east magnetic. The dip is more or less vertical.

The ore body consists of the gneiss which has been impregnated with pyrrhotite and pyrite and the decomposition of the sulphides forms the usual ugly brown gossan-stained surface. This mineralized zone is as wide as 135 feet in places, but for the most part is much less. It is about a quarter of a mile long. The

Contorted schists and gneisses, Fox township.

sulphides are, generally speaking, sparingly impregnated in the gneiss, but here and there are richer pockets or zones in which some almost pure sulphides are developed. In places masses of glassy quartz are associated with the ore.

About half a dozen pits have been sunk here and there along the hill on the more promising outcrops. A settler who lives in this township stated that the deepest pit was 25 feet. It was full of water at the time of the examination.

A sample of the pure ore was submitted to W. K. McNeill for analysis. Mr. McNeill reported that the material contained neither nickel nor copper.

It may be added that no intrusions of serpentine or gabbro were noted in the area, although these rocks might occur below the drift.

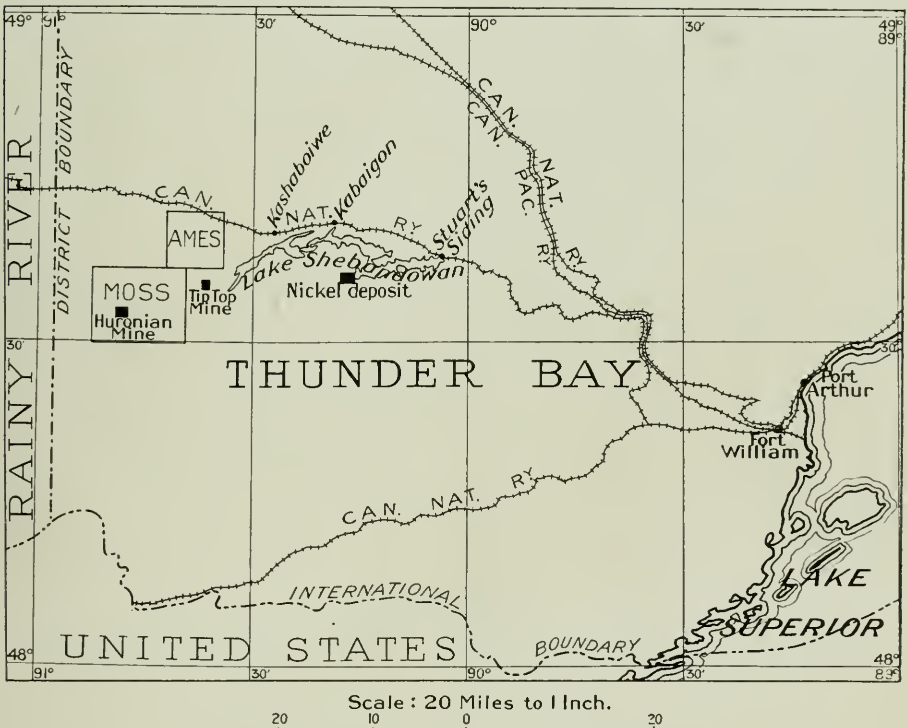
## LAKE SHEBANDOWAN NICKEL DEPOSIT

By

J. G. Cross

### Situation and Discovery

The Lake Shebandowan nickel property is situated at the southwest end of lower Shebandowan lake, in the district of Thunder Bay, about 73 miles west of Port Arthur, and about 4½ miles south of the nearest railway, the Canadian




Sketch map showing location of the Shebandowan nickel deposit and other mineral areas in the vicinity.

National. Shebandowan lake lies between the nickel property and the railway, and the nearest railway station, Kabaigon, is about 5 miles northwest of the property. The easiest way to reach the deposit is to leave the Canadian National railway at Stuart's siding at the east end of Lake Shebandowan and then canoe about 10 miles west along the lake, direct to the ore body. Although lumbering operations have been carried on for many years in this region, timber is still being cut in the vicinity of the lake, and two saw mills were being operated at the east end of the lake in 1919. Gasoline boats and steam tugs are used on the lake in connection with the lumber industry.

The Shebandowan nickel property consists of four claims, namely, T.B. 2192, T.B. 2204, T.B. 2219, and T.B. 2240, each claim consisting of 40 acres. The ore first outcrops on T.B. 2192, with a general strike of west 10 degrees north; it also occurs on T.B. 2204. The ore again outcrops on T.B. 2219, and on T.B. 2240.

The presence of nickel in the ore was first discovered by W. W. Benner, a chemist, in 1913. Benner's discovery was made near the water on the point at the east side of claim No. 2192 in pit No. 12. In the following year the writer detected nickel in the pits farther west.

### Geology

Lake Shebandowan has a length of about 25 miles and an average width of about three-quarters of a mile. The lake was geologically mapped by W. McInnes and the map published in 1896.[1] McInnes states that Keewatin rocks are exposed everywhere about the shores of the lake except on part of the south side of the Middle lake and the north side of the Lower lake, where granitoid gneiss is exposed.[2] The granitoid rocks are younger than the Keewatin and show intrusive contacts with the Keewatin rocks. It may be added that the rocks in the area are pre-Cambrian in age.

#### Keewatin

The Keewatin in the vicinity of the Shebandowan nickel deposit is a dark green, basic schist, dipping at very steep angles and having a strike which follows the granite contact, approximately east and west. The schist on the east end of T.B. 2192 at the water's edge on the point, gives a clue to the character of the original rock from which it was formed. Here there are traces of pillow structure in the basic schist, suggesting that the rock was originally a pillow lava. These pillow lavas are of very common occurrence in the Keewatin lava flows throughout the province of Ontario.

There is a zone of rusty weathering carbonate rock in the north part of T.B. 3103.

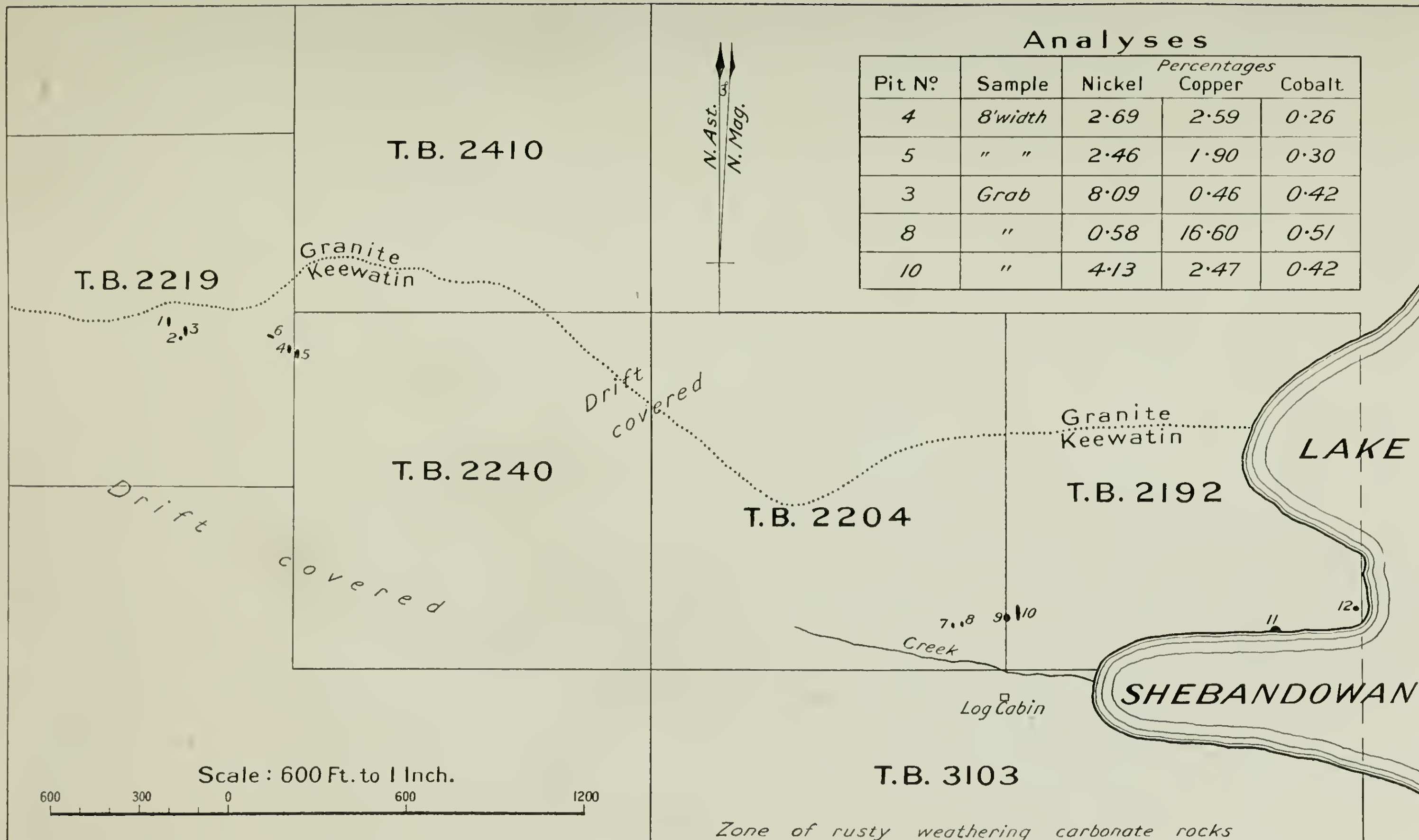
#### Serpentine Rock

About a mile east of the most easterly exposure of the nickel deposit there is a mass of serpentine rock of large but unknown extent, on the south shore of the lake. The rock contains considerable magnetite and a little pyrrhotite; small seams of asbestos also are found. There is also serpentine on an island between the nickel deposit and the large mass of serpentine just referred to. The relative age of the serpentine rock is not definitely known, but it is assumed to be younger than the Keewatin schists, since there are dike-like masses of serpentine apparently cutting the Keewatin. The age relation of the serpentine to the granite was not worked out, since the two rocks were not observed in contact.

#### Granite

The granite which intrudes the Keewatin at the nickel deposit is of considerable extent—several square miles. Along the contact between the Keewatin schist

[1] Geol. Sur. Can., Vol. X, 1897, Part H.
[2] Ibid., p. 36 H.




Analyses

| Pit No | Sample | Percentages Nickel | Copper | Cobalt |
|---|---|---|---|---|
| 4 | 8' width | 2·69 | 2·59 | 0·26 |
| 5 | " " | 2·46 | 1·90 | 0·30 |
| 3 | Grab | 8·09 | 0·46 | 0·42 |
| 8 | " | 0·58 | 16·60 | 0·51 |
| 10 | " | 4·13 | 2·47 | 0·42 |

Geological plan of Shebandowan nickel deposit, showing location of pits (solid black) sampled. The Keewatin includes green schists, pillow lava and rusty weathering carbonate rocks.

and the granite the schist is penetrated by dikes of granite, feldspar-porphyry, and felsite. These dikes are usually more or less parallel to the schistosity.

### Diabase Dikes

Medium-grained diabase dikes occur in the area, the age of which was not determined, whether Keweenawan or older.

### Nature and Extent of Ore Body

The ore body is found in Keewatin schists, near the contact between the schists and granite. The deposit occurs from 50 to 60 feet away from the granite. Although there is much drift, the pits and trenches show that the ore outcrops here and there for a distance of a mile. It has not been shown how continuous the deposit is between the pits. The width of the ore body varies from one to thirty-five feet or more.

The ore consists mainly of iron pyrites, together with copper pyrites and smaller quantities of pyrrhotite. It carries variable percentages of nickel, copper and cobalt, as shown by the assays given on the following pages. A sample, for instance, across a width of eight feet in pit No. 8 showed the ore to contain 2.45 per cent. of nickel, 0.30 per cent. of cobalt and 1.90 per cent. of copper. The nickel content of a grab sample of ore from pit No. 3 was found to be 8.09 per cent.

The ore occurs in disseminated grains, in irregular masses, and at times in vein-like occurrences. One of these vein-like occurrences is found in pit No. 4, where there is a vein about one foot wide consisting of sulphides carrying many rock fragments from half an inch to an inch or more in width. Elsewhere along the deposit it is characteristic to find rock fragments in the ore.

Some of the pits show the ore to be covered with a gossan capping 6 feet or more in depth. The gossan consists of iron oxides which are decomposition products from the sulphide ore. The location of the pits and outcrops, referred to in following paragraphs, is shown on the plan, p. 227.

The deposit appears first on T.B. 2192, on the shore of the lake, as a small vein of pyrrhotite, six inches to one foot in width, and the pure ore contains on analysis a little over 7 per cent. of nickel. This is the largest outcrop of pyrrhotite on the property; pyrite forms the main part of the ore elsewhere. Pit No. 12 was sunk here. About 200 feet west of this point a number of stringers of chalcopyrite outcrop on the edge of the lake and continue for about 200 feet; here pit No. 11 was sunk. No ore of importance was found. The ore again outcrops at pit No. 10, opposite the log cabin, on the same claim. Here the ore has a width of over 25 feet, and is much decomposed and intermingled with schist. The hanging wall was not reached. Select ore from this pit contained over 7 per cent. copper, nickel and cobalt combined. It was impossible to obtain a channel sample from this outcrop, as the ore was too much decomposed. The ore again outcrops on T.B. 2204, in pits Nos. 7 and 8 about 150 feet west of pit No. 10. In pit No. 7 the ore is of good quality, but narrow. In pit No. 8 the ore is about three feet wide and mostly chalcopyrite. It is in greenstone, the granite being about 100 feet to the north, and the intervening space heavily covered with glacial débris.

On T.B. 2240 the ore again outcrops, and has a width at the narrowest point of eight feet. The dip is 70 degrees to the north.

On T. B. 2219, just across the claim line, pit No. 4 was sunk. Here the ore has a width of 16 feet; three feet of this is quite lean, as will be seen from the results of the analysis. The hanging wall is schist; the footwall has not been reached. The granite dike which is in pit No. 5 also occurs in pit No. 4 and is only 13 inches wide.

The ore does not outcrop further, but in pit No. 3 on T.B. 2219 heavy gossan and ore were struck about 7 feet below the surface. The pure undecomposed material was rich in nickel. The ore at this point appeared to be of considerable width, about 35 feet. Trenching north from pit No. 2 what appeared to be the hanging wall was reached. This is a very dense, fine-grained rock heavily impregnated with sulphides. Pit No. 1, however, sunk 60 feet northwest of pit No. 3, showed ore and gossan in the bottom of the hole, which was 10 feet deep. Pits Nos. 1, 2 and 3 give an approximate cross-section of about 80 feet. This would seem to indicate that there may be an ore body of considerable size under the glacial débris. Further prospecting would have to be done to prove this definitely.

Two miles west of T.B. 2219 there is a large body of pyrrhotite, containing magnetite, but showing only traces of nickel.

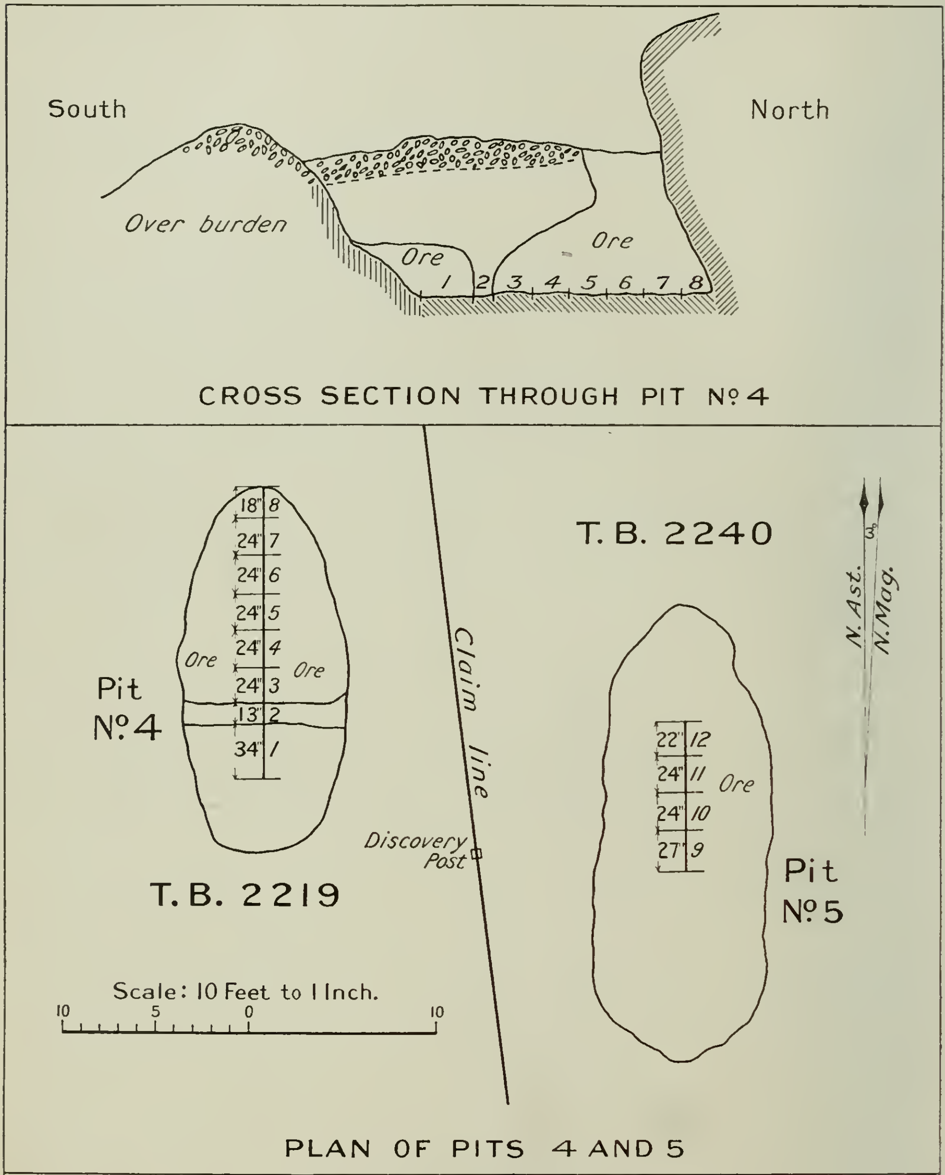
### Origin of the Ore Body

The origin of the ore body may be connected with the large mass of serpentine which lies on the south shore of the lake, and has already been mentioned. Although the known ore body occurs about a mile from the main serpentine mass, still it may be that ore occurs below the lake, between the known ore and the large mass of serpentine.

While the Shebandowan nickel deposit occurs mainly in the Keewatin green schist, near an intrusion of granite, there are small dikes or masses of serpentine a few feet or inches wide, associated with the ore body, apparently cutting the Keewatin schists. The intrusive nature of these serpentine dikes was not clear, but the presence of serpentine associated with the ore body suggests a connection between the ore and the serpentine. particularly in view of the known association of nickel ores with serpentine elsewhere in Ontario. Serpentine rock, for instance, is associated with the Alexo nickel deposit in the district of Timiskaming about 425 miles east of Lake Shebandowan. The Alexo occurs at the contact of the Keewatin and an intrusion of serpentine.

### Precious Metal Content

As the nickel ore of the Sudbury nickel area carries low values of the precious metals, a sample of the Lake Shebandowan nickel ore from pit No. 3 was submitted to W. K. McNeill, Provincial Assayer, to determine whether the material contained metals of the platinum group. Analysis showed that none were present in appreciable quantity. Mr. McNeill also found that this sample contained no arsenic.




**Analyses**

| Sample Nº | Pit Nº | Width of Sample | Nickel (Percentages) | Copper (Percentages) | Cobalt (Percentages) |
|---|---|---|---|---|---|
| 1 | 4 | 2′ 10″ | 0·99 | 3·43 | 0·33 |
| 2 | " | 1′ 1″ | 0·29 | 0·76 | 0·17 |
| 3, 4, 5, 6 | " | 8′ 0″ | 2·69 | 2·59 | 0·26 |
| 7 | " | 2′ 0″ | 1·01 | 0·67 | 0·34 |
| 8 | " | 1′ 6″ | 3·26 | 3·26 | 0·25 |
| 9, 10, 11, 12 | 5 | 8′ 1″ | 2·46 | 1·90 | 0·30 |

Cross section of pit No. 4 and plan of pits Nos. 4 and 5. Analyses are for samples 1 to 12, Shebandowan nickel deposit.

### Sampling

As pits Nos. 4 and 5 were the only pits where undecomposed ore was encountered, they were the only places where sampling could be done satisfactorily. The samples which number from 1 to 8 were taken from pit No. 4, and those which number from 9 to 12 from pit No. 5. These samples should give a reasonably accurate idea of the average of the ore over the width sampled. The size of the sample trench was 2½ inches wide and ¾ inch deep. See page 230.

### Analyses

The following table shows the grade of the ore from some of the pits on the property. The width across which the samples were taken is given.

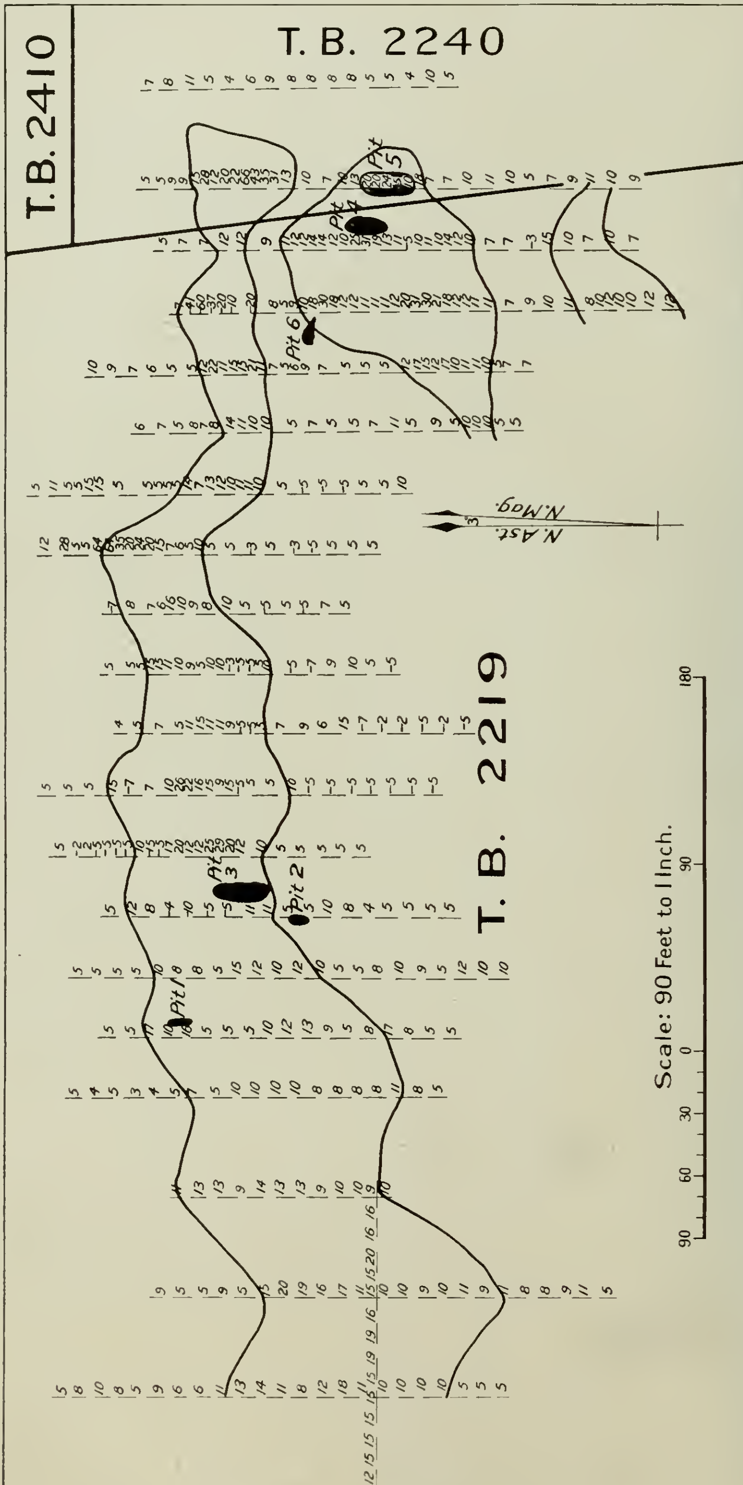
| Sample | Nickel Per Cent. | Copper Per Cent. | Cobalt Per Cent. |
|---|---|---|---|
| 1. Pit No. 4. Width 34 inches ore | .99 | 3.43 | .33 |
| 2. Pit No. 4. Width 13 inches, porphyry | .29 | .76 | .17 |
| 3. Pit No. 4. Width 24 inches ore | 1.97 | 3.30 | .36 |
| 4. Pit No. 4. Width 24 inches ore | 5.44 | 2.09 | .25 |
| 5. Pit No. 4. Width 24 inches ore | 1.85 | 1.91 | .19 |
| 6. Pit No. 4. Width 24 inches ore | 1.51 | 3.08 | .25 |
| 7. Pit No. 4. Width 24 inches ore | 1.01 | .67 | .34 |
| 8. Pit No. 4. Width 18 inches ore | 3.26 | 3.26 | .25 |
| 9. Pit No. 5. Width 27 inches ore | 3.80 | 2.22 | .35 |
| 10. Pit No. 5. Width 24 inches ore | 3.91 | 2.59 | .38 |
| 11. Pit No. 5. Width 24 inches ore | 1.50 | 1.35 | .17 |
| 12. Pit No. 5. Width 22 inches ore | .62 | 1.46 | .29 |
| 13. Pit No. 3. Grab sample | 8.09 | .46 | .42 |
| 14. Pit No.10. Grab sample | 4.13 | 2.47 | .42 |
| 15. Pit No. 8. Grab sample | .58 | 16.60 | .51 |
| 16. Selected | 11.55 | ........ | ........ |
| 17. Selected | 21.17 | ........ | ........ |
| 18. Pyrrhotite | 7.13 | ........ | ........ |

Two selected samples of the rich ore from pit No. 3 were taken by C. W. Knight of the Ontario Bureau of Mines and submitted to W. K. McNeill, Provincial Assayer, for analysis. The following results were obtained:

| | No. 1. Per cent. | No. 2. Per cent. |
|---|---|---|
| Copper | 1.88 | 0.68 |
| Nickel | 10.54 | 6.73 |
| Cobalt | 0.44 | |
| Arsenic | none | |
| Sulphur | 37.00 | 38.47 |
| Platinum | ? | |
| Iron | .... | 31.58 |
| Insoluble | .... | 9.54 |

The writer also took a sample from pit No. 3 of the high-grade ore and found it to have the following composition:

| | No. 3. Per cent. |
|---|---|
| Fe. | 38.22 |
| S. | 39.42 |
| Ni. | 8.03 |
| Cu. | .40 |
| Co. | .50 |
| Insoluble | 12.80 |




Plan showing dip needle observations, Shebandowan nickel deposit. The heavy lines enclose areas showing the higher dip needle observations.

### The Nickel-Bearing Mineral

To determine the mineral which contains the nickel the following analysis was made. The composition is suggestive of pentlandite, the theoretical composition of which is: sulphur 36 per cent., iron 42 per cent., nickel 22 per cent.

| | Per cent. |
|---|---|
| Fe. | 22.68 |
| S. | 35.75 |
| Ni. | 21.17 |
| Co. ud. | .... |
| Cu. ud. | .... |
| Insol. | 18.86 |
| | 98.46 |

### Dip Needle Observations

A magnetic survey was made with the dip needle in the vicinity of the ore. The readings are shown on p. 232. North and south lines were run every 30 feet along the strike of the ore between pits Nos. 1 and 5. West and east of these pits lines were run every 50 feet. Readings were taken every ten feet along these lines. Where high observations were found, readings were taken every five feet. All are plotted on the map. A compass and Jacob's staff were used to keep the dip needle in the plane of the magnetic meridian. Only vertical intensities were taken. What influence the magnetite in the country rock had on the results could not be determined. The massive high-grade ore from pit No. 3 affects the needle strongly, while the ore from pit No. 10 scarcely affects it at all. At one end of pit No. 6 the needle stood at 80 degrees positive over good ore, while a few feet farther west the needle stood at 70 degrees negative. The ore was continuous all the way. The pyrrhotite from pit No. 10 pulls the needle down to 90 degrees. The pyrite affects it to a much slighter degree.

The dip needle readings are very erratic, as might be expected. However, it is probable that a large number of the readings over 10 degrees are caused by ore, especially as the country rock in the vicinity of ore affects the dip-needle readings but slightly, with a few exceptions, and here considerable ore is mixed with it. The serpentine across the lake about a mile and a half to the east gives readings of 30 to 90 degrees for a distance of nearly 1,000 feet in length and 600 feet in width. Magnetite, chrome iron ore and nickel ore are mixed with the serpentine in small quantities. Undoubtedly these large deflections are due to the large amount of magnetite contained in the serpentine.

### Other Properties

Considerable mining and prospecting activity has been experienced in years gone by in the Lake Shebandowan area. As early as the winter of 1870-71 a gold deposit was discovered in what is now Moss township by two Indians in the employ of the Hudson's Bay Company.[1] The mine later became known as the Huronian. It lies about ten miles southwest of the lake. Little real mining was done at the Huronian until the Canadian Pacific railway was built, after which, in 1883, a ten-stamp mill was erected.

[1] Geol. Sur. Can., Vol. X, 1897, p. 58 H., W. McInnes.

The Tip Top copper mine lies about four miles west of Shebandowan lake and on the east shore of Round lake. It is seven miles distant from Kashaboiwe station on the Canadian National railway. This mine has made some shipments to the smelter at Trail, in British Columbia. The ore contains traces of nickel and a little cobalt. Descriptions of the property will be found in several reports of the Ontario Bureau of Mines.

Lake Shebandowan, looking eastward.

About four miles west of the Lake Shebandowan nickel deposit there is a copper prospect which has been worked intermittently. The ore is chalcopyrite and the deposit, which is 30 feet wide, is said to carry 1.8 per cent. of copper.

Other mineral deposits occur in the Lake Shebandowan area.

# HAILEYBURIAN INTRUSIVE ROCKS*

By

Willet G. Miller and Cyril W. Knight

### Introduction

In the pre-Cambrian of Ontario there is a widespread series of igneous rocks, of greater volume than formerly recognized, that intrudes the Timiskaming sediments but is older than the Algoman granite and gneiss. Descriptions of these rocks have been given in various papers and reports by the authors and their age relations have been discussed. For instance, in a paper published in 1915 the authors said [1]:

"It may be added that basic rocks of the age of sudburite are widespread and have frequently been mistaken for Keewatin[2]. They are represented by the peridotite and augite lamprophyre of the Porcupine region, one hundred miles north of Sudbury, and by the lamprophyres and other rocks of Cobalt, 90 miles to the northeast of Sudbury. For economic purposes, at least, some age name should probably be applied to these basic rocks."

Diabases that appear to be of this age occur in the vicinity of Cobalt and elsewhere and at times are confused with the later Nipissing diabase. Gabbro-diabase and basic lavas of Hastings and other counties of southeastern Ontario are also of this age. The Correlation Table that accompanied our report in 1915 shows the occurrence of these rocks in several districts[3].

Since the publication of that report and other papers in which we have described and referred to these rocks we have found an age name for them more necessary, especially in connection with structural geology of the mines at Cobalt. In this area lamprophyres and the so-called "older diabases" are of common occurrence and reference has frequently to be made to them. While we are loath to introduce another age name. still as a matter of convenience we now propose to employ the name Haileyburian for these post-Timiskaming and pre-Algoman igneous rocks. The name is taken from that of the capital of the district of Timiskaming, the town of Haileybury. Dikes of certain of these rocks occur in the environs of the town.

Certain of the rocks that we class as Haileyburian are older than others but they are all post-Timiskaming and pre-Algoman.

The following table with the addition of the name Haileyburian, gives the age classification employed by the geological staff of the Ontario Department of Mines, the names of the igneous systems or series being enclosed in parentheses, thus: (Laurentian intrusives), to distinguish them from the sedimentary systems.[4]

* This paper, under the title, "Certain Post-Timiskaming Igneous Rocks of Ontario for which the name Haileyburian is Proposed," was published in the *Canadian Mining Journal*, August 13th, 1920. Certain typographical changes have been made in it.

[1] Journal of Geology, Vol. XXIII, p. 590.

[2] Sudburite is a lava, often with pillow structure, but frequently schistose, that occurs in considerable volume in the Sudbury area. It has the same relation to norite as that of basalt to gabbro or rhyolite to granite. Ont. Bur. Mines, Vol. XXIII, 1914, Part I, p. 215.

[3] Ont. Bureau of Mines, Vol. XXII, 1913, Part II, Appendix.

[4] Journal of Geology, Vol. XXIII, 1914, p. 591.

**Pre-Cambrian Epochs of Ontario and Their Metal Production**

(*Keweenawan*)—Epoch, following basic intrusions, of (*a*) silver, cobalt, nickel, and arsenic at Cobalt and elsewhere, (*b*) nickel and copper at Sudbury, and copper elsewhere. Certain gold deposits, not now productive, appear to belong to this epoch.

*Animikean.*—Epoch of deposition of "iron formation" as a chemical precipitate. Includes the Cobalt and other series of sediments.

(*Algoman*)—Epoch, following granite intrusions, of gold at Porcupine and at many other localities, and of auriferous mispickel. Deposits of galena, zinc blende, fluorite, and other minerals appear also to have been derived from the granites, but some of them were not formed till post pre-Cambrian time.

(*Haileyburian*)—Preceding the intrusion of the Algoman granites, basic intrusives, of post-Timiskaming age, gave rise to nickel and titaniferous and non-titaniferous magnetite deposits and chromite.

*Timiskamian.*—Epoch of minor deposition of "iron formation" as a chemical precipitate, with conglomerate and other sediments.

(*Laurentian*)—Granite intrusions probably gave rise to ore deposits which have been removed by excessive erosion as is known to be the case with deposits of later origin.

| | |
|---|---|
| *Loganian...* | *Grenville.*—Epoch of deposition of extensive "iron formation" as a chemical precipitate, with limestone and other sediments. |
| | (*Keewatin*)—Composed largely of basic lava flows, many of which are now schistose. There are also acid lava flows such as rhyolite. |

End of Part I.

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H.

M.

TWENTY-NINTH ANNUAL REPORT

OF THE

# ONTARIO BUREAU OF MINES, 1920,

BEING

VOL. XXIX., PART II.

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# The Abitibi and Mattagami Rivers

## North of the National Transcontinental Railway

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CONTENTS



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1920

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III.—Clay and Shale Deposits of the Abitibi and Mattagami Rivers.

## ILLUSTRATIONS AND DIAGRAMS



## MAP

*(In pocket on inside of back cover.)*

## INTRODUCTORY LETTER

To the Honourable H. Mills,
*Minister of Mines.*

Sir,—One of the chief aims of the Bureau of Mines is to collect and publish authentic information regarding the mineral resources of the Province, especially of those regions which have as yet been little explored.

To the latter category belongs the larger part of that vast territory which extends northward and westward of Lakes Superior, Huron, and the Georgian Bay-Mattawa line. In parts of this territory the prospector has been at work for a number of years, but his labours have perforce been confined to those areas naturally accessible or which have been made so by man.

Both the southern and northern slopes of the watershed between the Great Lakes and Hudson Bay are well provided with rivers, which with their tributaries are invaluable for prospecting purposes, for in Ontario the prospector's chief means of travel is the canoe. Some of the rivers of the Great Lakes flow in a southern, others in a southeastern, and still others in a southwestern direction, with many deflections in their course, and these radiating waterways permit of much of the territory on the southern slope, which is mainly rocky in character, being penetrated and explored. The construction of the Canadian Pacific railway, by providing an east and west or cross-country route, greatly facilitated the prospector's work in this part of the Province by lessening the distances to be travelled by water, and bringing supplies and provisions nearer the scene of his labours. This result was also contributed to at later stages by the building of the Algoma Central and Hudson Bay, the Canadian Northern, and the Fort William branch of the Grand Trunk Pacific railway.

The northern side of the watershed is of very much larger extent than the southern, and its physiography is quite different. Here, leaving the new District of Patricia out of sight for the moment, are several great river systems all flowing northward. The Abitibi, Mattagami, Kapuskasing and Missinaibi and other large streams, occupy the eastern side of northern Ontario, and converging as they flow, pour their united waters into James Bay at the estuary of the Moose.

The central portion of this northern area is occupied by the river system of the Kabinakagami, Kenogami and Drowning rivers, together with that of the Ogoki, both systems connecting with the Albany, that great stream which drains much of southern Patricia and the northern portions of Thunder Bay and Algoma. Little more than the names of these rivers are yet known, and the territory they drain is almost entirely unexplored. From Pagwa station on the National Transcontinental railway, about 80 miles west of Hearst, a water route to James Bay may be followed with no portaging except in extreme low water periods. This route, via the Pagwachuan, Kenogami and Albany rivers, is quite feasible for gasoline-driven freighting pointers, and was used by Capt. C. M. McCarthy, of Elk

Lake, in 1917. During the present year, 1920, the route is being adopted to reach the iron deposits of Belcher islands in Hudson Bay.

To the west, the area is occupied by four smaller water basins, one, that of Lake Nipigon, and another drained by the Kaministiquia and Pigeon rivers, both of these water systems entering into Lake Superior. A third is that which discharges its waters through the Seine and Rainy rivers, into Lake of the Woods, while the fourth, lying to the north, drains into Lac Seul and the Winnipeg river, its waters, like those of the third of these basins, falling into Lake Winnipeg and by way of the Nelson river, finally into Hudson bay.

Previous to the building of the railways, little beyond the banks of the rivers and the shores of the lakes was open to the prospector. On the northern slope, much of the territory is composed of marsh and bog, and it was impossible to carry prospecting far inland. The building of the Temiskaming and Northern Ontario railway assisted greatly in opening up the eastern portion of the New North, while the National Transcontinental, running from east to west through the great Clay Belt and crossing the northbound rivers, enabled the prospector to penetrate into the inter-stream areas.

The extensive development of the pre-Cambrian formations which occupy the greater part of this region, offers a prospecting-ground unsurpassed in America, or indeed in the world, for its potential mineral wealth. To the truth of this statement, the Sudbury nickel field, the silver mines of Cobalt, and the gold fields of Porcupine and Kirkland Lake, with the numerous other gold camps undergoing development, bear ample witness. On the coastal plain the older rocks give place to Devonian and Silurian limestones, which are exposed in the banks of the rivers, and overlying or contained in which are found deposits of gypsum, lignite, refractory or porcelain clays, and iron ores. Reasoning from the similarity of these formations to those of southwestern Ontario, in which petroleum, natural gas and salt occur, it is not unreasonable to expect that similar deposits may yet be disclosed here.

As for the District of Patricia, which was added to Ontario in 1912, there has been little prospecting there as yet. The pre-Cambrian rocks predominate, except towards the coast of James and Hudson bays, where, like the territory to the east, Palaeozoic formations overlie. The district has an extent of 146,000 square miles, and as a whole, may be termed a virgin field. In it four large rivers take their rise, namely, the Kapiskau, Attawapiskat, Winisk and Severn. The first two run into James bay, and the latter two into Hudson bay. These with their affluents drain the larger part of the district, but there are other streams which empty into the Albany river and Winnipeg waters.

The available information obtained by explorers and geologists regarding Patricia was assembled by Dr. W. G. Miller, Provincial Geologist, and published as Part II of the Twenty-first Annual Report of the Bureau of Mines, 1912.

In co-operation with the Department of Mines at Ottawa, the Bureau last year undertook to make further investigation of the mineral resources of that part of this northern territory which lies between Cochrane and Moose Factory, in the region drained by the Abitibi and Mattagami rivers. J. G. Cross was instructed to examine the pre-Cambrian area north of the National Transcontinental railway, and also to investigate the rock associations and extent of the iron ore deposits on the Mattagami river. Mr. Cross had the assistance for provisioning purposes, of the expedition under W. R. Maher, an engineer sent out by the Temiskaming and Northern Ontario Railway Commission, to explore a route for a possible extension of that railway to Moose Factory. For the Department of Mines, Ottawa, M. Y. Williams and Joseph Keele reported respectively on the Palaeozoic geology, especially with reference to the possible occurrence of petroleum, and on the superficial deposits, particularly those of clay and sand. Dr. Williams is a leading Canadian authority on petroleum, and has spent much time in examining the oil-fields of southwestern Ontario, while Mr. Keele has made a specialty of clays and shales and of their utilization for commercial purposes.

The reports of all three explorers are submitted herewith, and are combined to form Part II of the Bureau's Twenty-ninth Report, under the title, "The Abitibi and Mattagami Rivers North of the Transcontinental Railway." A map of the area traversed accompanies and illustrates the reports. The data presented regarding the iron ores, oil possibilities, and deposits of refractory clay of a quality surpassing that of any yet found in Canada, are both interesting and important. They go to show that much mineral wealth, some of it of a nature hitherto unsuspected, exists in this northern region.

I wish to express my appreciation of the courtesy and spirit of goodwill evinced by the Department of Mines at Ottawa, and of the valuable assistance of R. G. McConnell, Deputy Minister of that Department, in the carrying out of this expedition.

I have the honour to be, Sir,

Your obedient servant,

THOS. W. GIBSON,

*Deputy Minister of Mines.*

Department of Mines,
Toronto, 1920.

*Photo by J. G. Cross.*

Smoky Falls, Mattagami River.

These beautiful falls, with a drop of 86 feet, receive their name from the mist which continually hangs over the crest.

# I.—PRE-CAMBRIAN ROCKS AND IRON ORE DEPOSITS

## In the Abitibi-Mattagami Area

By

J. G. Cross

### Introduction

Acting under instructions from Thos. W. Gibson, Deputy Minister of Mines for Ontario, the writer joined the party which was in 1919 making a reconnaissance survey of the proposed extension of the Timiskaming and Northern Ontario railway from Cochrane to Moose Factory. He was instructed to examine carefully the territory along the projected route and to confine the work to the pre-Cambrian area. The Paleozoic formations and clays were to be investigated, respectively, by M. Y. Williams and Joseph Keele, of the Department of Mines, Ottawa. Dr. Williams and Mr. Keele were to report upon mineral occurrences of a non-metallic nature, and it was the writer's duty also to examine and report in detail on the deposit of iron ore on the Mattagami river. This iron ore occurs in Paleozoic formations, about twenty miles north of the pre-Cambrian contact.

The proposed route of the Temiskaming and Northern Ontario railway runs a little east of the Abitibi river, below its junction with the Frederick House river, crossing the former at the Canyon and continuing northward on the west side at varying distances from the river, until the Paleozoic sediments are reached. The area, therefore, in which the writer worked was that lying between the Abitibi and Mattagami rivers, bounded on the south by the National Transcontinental railway[1] and on the north by the contact between the pre-Cambrian and Paleozoic rocks. Instructions were received, however, as noted above, to examine the iron ore deposits on the Mattagami river in the Paleozoic area.

The method of exploring this area as originally planned, was to run exploration lines east and west from the main water courses at uniform intervals of about fifteen miles. These lines were for the purpose of discovering and locating any rock formation that might be deserving of more detailed examination. It was found that this course had to be considerably modified in the field. The excessive rainfall of August and September filled the great areas of muskeg, through which it was necessary to pass, so full of water that they were little better than marshes, so that this method of exploration had to be abandoned during the latter part of the season. The months of June and July were very hot and dry, consequently traversing these great areas of muskeg was a matter of little difficulty, and the work as planned was carried on satisfactorily along the Abitibi river.

[1] The official title of the system of railway lines under the Dominion Government is "Canadian National Railways," but for the sake of clearness the old name of "National Transcontinental" is retained in this Report throughout to designate the line crossing northern Ontario from east to west, otherwise known as the Quebec-to-Winnipeg Division.

Excepting the siderite deposits on the Mattagami river no minerals of economic importance were discovered. Peat bogs covering great areas were everywhere observed, hundreds of square miles being covered with swamp, underlain with peat, apparently of good quality.

Altogether approximately 170 miles were covered by these exploration lines, almost entirely through muskeg, or slash. An average of one mile per hour was considered good going. The only rock exposures encountered away from the river bank were northeast of Newpost, on the Abitibi river. Here there are occasional outcroppings of garnetiferous biotite gneiss, for a distance of about ten miles, to the vicinity of Little Abitibi river. No minerals of economic importance were observed.

### Mineral Occurrences

The mineral and related occurrences may be briefly referred to under the following headings:—

Canyon of Abitibi river.

#### Metallic

Numerous quartz and calcite veins were carefully examined for traces of gold and silver; none were observed.

*Siderite.*—At the head of Grand rapids, Mattagami river, possibly in commercial quantities. Inferior material at the foot of the rapids.

*Limonite.*—Occurs sparingly with the above.

*Chalcopyrite.*—Occurs sparingly disseminated in a number of quartz veins examined, and similarly in the gabbro of the Abitibi Canyon.

#### Non-Metallic

*Peat.*[1]—Enormous areas of swamp and muskeg are underlain with peat. The depth is uncertain. The quality appears to be good.

*Lignite.*[2]—Lignite beds occur along the lower stretches of the Abitibi and Mattagami rivers. These do not appear to have sufficient depth or lateral extent to be of economic importance.

[1] Rep. Ont. Bur. Min., Vol. XIII, 1904; Vol. XV, 1906.
[2] Rep. Ont. Bur. Min., Vol. VIII, 1899; Vol. XIII, 1904; Vol XX, 1911

*Gypsum.*[1]—Gypsum similarly occurs along the Moose and Abitibi rivers.

*Pyrite.*—Pyrite, mixed with considerable quantities of pyrrhotite, occurs as irregular masses and lenses impregnating and replacing biotite gneiss, at the foot of Island portage, Mattagami river. The pyrite is not sufficiently rich to be considered an ore of sulphur. The sulphur content would probably not exceed 25 per cent.

*Clay.*[2]—Clays of a refractory nature were observed, often associated with lignite along the Mattagami river, below Long portage.

*Kaolin.*—An interesting occurrence of highly kaolinized syenite gneiss, containing as impurities biotite and garnets, was observed in the Canyon of Long portage, Mattagami river, and will be described in more detail, as this occurrence was in pre-Cambrian rocks.

Foot of the Carrying Places portage, Abitibi river. The rock exposures are hornblende and biotite-gneiss. The dip and gneissic structure are apparent from the photograph.

## Geology

### Abitibi River, Kettle Falls to Paleozoic Sediments

At Kettle falls, on the Abitibi river, there are exposures of hornblende-granite gneiss. The gneiss appears to contain inclusions of a more basic rock, which has been so altered that the original constituents could not be determined. These inclusions often contain much epidote, and thin seams of epidote were occasionally observed in the gneiss also.

From Kettle falls to the Carrying Places, a distance of about fifteen miles, rock exposures are rare, and consist of hornblende and biotite-granite gneiss. No inclusions were observed. At the Carrying Places these rocks are well exposed for

[1] Rep. Ont. Bur. Min., Vol. XIII, 1904.
[2] Rep. Ont. Bur Min., Vol. XIII, 1904; Vol. XXVII, 1918.

Foot of Lobstick portage, Abitibi river. The exposures are biotite-syenite gneiss, garnetiferous, showing effects of weathering.

Burntwood falls, Abitibi river; approximate drop fifteen feet.

a distance of about three miles, and the gneissic structure is highly developed. From here to the head of Lobstick portage, a distance of approximately twenty miles, only three small exposures of rock were observed, these being similar to the ones described. In the vicinity of Lobstick portage the rocks are well exposed; they are much more basic than those observed farther south, and consist of biotite-gneiss, and garnetiferous biotite-gneiss, with occasional small segregations of pyroxenite. The feldspar is greenish in colour, well striated, and is probably a plagioclase variety. Quartz was only rarely observed. W. A. Parks[1] describes these rocks as augite syenite. This series of rocks continues for about three miles, becoming more basic in character, until at the head of Clay Falls portage, the rock is a typical gabbro gneiss, with alternating bands of pyroxenite, and anorthosite. Two miles and a half farther north, at the head of the Oil Can portage, the rock is a typical gabbro, very coarsely crystallized in places, the gneissic structure having entirely disappeared. These rocks show evidence of much faulting and dislocation.

Looking north (downstream) from the foot of the Canyon, Abitibi river.

The Canyon presents the same series of rocks as were observed at the Oil Can portage. The cliffs of gabbro are high and precipitous, forming a strong contrast with the exposures elsewhere observed.

Toward the foot of the Canyon the gabbro gives place to a gabbro breccia, and much faulting and shearing have occurred. In places chlorite is abundant, seams of epidote and narrow irregular dikes of felsite also were observed. Granite intrudes the gabbro breccia at this point.

About a mile below the Canyon biotite-syenite gneiss appears. This rock outcrops occasionally to the foot of Otters portage, a distance of about twenty miles. Two miles below Otters portage the Paleozoic sediments begin. At Otters portage the biotite-syenite gneiss is apparently intruded by comparatively fresh looking granite, similar in appearance to that observed at the foot of the Canyon. No further exposures of pre-Cambrian rocks occur on the river banks, but P. Maher, locating engineer of the Temiskaming and Northern Ontario railway, states that a little farther down stream he observed a basic looking rock in the bed

[1] Rep. Ont. Bur. Min., Vol VIII 1899, page 184.

of the river. This rock was seen when the water was very low; a specimen of the float picked up on the river bank showed it to be a highly altered gabbro (?).

Generally speaking, the rocks at the head of Lobstick portage, represented by biotite, and augite-syenite gneisses, with occasionally the more massive and acidic facies, pass gradually by differentiation, into the typical gabbro observed in the Canyon.

### Mattagami Basin, Railway to Paleozoic Sediments

The Groundhog river, a tributary of the Mattagami, joins the latter at a distance of about thirty-five miles north of the National railway. The rock exposures along the Groundhog and Mattagami rivers are much more numerous than on the Abitibi river. The exposures consist largely of hornblende, and biotite-granite gneiss, until about the junction of the Kapuskasing river. From the

Mattagami river, below the Long portage. At the point on the bank of the river to the right of the small island is an occurrence of fire clay of good quality.

junction with the Kapuskasing to the head of Little Long portage the rocks assume a more basic character, hornblende giving place to biotite. The feldspar is greenish in colour, and is apparently a plagioclase variety; quartz is subordinate in amount. The gneissic structure is highly developed, and in places is schistose, particularly in the vicinity of Devil's portage. At the head of Little Long portage the gneiss becomes highly garnetiferous, these garnetiferous biotite-gneisses continuing to the foot of Long portage, where the last pre-Cambrian exposure was observed. About fifteen miles below the foot of Long portage, the Paleozoic sediments were encountered: these consisted of an outcropping of oil shale and green shales. Four and one-half miles below this point, at the head of Grand rapids, the Corniferous limestone is well exposed along the river banks for a distance of about two and one-half miles. It was in these limestones that the siderite deposits, described elsewhere in this report, were observed.

The great width of augite-syenite and gabbro observed in the Canyon and vicinity on the Abitibi river was represented only on the Mattagami river by a very narrow belt of gabbro breccia, seen at the head of Smoky Falls portage. This breccia is similarly intruded by a small batholitic intrusion of an acid nature, felsitic in character.

### Intrusives

Diabase dikes are of common occurrence along the Mattagami river; they vary in size from a few feet to several hundred feet, and are not persistent in strike. In texture they vary from coarse to medium in grain. Quartz diabase, olivine diabase, and more basic varieties, rich in magnetite, and probably containing ilmenite, were observed. These dikes were also noticed in the vicinity of Newpost on the Abitibi river.

### Feldspar-Porphyry Dikes

Between Lobstick portage and Clay Falls portage, on the Abitibi river, several large dikes of feldspar-porphyry were observed. The feldspar phenocrysts were

Mattagami river, above the Long portage, during a low water period.

of a plagioclase variety and were abnormally large. The feldspar-porphyry dikes were cut by small dikes of diabase and trap, and were consequently older than these latter.

### Pegmatite Dikes

Pegmatite dikes occurred in great profusion in the biotite, and garnetiferous biotite-gneisses, syenites and granites. These were often very large, consisting almost entirely of feldspar and a little quartz; chlorite was present in considerable quantities where these dikes intruded the more basic formations.

### Batholiths

Batholitic intrusions of granite and felsite were seen, but were not of common occurrence. A considerable area of a very coarse-grained gabbro appeared to intrude the garnitiferous-biotite gneiss northeast of Newpost, on the Abitibi river. Whether or not this was a dike could not be determined, as the contact with the gneiss was usually covered. The coarse grain and the extreme width, fully a quarter of a mile as far as could be observed, would suggest that this intrusion of gabbro is of a batholitic nature.

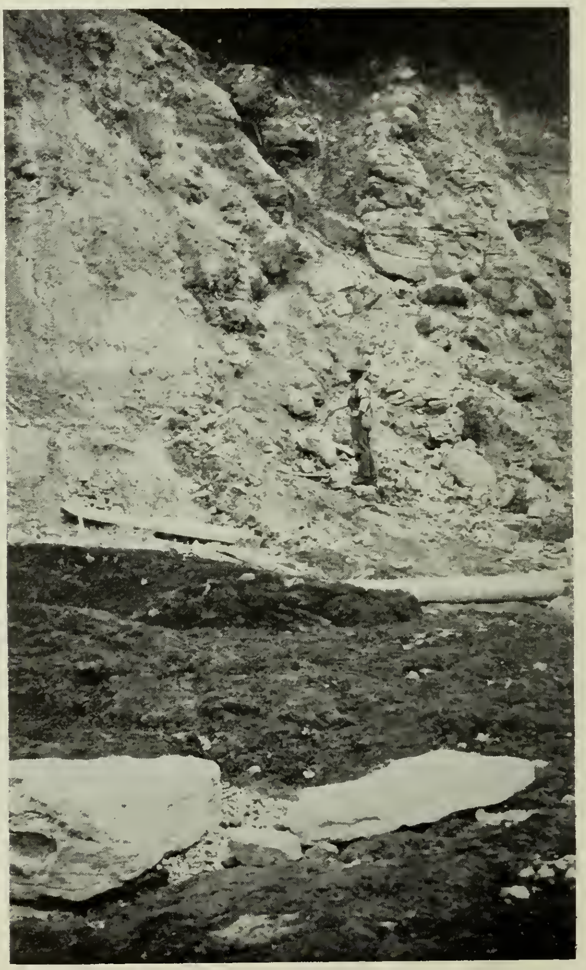


*Photo by M. Y. Williams.*

Deposit of iron ore on west side of Mattagami river at Grand rapids. The dark mass in foreground is the ore. Cliffs of weathered limestone rise in the background.

### Summary

The rocks described in preceding pages may be tentatively classed as Laurentian. It is highly probable, however, that more detailed geological exploration work will prove that certain of these gneisses are highly metamorphosed post-Keewatin sediments, representing, for example, the Grenville series. Such rocks were observed and described by T. L. Tanton as occurring east of the interprovincial boundary between Ontario and Quebec.

The physical features of the area under discussion have been so well set forth in previous reports [1] that further description is unnecessary.

### Economic Possibilities

On account of the heavy glacial overburden the rock exposures are almost entirely confined to the banks of the rivers, and prospecting is, therefore, difficult. The rocks observed are largely granites, syenites, and gneisses. The gabbro in the canyon of the Abitibi river looked promising, and a careful search was made for copper and the precious metals, but excepting for a very small amount of chalcopyrite nothing worthy of note was found.

Numerous quartz veins were observed in nearly all the more acidic formations; these were panned for gold with negative results. The veins were largely composed of glassy quartz, and occasionally a little calcite or dolomite. Save for a very little iron pyrites, or a few specks of chalcopyrite, no other minerals were seen. However, in the immediate vicinity of Devil's portage, Mattagami river, there is evidence of considerable igneous activity, and the quartz veins present a more kindly appearance than any observed elsewhere, as they contain considerable pyrites in places. No gold could be obtained by panning.

A number of small calcite seams were carefully examined for silver and associated minerals, but none were found. A boulder of float picked up at Devil's portage contained a little galena and zinc blende.

### Siderite Deposits, Mattagami River

The Mattagami river siderite deposits are situated at Grand rapids on the Mattagami river, about seventy-nine miles almost directly north of Mattagami station, National Transcontinental railway. By the river the distance is approximately one hundred and ten miles. Reference tree 83 is located at the head of Grand rapids, this and other consecutive numbers indicating identification points on the Mattagami river as traversed in 1911 by Ontario Land Surveyors, Sutcliffe and Neelands.

### Description of the Ore

The ore is essentially siderite, although limonite is occasionally present. The limonite is found in vuggy or nodular masses in the siderite, and also occasionally forms a thin casing around the margin of the larger siderite bodies. On the whole the limonite forms only a very small percentage of the ore

Wherever exposed the surface of the siderite has been oxidized to limonite; hematite is also probably present, judging from the streak. This oxidization is very superficial, being seldom more than three inches in thickness. In the inferior grades of ore, where there is much silica and clayey material, the oxidization is more pronounced; nowhere, however, was extensive oxidization observed.

In colour the siderite varies from dark brown to nearly white. The different shades of colour are probably due to finely disseminated limonite, or organic matter. Often the organic matter is visible in fairly large pieces, and appears to be of a

[1] Geol. Sur. Can., Memoir 109, 1919; Rep. Ont. Bur. Min., Vol. VIII, 1899; Vol. XIII, 1904; Vol. XX, 1911.

lignite nature, having the appearance of charcoal. The structure is compact and finely granular. The fracture is uneven. A light coloured, coarse grained variety was observed as float, farther up-stream. No ore of this nature was found in place, and it is assumed that this material came from other localities, not yet discovered. Speculation as to the origin of this float will be presented later.

Siderite occurs at both the head and the foot of Grand rapids, but it is only in the former locality where ore of commercial quality exists. This showed on analysis the following composition:—

Sample (6) chipped, 600 ft.

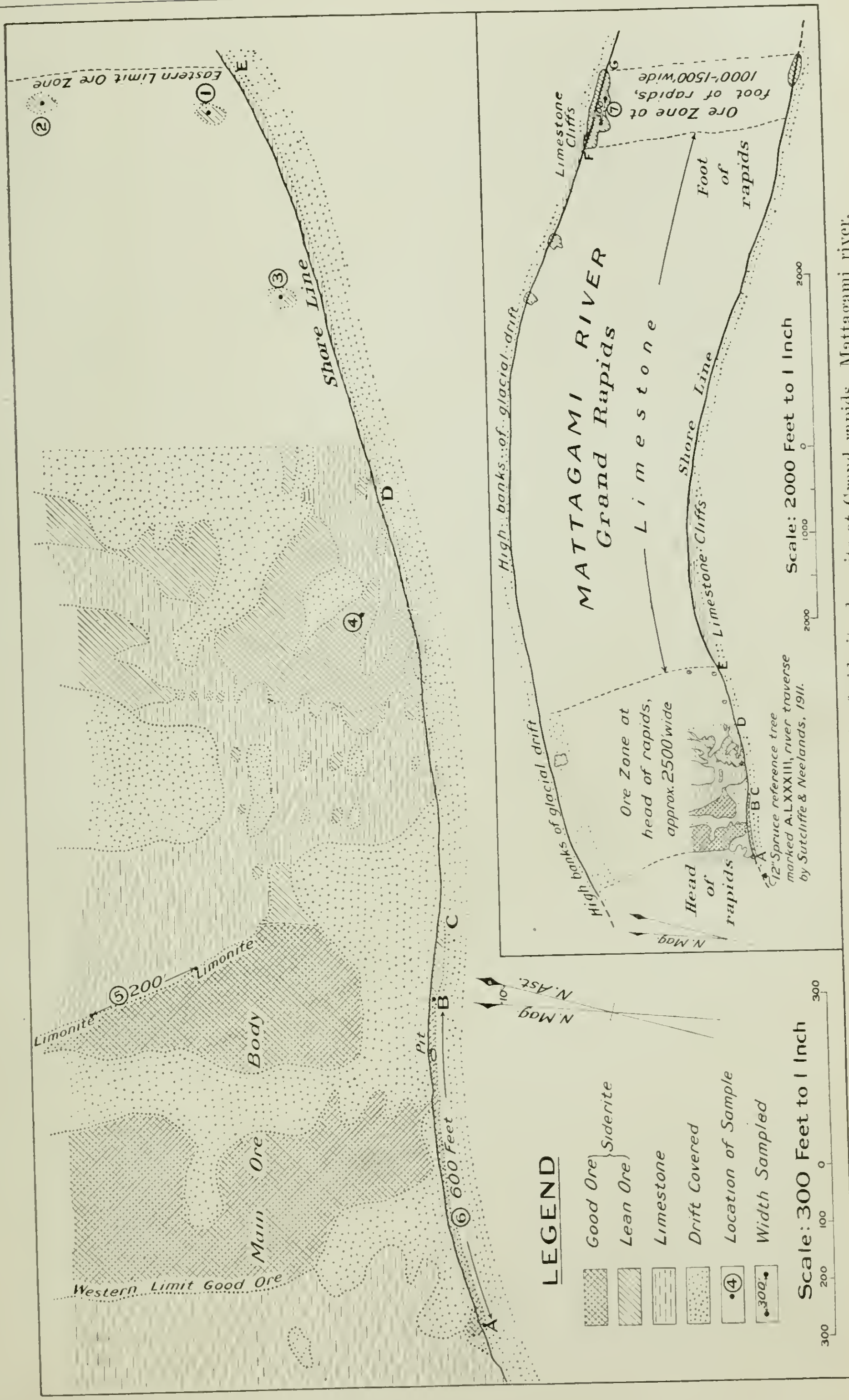
| | Per cent. |
|---|---|
| Iron | 43.52 |
| Silica | 5.40 |
| Alumina | 2.63 |
| Sulphur | 0.74 |
| Phosphorus | 0.08 |
| Manganese | 0.00 |
| Water | 2.18 |
| Carbon dioxide | 30.40 |

The inferior grades of ore at the head of the rapids gave the following:—

| | Per cent. |
|---|---|
| Sample (1) channel, 10 ft. | |
| Iron | 30.32 |
| Insoluble | 42.46 |
| Sample (2) channel, 12 ft. | |
| Iron | 35.37 |
| Insoluble | 29.10 |
| Sample (3) channel, 15 ft. | |
| Iron | 38.40 |
| Insoluble | 29.18 |
| Sample (4) channel, 10 ft. | |
| Iron | 45.38 |
| Insoluble | 17.16 |
| Sample (5) chipped, 200 ft. | |
| Iron | 47.10 |
| Insoluble | 17.10 |
| Phosphorus | 0.07 |
| Sulphur | trace. |

Samples 4 and 5 contained considerable limonite.

The chief impurities in the ore are silica, clay, limestone, sulphur and organic matter. The phosphorus is not abnormally high for this class of ore. Silica in the form of sand and gravel was often observed in the inferior grades. The clay content is also very high in places, the silica and clay frequently forming the greater part of the outcropping. Limestone is also present, often forming a breccia, the cementing material being siderite of inferior quality. Sulphur is present in all the ore. Often this can be observed as small pockets of pyrites in cavities in the siderite, and occasional specks of pyrite can be seen, with the aid of the glass, in nearly every specimen observed. Organic matter is also contained in all the ore, but in varying quantity; some of the siderite contains so much organic matter that




General plan (above) and detailed plan (below) of siderite deposits at Grand rapids, Mattagami river.

it is almost black in colour.[1] The best quality ore contained 1.27 per cent. carbon. This organic matter is probably lignite, as occasional pockets and seams of lignite were observed in the ore.

From the foregoing analyses it is apparent that samples Nos. 1 to 5 represent ore of very inferior quality, while sample No. 6 represents siderite of good commercial grade. The latter will be referred to as the main ore body, and the former as ore of inferior quality.

### Dimensions of Main Ore Body

The main ore body has a maximum width of approximately 600 feet as nearly as could be determined. The small number of exposures and the overburden of glacial debris made the width difficult to ascertain definitely. The lateral extension could not be determined, as the body disappeared on the south under the glacial debris of the river bank; on the north it is exposed in the bottom of the river for a distance of about 600 feet, but is finally obscured by the dirty river water, and by a covering of glacial boulders. Whether or not the ore extends across the river bottom, a distance of about 2,100 feet (measured by triangulation), could not be determined, but a very small outcropping on the north bank would suggest that the ore body is continuous for at least the width of the river.

The deposit may be regarded as consisting of two distinct zones, that at the foot, and that at the head of Grand rapids. The latter has a width of about 2,500 feet. and the former a width of about 1,500 feet. A belt of good ore 600 feet in width forms the upper part of the occurrence at the head of the rapids. This was the only ore observed in this locality that was worthy of consideration as such. The occurrence at the foot of the rapids was of inferior quality, and does not require extended reference. These ore-bearing zones appear to have a trend a little west of north (magnetic), and are separated by about a mile of barren limestone.

The iron-bearing zone at the foot of the rapids extends across the entire width of the river, and is well exposed on the banks at either side. Although considerable siderite and limonite were observed, the percentage of iron was very low, and that of impurities correspondingly high. An average sample of this material over a width of 300 feet, on the north side of the river, gave the following result:

| Sample (7) chipped, 300 ft. | Per cent. |
|---|---|
| Iron | 35.37 |
| Insol. | 30.40 |

### Occurrence and Rock Associations

The ore occurs in large irregular masses in limestone of Corniferous age, which is in places highly fossiliferous, although toward the head of the rapids the limestone becomes more siliceous, and fewer fossils were observed. The extreme westerly exposure was very siliceous, and no fossils were seen. Whether the limestone passes uniformly into sandstone, or whether highly siliceous layers of considerable thickness are interbedded with the limestone, could not be ascertained. The difficulty of determining the geological sequence of these sediments was further augmented by the almost horizontal attitude and the limited exposure.

[1] Rep. Ont. Bur. Min., Vol. XX, Pt. 1, 1911, page 245.

M. B. Baker[1] speaks of these sediments as dipping to the southeast. While the dip can scarcely be noticed, the sediments at Grand rapids appear to form a very gentle anticline, with the siderite, and sideritic material, occupying the corresponding synclines on either side. This would account for the barren stretch of limestone between the two ore zones. Another possible explanation is that the ore was continuous from the head to the foot of the rapids, but the river had eroded away the central portion of the ore, exposing the limestone floor underneath. Such being the case, the ore would not be expected to continue to any considerable depth, as the amount of folding of the anticline would not exceed 40 feet.

The ore appears to occupy irregular openings, cracks, and cavities in the limestone, some of them very large. Generally speaking, the larger the cavity the better the grade of ore. The best ore occupies the largest cavity, and has an approximate width of 600 feet; this is the main ore body.

It is probable that these openings were originally enlarged joint planes, and pockets formed by the dissolving and erosion of the limestone.[2] The cavernous nature of the limestone is well illustrated by the photograph on page 244 of the Ontario Bureau of Mines report for 1911, Vol. XX. Occasional small streams were observed issuing from the base of the limestone cliffs in the vicinity of the ore, thus further testifying to the cavernous nature of the limestone.

That replacement also played a part in enlarging these original openings seems probable. The sides of the cavities, where the ore had been removed by erosion or other causes, were smooth and curved, and there also appeared to be considerable impregnation of the ore into the limestone wall in places; this is well shown by the following analyses on page 244 of the Ontario Bureau of Mines Report, 1911.

| | | Iron, per cent. |
|---|---|---|
| Sample No. | 1—At the actual contact (between siderite and limestone) left side of exposure | 6.50 |
| " | 2—Two inches from the contact, left side exposure | 3.22 |
| " | 3—One and a half feet from contact, left side exposure | 1.50 |
| " | 4—Centre of body | 0.65 |
| " | 5—One and a half feet from contact, right side | 1.28 |
| " | 6—Two inches from the contact, right side | 3.58 |
| " | 7—Actual contact, right side | 9.90 |

Assuming that the iron was carried in solution as ferrous sulphate, the following reaction[3] might take place: $FeSO_4 + CaCO_3 = FeCO_3 + CaSO_4$. The solutions being cold and dilute, the calcium sulphate would be carried off in solution. Any silica in the limestone would remain behind and contaminate the ore, together with sand and gravel, and other impurities that might wash into the cavities. The abundance of organic matter present would cause the precipitation of siderite, rather than limonite. A deposit somewhat similar in occurrence to the one under discussion occurs in the iron region along the Chesapeake and Ohio railroad in Virginia.[4] The conditions here were more favourable for the production of brown ore than siderite.

The weathering of great areas of basic igneous rocks, containing much pyrite and biotite, observed further south, and also the weathering of the black

[1] Rep. Ont. Bur. Min., Vol. XX, 1911, Pt. I.
[2] Ibid.
[3] Rep. U. S. Geological Survey, Monograph 52, page 520.
[4] Eng. and Mg. Journal, July 5, 1913, p. 1.

ferruginous shales in the general vicinity, would give rise to the ferrous sulphate solutions, which in contact with the limestone would bring about the above reaction. A great number of small streams heavily charged with iron in solution (probably the sulphate) were observed along the Abitibi and Mattagami rivers, north of the pre-Cambrian rocks. These waters flowed out from beneath the clay or the muskeg, and when exposed to the air deposited their burden of iron as limonite. Crawfish placed in this water did not live longer than half an hour; evidently the water contained very little oxygen.

The age of these siderite deposits has been placed by M. Y. Williams, of the Canadian Geological Survey, and by Jos. Keele, of the Mines Branch, Ottawa, as Cretaceous, and practically contemporaneous with the refractory clays, and lignite series which occur in the immediate vicinity and elsewhere along the Mattagami river.

### Method of Examination and Sampling of Deposit

The examination and sampling of a deposit of this nature was a matter of considerable difficulty. The only exposures were along the banks of the river, and these were small and isolated. The heavy mantle of glacial material, and the talus slopes resulting therefrom, obscured the greater part of the ore. An excellent opportunity was afforded, however, for the examination of the ore in the bed of the river, as the water was very low and comparatively clear, and it was from the data thus obtained that the greater part of the information concerning this deposit was deduced.

It was decided that the best method of exploration was to run traverse lines along the bank of the river, and at right angles, approximately, to these run parallel lines every 100 feet apart, as far across the river as conditions would permit. These lines were to extend as far as the ore was exposed in the river bottom. A preliminary examination showed that the only ore worthy of such detailed work occurred at the head of Grand rapids, and here only the most westerly exposure. The water was not very deep, seldom over the knees; however, there was a very swift current, and it was a matter of some difficulty to get all the lines run. The various outcroppings of ore, where they intersected these lines, were noted, and the map compiled therefrom. These lines were run by compass, and the distances measured by pacing.

It was highly desirable that an average sample of any commercial ore encountered should be obtained. It was found impossible to observe sufficient continuous exposures to take a channel sample. Even if such an exposure were found it would have been necessary to cut a very deep channel, and to remove all oxidized material, in order to ensure a representative sample. The ore in the river bed did not present this difficulty, as the oxidized material had been largely removed by erosion. Channel samples were taken of the ore in the river bed, the occasional projections of the ore above the surface of the river affording an opportunity to do this. The main ore body, however, had no such projections, so that this method of sampling was not applicable in the place where it was most needed. What should represent a fairly uniform sample was obtained by breaking samples of the siderite, at uniform intervals, both under the water and along the bank of the river. All oxidized material was carefully removed before quartering down and bagging for assay. So small a sample from so large an ore body could not be guaranteed to be truly representative. Diamond drilling, or ton lot samples, would be the only safe way to determine the exact composition of the deposit. The iron content of the sample from the main ore body was found to be 43.52 per cent., a result which agrees very closely with M. B. Baker's sample, namely 43.27 per cent.[1] Baker does not state whether the sample he secured was representative of the best, or whether it was a grab sample.

The results of the analyses of the samples will be found on a preceding page. Although the complete analysis of sample No. 6 is given, it was not considered necessary to make complete determinations on the remaining samples, as the inferior character of the material was clearly seen on inspection.

### Previous Exploration Work

The deposits both at the head and the foot of Grand rapids had a small amount of exploration work done on them by the original owners. At the head of the rapids the work appeared to be confined to trenching at intervals, with the view of picking up the ore at the top, and away from the river bank. Evidently these efforts met with little success, as no ore was observed in the bottom of the pits and trenches. However these are so badly caved, and so encumbered with underbrush, that if any ore was uncovered it would not now be visible. Judging from the dumps at the sides of these excavations, no ore was found. A pit near the water's edge was sunk in very good ore: a good photograph of this pit is shown in the Report of the Ontario Bureau of Mines for 1911, Vol. XX, Part 1, page 227.

The exploration at the foot of the rapids seems to have been largely confined to drilling. A small hand drill was observed all set up and ready for work, on the north side of the river. Judging from the locality where the drill was set up very poor ore must have been obtained in the cores, as the drilling operations were carried on in the most inferior ore that was observed. No evidence of drilling was observed at the head of the rapids in the large body of siderite previously described.

### Conclusions Regarding Ore Body

The analysis of sample No. 6 shows that the ore is a siderite of very good quality. This material when calcined gave a product that analysed 61.22 per cent. of iron. The sulphur and phosphorus content are too high for a Bessemer ore, but the material should be well adapted for the manufacture of steel by the basic open hearth process, and for the manfacture of pig iron.

Regarding the possible occurrence of similar ore bodies, it would appear, judging from a superficial examination only, that these siderites may be quite widely distributed. The following reasons are ascribed for this assumption:—

(1) The occurrence of siderite elsewhere in the same general vicinity.

(2) The similarity to this area, geologically and physically, of other large areas in the locality.

[1] Rep. Ont. Bur. Min., Vol. XX, Pt. 1, 1911, p. 225.

(3) The great abundance of siderite boulder drift for many miles along the Mattagami river. The deposits described would not seem of sufficient size to supply this profusion of boulders.

(4) The occurrence of siderite drift differing greatly in physical properties from any observed *in situ*.

(5) The existence of a talus slope of sideritic material four miles further up-stream than the deposits at Grand rapids.

The depth of the overburden is problematical, and it is only by boring or other means that the actual depth can be satisfactorily determined. Judging from the appearance of the outcrops of limestone, etc., observed, the glacial débris is not excessive, and appears to consist of clay and sand, with few boulders.

The occurrence of siderite on the Opazatika river, very similar to the occurrence described at Grand rapids, on the Mattagami river, would seem to indicate that these siderites have a wide distribution. The following brief description by J. M. Bell, who reported on this, and the deposit on the Mattagami river,[1] may be of interest:

The Opazatika iron-bearing limestones cross that river about 25 miles above its mouth, and form a deposit of scientific interest, and of possibly economic value. The exact nature of the body is difficult to understand, owing to the broken, and generally unsatisfactory condition of the rocks, and their small visible lateral extent, but apparently it is a bed of more or less ferruginous, magnesium limestone appearing on both sides of the river, at and just below the crest of the second rapids above the Break-neck falls.

The iron-bearing rocks are exposed for some 225 yards continuously on the east bank of the stream, and appear as several isolated outcrops on the opposite side for a somewhat shorter distance. Besides the main exposure on the eastern bank, there occurs a regular heap of large pieces of carbonate, which are apparently in place at a point some 250 yards south of the prominent outcrop, but the high state of the water, covering much of the carbonate beneath water, made it impossible to make sure of this point. Back from the bank of the river no outcrops of solid rock appear, but I think it lies at no great distance beneath the glacial drift. The inconspicuous exposures on the western bank, and the upper doubtful outcrop on the opposite side, are almost hidden by the large number of loose boulders, which have been washed from the overlying beds of boulder clay and hard pan. The main outcrop of carbonate on the eastern shore rises above the water as a low cliff seven to eleven feet in height, depending on the level of the river. The carbonates are here overlain by a rusty layer of the products of their own distintegration."

J. M. Bell further reports the analysis[2] of a sample of the pure carbonate from the above as containing:

| | | |
|---|---|---|
| Carbon dioxide ................................ | 47.9 | per cent. |
| Ferric oxide ................................ | 62.1 | do |

Mr. Borron describes a somewhat similar deposit on the Oba river.[3]

The ore had no influence on the dip needle, as might be expected. Previous reports mentioned the presence of magnetite, and it was anticipated that there might be enough magnetite present to trace the orebody for a considerable distance. If magnetite exists it must be in very small quantities, for nowhere was the slightest deviation of the needle observed. The instrument used was the ordinary type; whether more refined methods would prove more successful would be difficult to say.

The economic possibilities of a deposit of this kind are somewhat problematical. The unfavourable situation, and the long railroad haul to the nearest blast fur-

[1] Rep. Ont. Bur. Min., 1904, Vol. XIII, Pt. 1, p. 150.

[2] Ibid, p. 152.

[3] Report on the Basin of the Moose River, page 72.

naces, are the chief objections. The extent and depth of the ore bodies, and the amount of overburden are factors that still have to be determined. The ore, being siderite, would have to be roasted. The great areas of peat, and spruce suitable for cordwood, in the immediate vicinity, might probably solve the roasting problem. However, all factors considered, it would seem that further prospecting for ore of this nature is justifiable.

### Kaolinized Syenite on the Mattagami River

About a mile and one-half below the head of Long portage on the Mattagami river, and on the right-hand side looking down stream, a highly kaolinized syenite gneiss occupies the bottom of a ravine which enters the river valley from the east.

Mattagami river, below the head of the Long portage, showing wide and shallow character of the river. Highly kaolinized syenite occurs along the right bank.

This material is exposed for a distance of about 400 feet. The height is about 20 feet at the highest point. The material is kaolinized to a remarkable degree if the kaolinization is of post-Glacial age. If, on the other hand, it is assumed that the bottom of this valley escaped the erosion of the last glacial period, then the kaolinized material would be pre-Glacial in age, which would account for the extreme alteration.

The kaolinized material is probably too impure for use in the manufacture of chinaware, but might be suitable for making fire-brick and refractory ware. The heavy overburden of glacial drift would probably prevent this developing into a commercial proposition, even if railway facilities were available and the kaolinization were proved to continue to a considerable depth.

## Plans and Maps

*Detailed plans.*—Plans were prepared (page 11) using the information gained from the examination of the river bottom at Grand rapids. The large scale plan (300 feet to the inch) shows the relation of the siderite to the limestone and inferior grades of ore. The small scale or general plan shows the relation of the two ore zones, width of the river and so forth. Localities where the samples were taken are also shown on the large scale plan.

The drift covered areas were much more extensive than appears on the plan; however, where the exposures were sufficiently close together it was considered safe to mark the entire area as limestone, or ore, as the case might be.

*Route maps.*—The map of the Moose River Tributaries[1] was used in the field as a route map and for plotting the position of the various exploration lines which were run away from the main water courses. The exploration lines along and in the immediate vicinity of the rivers were not sketched. The data thus obtained was used by officers of the Bureau of Mines in compiling a new map[2] (No. 29*f*) which accompanies this report and shows, in addition, the work of Messrs. Keele, Williams, and earlier explorers.

[1] Route map to accompany report by M. B. Baker, Ont. Bur. of Mines Rep., Vol. XX, Pt. 1, 1911.

[2] The title of the map is "Explorations along the Abitibi, Mattagami and Missinaibi rivers."

# II.—PALEOZOIC GEOLOGY OF THE MATTAGAMI AND ABITIBI RIVERS

By

M. Y. Williams

## Introduction

As the need for increased production of petroleum in Canada is becoming more and more pressing, attention is being called to the less known sedimentary basins as possible sources of supply. Among these, the region to the south and west of James and Hudson bays, is perhaps easiest of access. For many reasons public attention has been called to this region, and as a result, during the summer of 1919, the Department of Mines of Canada, co-operating with the Bureau of Mines of Ontario, undertook the exploration of the area between the National Transcontinental railway and Moose Factory, following the valleys of the Mattagami, Abitibi and Moose rivers. J. G. Cross, geologist for the Ontario Bureau of Mines, covered the pre-Cambrian region traversed by the upper waters of the rivers, the officers of the Department of Mines of Canada confining their attention to the sedimentary basin adjoining James bay. Joseph Keele, chief of the Ceramic Division of the Mines Branch, paid special attention to the lignite, iron ore, clay and other surficial deposits; and the writer, representing the Geological Survey, studied more especially the Paleozoic stratigraphy and rock structure, and their significance in relation to possible accumulation of petroleum.

## Acknowledgments

The writer wishes to acknowledge the debt he owes C. M. McCarthy of Elk Lake, who secured guides for the trip, and accompanied the party as far as Long rapids on the Mattagami river. His knowledge of the region was of great value, not only in travelling but in finding rock outcrops. The guides which he selected proved faithful and efficient and added much to the success of the trip.

Acknowledgments are also due Messrs. Poole and Peters of the Forestry Branch, Department of Lands and Forests, Ontario, W. B. Way, Superintendent of the Canadian National Railways at Cochrane, and other railway officials for kind co-operation and assistance.

The fossil identifications of this report have been revised by E. M. Kindle of the Geological Survey.

## Route Travelled

The party travelled by canoe downstream via the Groundhog, Mattagami and Moose rivers to Moose Factory and back by the Moose, Abitibi and Frederick House rivers. The start was made on August 1st from Fauquier, where the National Transcontinental crosses the Groundhog river, and the trip was completed on September 5th at the landing on the Frederick House river, 3 miles from Clute post office and 15 miles from Cochrane by waggon road. August was chosen as the best time to make the trip because of the greater facility with which the river sections may be studied at low water.

### General Character of Paleozoic Basin

At Long portage on the Mattagami river, and Otter portage on the Abitibi river, the surface of the pre-Cambrian, crystalline rocks slope steeply to the north below the younger deposits, not to reappear along the lower waters of these rivers, where all outcrops are of sedimentary formations—sandstones, shales, limestone and gypsum. To the east of the area traversed, however, along the Little Abitibi river, a few miles above its junction with the Abitibi river, pre-Cambrian gneiss is reported to outcrop. Other pre-Cambrian outcrops are reported from the east branch of the French river, and from the country about 25 or 30 miles east of Moose Factory. Because of the ease with which the sedimentary formations weather and wear away, they outcrop only at intervals along the rivers, and in some cases as very small exposures.

The river banks rise on an average to an elevation of about 50 feet above low water, where a terrace is commonly found, covered with a fine growth of white spruce, white and black poplar, and white birch. White cedar, tamarac and jackpine do not extend much farther north than the edge of the pre-Cambrian rocks. Back of the river terrace, there is commonly a slope of 30 or 40 feet up to the general level of the country, which appears to be nearly flat and is covered with typical northern muskeg—a floor of sphagnum moss, labrador tea and laurel, studded with widely spaced and stunted black spruce. The outcrops of rock seen are along the water's edge and they rarely rise as high as 50 feet. The overlying deposits are of glacial and fluviatile, unconsolidated materials, more specifically described by Mr. Keele. Along the lower Moose river the topography changes, in that ice has shoved up the banks of the river from 4 to 8 feet above the general elevation of the country, which gradually descends towards James bay.

### Summary and Conclusions

*Paleozoic Section.*—The Paleozoic formations exposed are indicated in the accompanying table.

| Formations | | Mattagami River | Abitibi River |
|---|---|---|---|
| Devonian | *Portage* | Green and black shale | Green and black shale? |
| | *Genessee? Ohio shales* | Black shale | Black shale |
| | *Tully* | ........ | Thin green limestone in green and black shale |
| | *Hamilton* | ........ | Green and brown shale? |
| | *Onondaga* | Buff dolomite | Buff dolomite |
| Silurian | *Salina Gypsum* | Gypsum | |
| | *Shales* | Red shale; Grey shale; Laminated limestones | |
| | *Formation not determined* | ........ | Grey argillaceous limestone |
| Ordovician | *Queenston?* | (Not seen) | Red shale |
| | *Basal clastics* | ........ | White sandstone, conglomerate, etc. |

*Igneous Intrusives.*—Dikes of green trap cut the Onondaga limestone and lower formations.

*Secondary Deposits*—Concretionary ironstone, including lignite fragments, occurs in caverns in Onondaga limestone.

The Paleozoic sections on the Mattagami and Abitibi rivers contain rocks representing the Ordovician (Queenston?), Silurian (doubtful beds and Salina), and Devonian (Onondaga, Hamilton, Tully, Genessee and Portage) systems.

Economic possibilities within the Paleozoic formations appear to be confined to the gypsum deposits of the Moose river, the oil-bearing shales of the Mattagami and Abitibi rivers and the chances of oil occurrence throughout this large basin of sedimentary rocks. Under present conditions of transportation the chance of oil occurrence is the only inducement for prospecting.

## Detailed Geology

### Oldest Formations and Sextant Portage Section

The oldest recognized Paleozoic strata are seen in the fine section in the east bank of the Abitibi river about one-quarter mile below Sextant portage. Trap rock occurs near the foot of the portage, but it is doubtful whether this is a part of the basal pre-Cambrian floor or a later intrusive. The lowest observed deposits consist of about five feet of coarse, friable, white sandstone, mixed with sandy shale and conglomerate. Judging from their conformable relationships with the overlying beds, they are probably of Ordovician age. The succeeding 10 feet consists of loose, arkosic conglomerate and sand, made up of fragments of pre-Cambrian rocks. Above this are 10 feet of soft red shale, identical in field characteristics with the Queenston shale of Ontario and New York. This shale is exposed in the west bank, up river for about one-half the distance between the Sextant and Otter portages. Mr. Keele has made test bricks of this material, and finds that it compares closely with the Queenston shale at Milton, Ontario. The red shale is succeeded upward by about five feet of red sandstone and shale, and two feet of thin green beds, suggesting glauconite. Above these again are about five feet of limestone alternating with red shale. As no fossils were found in the red shale formation, its age determination depends upon its position in the section and its physical character. On these grounds it is classed provisionally as Queenston.

About 18 to 20 feet of green-grey, argillaceous limestone succeeds the red shale formation. A few fucoidal markings were all the indications of fossils seen in these beds, which appear to overlie the red shales conformably. It is probable, however, that what appears to be glauconite represents a disconformity, in which case the limestone with red shale partings would belong to the shaly limestones above. From its position in the section, it seems probable that the impure limestone represents an inshore phase of some of the Silurian deposits, but its exact age cannot be determined from the evidence at hand. The shallow water conditions and the proximity to the pre-Cambrian old land, with the consequent large supply of clastic material derived from it, offer a satisfactory explanation of the character of the deposits in this section.

Buff magnesian limestone of Onondaga age rests on the impure limestone. No unconformity is evident, but the abrupt change in sediments with an equally abrupt appearance of typical Onondaga fossils may be interpreted as indicating a time lapse between the Silurian and the Devonian periods, or an Epi-Silurian emergence followed by erosion and submergence. A sea favouring coral and crinoid life characterized Onondaga time here as elsewhere in the interior of North America.

A fine sedimentary-igneous rock contact occurs on the west side of the river, opposite the Coral portage, where a trap rock of pre-Cambrian age, about 50 feet across, rises about 30 feet above the level of the water. Its surface is irregular, jointed and deeply eroded, the upper 15 feet being so weathered as to be friable with residual green clay covering part of the surface. The Onondaga limestone resting against the south side of this rock has suffered local faulting, evidently due to a solution channel which has formed along the contact with the trap. On the north side of the trap mass, horizontal arkose (at base) and coarse-grained sandstone beds rest on the eroded surface of the trap, rising in a 15-foot section. The Onondaga limestone beds of the Coral portage dip to the east as though underlain by an extension of the trap mass. Thin sheets of intrusive trap penetrate the fractures of the limestone in the faulted zone mentioned. Other intrusives in this vicinity are described below.

The horizontal, undisturbed condition of the sandstone, and the basal arkose, suggest a much younger age than that of any of the other rocks. The material appears to be derived from the sandstone seen at Sextant portage, and may correspond in age with the lignite beds. The deeply weathered condition of the Paleozoic floor is very suggestive of the emergent conditions prevailing before the Paleozoic seas encroached on this part of the ancestral Canadian shield.

### Silurian Formations

Strata of Niagara age occur on the Albany and other rivers to the northwest, but are not known on the Moose river and its tributaries. The impure limestones of the Sextant portage section are doubtfully considered as Silurian, their closer affinities being unknown. Strata believed to be of upper Silurian age, however, outcrop on the Moose river, below the mouth of the Missinaibi river. Here, shales and thin limestones outcrop at the head of the third island from the foot of the Grey Goose Island group. The strike of the beds is north 80 degrees east, the dip northerly 13 to 19 degrees. The section, in descending order, is as follows:

Green shales, mostly removed by erosion.
Soft, red, plastic shale, 29 feet;
Soft, green sandstone, 7 feet;
Covered interval, 20 feet;
Hard, pink and grey dolomite, 2 feet;
Soft, yellow dolomite, 20 feet;
Dolomite in 1-foot beds, 15 feet; horizon of poorly preserved gastropods at top;
Soft, thin-bedded, cream-coloured dolomite, 15 feet;
Covered interval, 15 feet;
Thin, grey, laminated dolomite, with dark partings, 8 feet;

Red and green shales outcrop near the centre of the west side of the island, in an exposure 20 feet high. If the dip of the formation is northerly for this distance, which is probable, these beds occupy a higher position in the section than those above described.

Buff limestone containing fossils of Onondaga age, outcrops at the head of the large island next to the lowest of the Grey Goose group. This outcrop is in the form of an anticline, the direction of the axis being about north 80 degrees east. The cross section is exposed for about 500 feet, the dip on the north limb being 16 degrees and on the south 25 degrees, the top being flat.

Just north of the exposure described, the strike of the beds is south 49 degrees east, and the dip southwest at an angle of 9 degrees. Other small folds succeed to the north.

*Gypsum.*—Gypsum and selenite beds occur in the west bank of the river opposite the lower third of the island with the limestone exposures. These beds dip southerly beneath brecciated limestone which is elsewhere seen at the base of the Onondaga limestone. Gypsum also occurs on the east bank opposite the foot of the island. The structure is somewhat confusing, but it is clear that the gypsum overlies the shale series, and the Onondaga limestone overlies the gypsum. Although no fossils were found below the Onondaga, it is safe to infer from their position in the geological column and from their close resemblance to the Salina of Ontario and New York, that the red and green shales are Salina in age, as is also the overlying gypsum. Bluffs of gypsum, rising as much as 20 feet in height, continue downstream for about 4 miles. At a number of localities the gypsum is overlain by Onondaga limestone, which rests in irregular, eroded channels in the top of the gypsum. A good exposure of the contact may be seen east of the lower end of the lowest of the Grey Goose island group. Gypsum is also exposed for about 200 yards along the east bank of the river opposite the third island of the group below the Grey Goose group. The surface dips to the north and is overlain by Onondaga limestone. The total thickness of the gypsum deposits cannot be directly measured, but may be estimated to be at least 40 feet. No gypsum deposits are known on the Abitibi river, but about 1 mile above its mouth, a 10-foot section of dolomite, containing some gypsum, occurs in the west bank of the river. The beds of Onondaga limestone at the mouth of the Abitibi appear to correspond with those usually overlying the gypsum deposits. The gypsum may lie a short distance below.

### Onondaga Magnesian Limestone

The lowest beds of the Onondaga (Corniferous) limestone rest as described above, in eroded channels in the underlying gypsum. A decided unconformity is here present between the rocks of Silurian and Devonian age, and formations represented elsewhere are absent. In many places, the lowest Onondaga beds are nodular, or brecciated, gypsiferous and unfossiliferous. Examples of such beds occur above the gypsum beds of the Moose river and at the base of the iron ore deposits at Long rapids of the Mattagami river, where domes 25 yards across with a 5-foot rise at the centre are a common feature. Here, a considerable quantity of pyrite occurs in the limestone, although most of it has altered to limonite. At the head of Long rapids the beds of limestone exposed near the low water-level, are saccharoidal, finely granular, pea-green in colour, weathering grey or more rarely rusty red or brown. These beds are probably near the base of the Onondaga formation. The 12-foot cliff of limestone at the angle between the Moose and Abitibi rivers, is thin-bedded, hummocky, unfossiliferous and resembles closely the basal limestone described above. Hummocky limestone along the Abitibi river about one mile below the head of Long rapids is similar in character, but probably represents a higher horizon. The basal beds of the Onondaga where seen opposite the Coral portage, resting upon a green trap rock, are green and probably glauconitic. The basal Onondaga beds at the Sextant portage are fossiliferous and not different from higher beds.

*Photo by M. Y. Williams.*

**Section of Onondaga limestone in cliff 50 feet high, Long rapids, Mattagami river.**

The thickest section of Onondaga limestone seen, is that along the Long rapids of the Mattagami river. In the east side of the river and about 300 yards from the head of the rapids, a cliff of limestone rises 50 feet above low water-level. Beds exposed along the river, upstream and down, appear to belong to lower horizons, so that the thickness exposed is probably not less than 60 feet. The vertical cliff section (see illustration) is as follows: eight feet of thin beds at bottom, containing crinoid columns; six feet of massive rock, containing cup and compound corals and stromatoporoids; upper 36 feet in beds two to three feet thick, more or less cross bedded halfway up, and containing a rich fauna. The following species collected in the vicinity are mostly from the upper division: *Streptelasma prolifica* Billings, *Cystiphyllum varians* Hall, *Cyathophyllum robustum* Hall, *Favosites americana* Hall?, *Michelinia convexa* (d'Orbigny), *Rhipidomella livia*

(Billings), *Gypidula comis* (Owen), *Atrypa reticularis* (Linnæus), *Delthyris consobrina* (d'Orbigny), *Meristella nasuta* (Conrad), *M. doris* (Hall), *Conocardium cuneus* (Conrad), *Orthoceras bebryx* Hall?, *O. troas* Hall, *Proetus macrocephalus* Hall. The upper beds are brown in colour weathering creamy, and the lower beds are cream-coloured. The rock is deeply weathered and saccharoidal, and proves on examination to be a somewhat argillaceous, magnesian limestone.

The higher beds of the Onondaga limestone are represented by much loose rock at the mouth of the Kwataboahegan river; and by rock nearly in place just above tide-level, about 1½ miles (estimated) up Maidman creek, and in the Fishingtent rapids on the east side of Moose river below the mouth of the Abitibi river. The highest beds of Onondaga limestone are seen along Long rapids of the Abitibi river, where they are overlain by shales as described below. The upper 20 feet of limestone consists of beds which are heavy and uneven at the top, but are thinner lower down. The colour is buff or grey. Small worm castings or fucoids were the only fossils seen.

The limestone of the Coral portage represents about 40 feet of a section, being probably the middle Onondaga beds. Corals and stromatoporoids are the common fossils. On the west side of the rapids, opposite the portage, the limestone overlies a green, pre-Cambrian trap rock as already described.

At the section on the east side of the river below the Sextant portage, the Onondaga is represented by about 15 feet of basal beds as already described.

### Fossils

Many species of fossils have been collected from the Onondaga limestone south of James bay by previous workers in the region. Those collected by the author were taken merely for stratigraphic purposes, and consist of the following besides those mentioned above:

East side Moose river opposite Grey Goose island:

*Cystiphyllum vesiculosum* Goldfuss, *Martinia subumbona* (Hall).

Head of second island from foot of Grey Goose group, Moose river:

*Gypidula comis* (Owen), *Atrypa reticularis* (Linnæus), *Atrypa spinosa* (Hall), *Reticularia fimbriata* (Conrad), *Martinia subumbona* (Hall), *Pleurotomaria doris* (Hall)?

East bank of Moose river opposite north island of Grey Goose group:

*Atrypa reticularis* (Linnæus), *Delthyris cf sculptilis* Hall.

Corals are abundant in the vicinity of the Coral and Sextant portages and include the following:

*Streptelasma prolifica* Billings, *Cystiphyllum vesiculosum* Goldfuss, and *Heliophyllum prolificum* Hall?

An analysis of the fossils listed supports the conclusion that these limestones are of Onondaga age, as *Meristella doris*, *Rhipidomella livia* and *Conocardium cuneus* are confined to the Onondaga limestone in southwestern Ontario. Of these *C. cuneus* is the best guide to the Onondaga in the region south of James bay. The presence in the same formation of *Martinia subumbona* suggests the Delaware formation of southwestern Ontario and *Gypidula comis, Delthyris consobrina* and *Proetus macrocephalus* suggest the Hamilton formation. As these formations are conformable in southern Ontario and New York state, the fossils are not very distinct and it is quite possible that the limestones of the James bay region may represent in part all three formations as known farther south.

### Upper Devonian Formations

The Long rapids of the Abitibi river are caused by the water flowing over transverse folds, involving the top of the Onondaga limestone and the overlying grey and black shales and interbedded limestones.

As a result of structural conditions, the section continues on and off for about four miles. The outcrops from which the following description was taken, occur along the west side of the river opposite the large limestone island near the foot of the rapids. As reconstructed in ascending order, it is about as follows: 20 feet of heavy, unevenly-bedded limestone, of Onondaga age; probably six or seven feet of green clay shale; about eight or ten feet of brown to black shale; a 2-foot bed of green limestone with shale partings, and carrying considerable pyrite. This limestone bed contains *Hypothyris cuboides* (Sowerby) and *Leiorhynchus* (?) sp., the former being characteristic of the Tully limestone of New York state.

It would thus seem probable that the 13 or 18 feet of shale overlying the Onondaga limestone, contains any Hamilton shale present, the limestone above being Tully in age. However, the presence of Hamilton beds here is not established.

Above the Tully limestone, several sections of brown and black shales from 15 to 30 feet thick, are exposed along the river, thin beds of soft green shale occurring at different horizons. On the east side of the river, fine shale sections are exposed, the probable thickness represented being 50 feet. All told, it is probable that about 100 feet of brown and black shales occur along the river. Numerous small spores occur in shale beds which represent approximately the middle portion of the section. These are somewhat smaller than the spores seen in the Huron shale of Kettle point, but there appears no good reason for considering them other than *Protosalvinia huronensis* (Dawson). On the evidence of these spores—the only fossils seen—the shales above the limestone referred to the Tully are probably to be correlated with the Huron shales of Kettle Point, Ontario, and of Ohio, the Huron being the lower division of the Ohio shales. It has not been determined whether or not the higher beds represent the Cleveland or upper division of the Ohio shale.

*Portage Shales.*—On the Mattagami river, about four miles above Pike creek, a very small outcrop of bluish shale containing nodular limestone, about one foot thick, occurs near low water-level. Calcareous concretions of spheroidal shape and one foot or less in diameter occur in the limestone along with pyrite concretions. The only fossil recognized is *Pugnax pugnus* (Martin). About one foot of pea-green shale overlies the limestone, this in turn being overlain by a few inches of black shale, which is covered by glacial till. *Pugnax pugnus* is characteristic of the Portage phase of the Ithaca fauna of New York state, and it consequently appears that this outcrop is of Portage age, and that the Ohio shale may be expected below it. C. M. McCarthy has found brown shale on the west side of the Mattagami river a little higher up. No fossils were seen in the specimen submitted, but it is probable that the beds represented are lower than the limestone outcrop and are of Ohio shale age.

### Post Middle Devonian

*Trap Intrusives.*—In the vicinity of Coral and Sextant portages, thin dikes and sheets of trap cut the sedimentary rocks from the base of the section as high up as the Onondaga limestone. The author found sheets of trap, a few inches thick, cutting Onondaga limestone on the west side of the Abitibi river opposite Coral portage; and just above Sextant portage, a dike dipping to the north at a steep angle, cuts up through the red Queenston shale. The author did not examine this close at hand, but W. R. Maher, locating engineer of the Timiskaming and Northern Ontario Railway Commission, obtained samples of it and reports that the dike varies in thickness from two feet to six inches. The lowest five feet exposed, dips vertically and becomes much contorted.

Mr. Maher also found thin trap sheets lying upon limestone beds west of the Abitibi river, between Otter and Sextant portages. Some of the igneous rock at the foot of Sextant portage may be of the same age.

The dike was mentioned by W. J. Wilson,[1] who, however, did not examine it. He also found "seemingly bedded eruptive rocks" on the west side of the river opposite Sextant portage. O. E. LeRoy reported on these for him as follows:

> The hand specimens represent a very dark, amost black, augite lamprophyre of a type closely allied to the monchiquites. The section consists of aggregates of calcite and serpentine as pseudomorphs after olivine; and pale brown and pink idiomorphic augites in a ground mass of augite, shreds of biotite, calcite, chlorite, magnetite and a fibrous zeolite.

Specimens of the dike opposite Sextant portage were collected by Mr. Maher, and N. L. Bowen,[2] who examined them reports that the material is deeply weathered, and that he can add nothing to LeRoy's description except that the fibrous mineral proves to be a new species related to the zeolites, which he has named *Echellite*. (See American Mineralogist, Vol. 5, Jan., 1920, p. 1.)

Although these intrusives have been mentioned previously, their importance appears to have been overlooked. Their age is clearly post middle-Devonian, and they compare in general character with the dikes of similar age at Ithaca, New York state. The intrusives in the vicinity of Montreal may be of the same age, but elsewhere, no intrusives younger than pre-Cambrian are known in central Canada. It is possible, however, that some of the trap dikes cutting pre-Cambrian rocks in northern Ontario and Quebec may belong to the same period of intrusion.

### Ecomonic Deposits

#### Iron Ore

The iron ore deposits are described by J. G. Cross and J. Keele (see also M. B. Baker, 20th Ann. Rept., Bur. of Mines, Ontario, 1911), but their relationship

[1] Geol. Surv., Can., Sum. Rept., 1902, p. 237a.
[2] Professor of Mineralogy, Queen's University, Kingston.

to the Onondaga limestone may be mentioned here. At Long rapids of the Mattagami river, the Onondaga limestone shows numerous sections of solution cavities, some 30 feet deep, and 50 feet or more across, the bottoms being near the present low water level of the river. The limestone at these localities is deeply weathered. Some beds of the formation contain considerable quantities of iron pyrites, as may be seen at exposures about four miles below Long rapids, and streams issuing from the limestone are commonly coloured with hydroxide of iron which collects under suitable conditions. The iron ore as already described by Mr. Baker, consists of ironstone or bog ore, which includes limestone fragments and in part replaces the limestone. Unconsolidated sand and fragments of lignite were also found to be included in the ore. This may not mean that the whole iron formation is post-lignite in age, for some bog ore is forming at the present time and some may have formed at a much earlier period. Of whatever age the deposits, the iron pyrites of the adjoining Onondaga limestone formation is probably the source of the iron. It is noticeable that no iron deposits of this character occur along the Mattagami river except in the cavities of the limestone.

### Gypsum

As already described, the gypsum beds underlie the Onondaga limestone, and were deeply eroded before Onondaga time. It seems very probable under these circumstances that the gypsum is of Salina age, or approximately of the same age as the gypsum beds of southern Ontario. The shale beds underlying the gypsum are very similar to the Salina shales.

The gypsum has already been well described by previous writers.[1] Although cut by cracks and solution channels which have allowed soil and clay to penetrate the beds, much gypsum is still little contaminated, and fine large masses of selenite and marbled gypsum occur. The total thickness of the beds is not known, but as much as 20 feet of gypsum occurs in some of the cliffs. These deposits may be looked upon as a reserve to be drawn upon when transportation and market conditions make their exploitation possible.

### Possibilities of Oil Accumulations

Extensive basins of sedimentary rocks of Paleozoic age or later are commonly found to contain oil accumulations, which may or may not be indicated by oil seepages or springs. The extensive Paleozoic area to the south and west of James and Hudson bays, is known to contain formations of the same age as oil-bearing strata elsewhere, but to date no oil seepages are known to occur. Owing, however, to the long period of weathering along the rivers, which may have dissipated any oil formerly present, and to the heavy burden of clay, silt and muskeg moss which covers the interstream areas, the lack of observed oil seepages is not to be wondered at.

[1] Bell, Robert, Geol. Surv., Can., Rept. of Progress, 1875-76, pp. 321-322.
Bell, J. M., Ont. Bur. of Mines Rep., 1904, pt. 1, p. 156.

The Trenton formation outcrops on the Nelson and Churchill rivers, the Niagara on the Nelson, the Albany and the intervening rivers, and the Salina and the Onondaga (Corniferous) on the lower Albany river and the Moose river with its tributaries. From analogy with other occurrences, these formations may be expected to contain oil. Economic accumulations, however, may only be looked for where there is an impervious cover to retain oil in the formation, and where the structure of the formations is favourable for oil accumulation.

In the region drained by the Moose river and its tributaries, the Onondaga limestone and the Salina shales are known to occur, but the Niagara and Trenton have not been observed, although they may be present beneath the outcropping formations. The Salina is not generally oil-bearing, but some of the lower dolomitic beds of this formation produced large quantities of oil in parts of southwestern Ontario, notably in Tilbury township, Kent county, and in Mersea township, Essex county. As the Salina consists of alternating shales and limestones, it is probable that suitable cover is present for any oil-bearing horizons which may exist. The Salina formation as a whole is generally well covered by younger formations.

The Onondaga limestone, which has been the most uniformly productive formation of southwestern Ontario, outcrops at the surface over wide areas, as already described, and for that reason an impervious cover is generally lacking. In the vicinity of Long rapids of the Abitibi river, and about four miles above Long rapids of the Mattagami river the Onondaga is covered in part by impervious shales. The areas known to be covered, however, are comparatively small and, unless larger areas occur beneath the interstream regions in the vicinity, it is scarcely likely that extensive accumulations of oil are present in the Onondaga. The shale areas, however, probably indicate the deepest part of the basin (that is the greatest accumulation of sediments) and consequently a suitable location for testing the lower formations.

The structure in the Long rapids region of the Abitibi river consists of a well-marked series of low folds, the major anticlines being represented respectively by the limestone areas near the head and the foot of Long rapids. The axes appear to extend north about 65 degrees east, and the dips of the limbs probably average six degrees, although one was noted measuring 13 degrees. Smaller subsidiary folds are superimposed on the larger folds, the whole structure being clearly expressed in the exposures on the islands and in the banks of the river. The proximity of the pre-Cambrian gneiss reported about four miles to the northeast on the Little Abitibi river suggests that the folding is due to the unevenness of the underlying crystalline rocks.

On the Mattagami river the formations lie nearly flat.

Among the islands in the Moose river below Grey Goose island, a series of folds occur with axes running nearly east and west and with dips as high as 25 degrees. The large island, next to the lowest of the group, lies in a syncline, but has at its head, a sharp local anticline which dips 15 degrees to the north and 25 degrees to the south. The gypsum deposits appear to indicate a broad low anticline, and the Salina red and grey shale and limestone series of the third lowest island of the Grey Goose group, evidently form the northern limb of another anticline. The alignment of the gypsum outcrops of Moose river, Gypsum "mountain" and of the French river valley suggests the location of one of the best marked anticlines in the region.

As pre-Cambrian crystalline rocks outcrop at various places throughout the region east of the Abitibi river, it is scarcely probable that the Paleozoic basin is very deep anywhere in their vicinity. It is more likely that the basin is deeper to the west, the centre possibly being near the centre of the Onondaga outcrops in the interstream region between the Moose and Albany rivers. It is doubtful whether a depth of Paleozoic strata greater than 600 or 700 feet is to be expected even there.

### Oil Shales

Dark bituminous shales, as already described, outcrop on the Mattagami river just north of Speight's 1911 base line, and, on the Abitibi river, in Long rapids. The outcrops along the Mattagami are of limited extent, but there is evidence that the outcropping beds are of Portage age; and if they are, the whole Ohio shale section may be present. Prospecting may show that still larger areas of shale are present than are indicated by the discoveries made so far. The shales along the Abitibi river occur in a syncline about 1½ miles wide, near the upper end of Long rapids, and as north dipping beds about one-half mile across near the lower end of the rapids. These beds also probably lie in a syncline. The section extends upwards from the top of the Onondaga limestone, and may be as much as 100 feet thick. Exposed sections in the west bank of the Abitibi river are 30 feet high, and sections seen in the east bank are probably higher. The black shales are interbedded with soft green shales of varying thickness, and even within the black shales, the oil content varies considerably. The following analyses of the shales of the lower part of the Long rapids of the Abitibi river were made by the Mines Branch of the Department of Mines, Ottawa.

No. 1575. Oil shale (surface exposure from Long Rapids, Abitibi River), sent in by M. Y. Williams, Geological Survey.

| | Per cent. |
|---|---|
| Moisture | 1.7 |
| Ash | 86.6 |
| Volatile matter | 10.2 |
| Nitrogen | 0.41 |
| Oil yield (crude) | 3.9 |
| Calorific value | 590 cals. per gram. |

Nos. 1572 and 1573. Samples of oil shale sent in by J. Keele from Long Rapids, Abitibi river. No. 1572 being a weathered sample (Bituminous limestone). No. 1573 being an unweathered sample (Black shale).

| | 1572 Per cent. | 1573 Per cent. |
|---|---|---|
| Moisture | 0.4 | 1.4 |
| Volatile matter | 26.8 | 13.1 |
| Ash | 61.4 | 84.8 |
| Nitrogen | 0.20 | 0.37 |
| Oil yield (crude) | 1.6 | 5.5 |
| Calorific value | 230 cals. per gram. | 639 cals. per gram. |

As these shales were taken from the bank of the river, and must have suffered much from weathering, it is probable that deeper buried portions would have a somewhat higher oil content.

# III.—CLAY AND SHALE DEPOSITS OF THE ABITIBI AND MATTAGAMI RIVERS

By

Joseph Keele

## Pleistocene or Glacial Deposits

### General Statement

A great sheet of glacial drift covers the whole region drained by the Abitibi and Mattagami rivers from James bay to some distance south of the National railway. It is composed principally of boulder clay or till gathered in the Hudson bay basin, moved southward by land ice and spread like a huge poultice over the land surface, completely obliterating the topographic inequalities of the underlying rocks.

This thick drift sheet, which was derived principally from the Paleozoic and Mesozoic rocks bordering the southern part of the Hudson Bay basin and possibly in part from the sea bottom, extends southward and covers the pre-Cambrian rocks from the Paleozoic border to a distance from 20 to 40 miles south of the National Transcontinental line. The only field data we have at present concerning the southern limit of this thick clay drift is the presence or absence of lakes. Where the drift is thick and persistent, lakes and rock ledges are practically absent, but where this drift thins out and disappears to the southward, lakes and rock ridges become numerous.

The pre-Cambrian rock surface yielded less material than the more easily eroded Paleozoic rocks and very little clay during glaciation, hence when the southward moving ice sheet exhausted its load of fat northern clay it could not gather much more as long as it moved only over the old crystalline rocks.

The generally barren character of the pre-Cambrian upland when not enriched by the northern till, is exhibited along the Temiskaming and Northern Ontario railway line between North Bay and Cobalt, where the glacial drift consists of sand, gravel, and boulders only. The drift here is generally thin, so that it does not obscure the inequalities of the old pre-Cambrian surface, therefore rock ridges, small valleys or lakes are constantly in view of the traveller.

A very different aspect would open to an observer travelling on the proposed extension of the railway through the region north of Cochrane, where there is a marked absence of lakes and rocky ridges. So effectively has the till sheet levelled up the surface that if the whole area along and north of the National Transcontinental line were denuded of trees, it would be a rolling prairie country. The Abitibi and Mattagami rivers and their branches flow in roughly parallel trenches incised in the till sheet. These rivers occasionally lay bare a rock ridge which stands at a higher level than the general rock surface beneath the glacial till, and at these points rapids or falls occur.

The great mass of the unconsolidated surface materials originating from glacial conditions consists of till or boulder clay. In northern Ontario this till sheet is so thick and so persistent that it deserves a formation name, but none has hitherto been applied to it. It forms the greater part of the extensive clay belt over which the National Transcontinental railway is built, and includes a vast reserve of agricultural land. This till sheet is not entirely continuous, but is interrupted by minor areas of sand or gravel which are the result of the washing and sorting of the boulder clay by streams of water issuing at the edges of ice sheets.

The surface of the till sheet slopes gradually to the north. The elevation of the railway at Cochrane station is 911 feet above sea level. At Otter portage on the Abitibi river, 90 miles north of Cochrane and near the northern edge of the pre-Cambrian rocks, the summit level is 425 feet. If there was a uniform slope to the surface, this would give a grade of nearly five and a half feet per mile over the area underlain by pre-Cambrian rocks.

The elevation of the surface descends abruptly from Otter portage down to the area underlain by Paleozoic rocks; the difference in elevation as given by the summit level on the Coral portage, which lies just at the inner margin of these rocks, is 120 feet, the distance to this point from Otter portage being four miles.

As the summit of Coral portage is 305 feet and tide water lies 70 miles to the north of this point, the northerly slope of the till sheet which overlies the Paleozoic coastal plain is a little over four feet to the mile.

Accurate elevations in this region are made available for the first time from the results of the Timiskaming and Northern Ontario railway reconnaissance survey conducted under the direction of W. R. Maher, during the year 1919.

There are no large areas of the till sheet entirely level in these regions, but the surface exhibits a series of gentle undulations. The hollows are swampy, owing to the fact that water collects in them, and cannot escape on account of the impervious character of the underlying boulder clay and the small amount of evaporation. The hollows accumulate a deposit of peat, and in time may support a thin growth of stunted black spruce. The higher portion of the surface is dry, and supports a forest growth of poplar and birch in addition to spruce. Travelling in any direction, then, one passes alternately from wet to dry land.

No definite evidence of multiple glaciation during Pleistocene time was found in the region examined. In places stratified sands and clays are overlain and underlain by till, but such occurrences are probably to be explained as the result of minor retreats and advances of the ice-sheet. No fossils were found in the stratified deposits interbedded with till, nor was any other evidence obtained which would suggest that inter-glacial warm climate conditions prevailed at any time during the Pleistocene in this region. It was found that the clay beds which occur on the Mattagami river, and which have been referred to by previous workers as inter-glacial in age, are pre-Glacial in age.

### Boulder Clay or Till

This is the most widespread member of the glacial deposits, and forms the banks of all the rivers to a much greater extent than any other material. It is composed of clay, sand, gravel and larger stones of varying size which are sometimes as large as three or four feet in diameter. A good deal of the finer part of the mass is derived from the wet grinding of rocks during the movement of land ice. This wet ground material is silt and not a true clay, but quantities of real clay from pre-Glacial areas were gathered and included in the mass of the till along with the coarser rock material, the clay forming the plastic binder for the whole mass.

The greater part of the northern Ontario till is fine in texture, being composed mostly of plastic clay, silt, and small rock particles up to the size of peas. It has a raspy feel when dry, owing to the presence of numerous angular rock particles, and carries a high lime content, as might be expected in a boulder clay derived principally from limestone areas.

A large proportion of the pebbles and stones in the till are derived from the limestone margin which encircles James bay. A very good collection of Devonian fossils may be obtained from the drift in the vicinity of Cochrane, as about half the pebbles contained in the till at that point are limestones of this age.

The nearest Devonian rocks to Cochrane lie about 100 miles to the north. Fragments of the iron formation, possibly derived from the Belcher islands, are one of the conspicuous products washed from the boulder clay. These islands, situated in Hudson bay, are 500 miles north of Cochrane, but only a very few fine fragments of the iron formation reach as far south as the National Transcontinental railway line. These fragments, however, become larger and more plentiful on the lower parts of the rivers.

The boulder clay is massive for the most part, and rarely shows any lamination or bedding. It is a dull grey colour when fresh, but it takes on a yellowish tone on exposure to weather. The weathering penetrates to a variable depth, so that an irregular line forms between the upper yellowish weathered part and the lower grey portion as seen in the steeper banks of the rivers.

The greatest thickness attained by the boulder clay is unknown, as it extends below the river levels even in their lowest water stage, but the greatest known thickness above river water is 150 feet.

The best exposures of till are seen on the Mattagami river, particularly good sections occurring just below Devil's rapid within the pre-Cambrian areas, while in the Paleozoic area the best sections occur just below Grand rapids.

### Glacial Sands and Gravels

The continuity of the boulder clay is broken in places by small areas of silt, sand, or gravel. These deposits occur at irregular intervals, and appear to mark points in a melting ice sheet where water was discharged from above or below its surface. The boulder clay supplied the materials, while running water accomplished the washing, distribution, and sizing of the washed products. One of the most striking examples of marginal drainage occurs on the Timiskaming and Northern Ontario railway line between Porquis Junction and Cochrane in the vicinity of Nellie Lake[1] where glacial kettles, some dry and others containing water, gravel heaps or kames, accumulations of large boulders, and sand plains are the results of the vast washing process which was carried on here. The finer material, such as clays and silts, which resulted from this washing of the boulder clay, were deposited in a large settling basin just to the southward which has since been emptied of its water.

[1] See Ontario Bureau of Mines Map No. 28*b* (Abitibi – Night Hawk Gold Area), for delimitation of Pleistocene deposits.

Another series of gravel ridges, boulder accumulations, and sand patches occurs between Cochrane and the eighth concession of the townships of Clute and Glackmeyer in a belt about four miles wide in a north and south direction. North of this the till plain appears to be intact until broken by a large area of fine-grained, grey, fluvio-glacial sand below Island portage on the Abitibi river, or a distance of 40 miles north of Cochrane.

Another extensive deposit of a similar sand occurs at Abitibi Canyon, 25 miles below Island portage. The sand at this point is at least 100 feet thick and is fine grained, compact, and greyish in colour. The bank between and north of these sand areas appears to be composed of the unbroken till sheet, but the heavily wooded slopes make it difficult to define the limit of the sand area.

In many places the fluvio-glacial sands do not outcrop at the surface, but are buried beneath a till sheet. Below Little Long rapid on the Mattagami river, the bank 40 feet high consists of 35 feet of yellowish, grey sand overlaid by five feet of till.

Further north, at the south end of the Long portage, the glacial section is as follows:

| | | |
|---|---|---|
| Coarse gravel | 7 | feet. |
| Yellowish boulder clay | 6 | " |
| Bluish boulder clay | 6 | " |
| Fine, light grey sand and silt interbanded | 17 | " |
| Compact blue grey silt, mostly massive, but banded in some parts | 16 | " |
| Hard, compact, dark grey till | 2 | " |
| Total | 54 | feet. |

The above section is not to be understood as containing inter-glacial material, it merely means that the ice sheet re-advanced and remained for a brief period over its own fluvio-glacial deposits. Other instances of a similar kind will be recorded later.

A sheet of coarse gravels similar to the above is formed along the trail of Otter portage on the Abitibi river, and these gravels extend northward to beyond Sextant portage, where they overlie the Devonian limestones just at their contact with the pre-Cambrian rocks.

### Stoneless Glacial Clays

The stoneless glacial clays are the washed product of the boulder clay or till, consequently they are mostly always found at the surface overlying either sand, gravel, boulder clay or bedrock, according to the character of the bottom of the still water basin into which they were discharged.

Occasionally the stoneless stratified clays are found buried beneath till, owing to a re-advance of ice over the sediments previously laid down from it.

Large areas of stoneless stratified clays occur south of the National Transcontinental railway line. These clays were probably laid down in a fresh water basin of large dimensions, whose northern rim was the waning ice sheet. Lake Abitibi, the largest lake in the region, is a remnant of this once extensive water body. The clay sediments have been traced[1] from the vicinity of Abitibi lake

[1] Abitibi - Night Hawk Gold Area, Vol. XXVIII, Part II, Ont. Bur. Mines, 1919, p. 37.

westward to Night Hawk lake, a distance of about 40 miles, the conclusion being that the water body was once continuous over the intervening area It is probable that this body of water reached southward across the present watershed and included the valley of lake Timiskaming.

In addition to the large body of water outlined above, there appears to have been smaller water bodies ponded in depressions or in front of the ice, because occasional patches of banded clay are found lying on the boulder clay. Deposits of this kind are seen on the Frederick House river at the railway bridge and also at the crossing of the Missinaibi river 100 miles to the west, the intervening area being almost entirely underlain by boulder clay.

These stoneless clays for the most part exhibit very pronounced stratification, being built up of alternating layers of silt and clay slightly different in colour. The silt layers have a high lime content and low plasticity, being composed mostly of finely ground rock, while the clay layers contain far less lime and have a sticky plasticity.

The top of the stratified clays generally comes to the surface, but occasionally they are concealed by sand deposits of varying thickness which were strewn over the clays as the lakes diminished and disappeared.

In some places the stratified clays are found buried beneath the till, owing to the erratic movement of the ice sheet. One of the best examples of this condition is seen at the south end of Coral portage on the Abitibi river, where the clay bank is 90 feet in height above the river. A small stream has cut through this bank exposing a section 60 feet in depth. The upper 25 feet is hard compact, greyish till, carrying large stones. The lower 35 feet is stoneless, with alternating olive and ash-grey layers of clay interlaminated with films of sand and silt. This stratified clay is followed downward by the ordinary till sheet of the region, which is exactly the same as the till overlying it.

There is no indication of any large occurrence of stoneless stratified clays overlying the uppermost boulder clay north of the Abitibi-Timiskaming area, until well within the coastal plain about 100 miles south of the shore of James bay. These clays differ from the more southerly clays, inasmuch as the latter were laid down in fresh waters. The northern clays appear to have been deposited when the land on which they lie was 300 feet or more lower than at present, so that when the ice disappeared it was replaced by the marine waters from Hudson bay. It is an open question, however, whether the ice all disappeared before these clays were deposited, or whether the ice became thin enough to allow the marine water to get in front of it at this stage of the retreat. In either case the evidence of marine deposition is indicated by the fossils and the structure of the clay. We no longer see sharp differentiation between clay and silt made by the fresh water suspensions, but the massive almost structureless clays of rapid salt water deposition.

The marine clays have a large areal extent, but do not appear to have attained any great thickness, the greatest depth observed being only about 12 feet, while at most places they were only half this thickness. They disappear under tide water at the mouth of the Moose river, and gradually rise with the slope of the land southward until they attain an elevation of about 300 feet above sea level.

### Swamp Clays

Certain dark coloured isolated patches of clay occur on the banks of the Abitibi and Mattagami rivers whose origin and position in the glacial series is often difficult to determine. For convenience they are referred to as swamp clays. They are stratified clays overlying the regular till sheet and underlying the river silts, a position just like that of the marine clays. They differ very materially, however, from the marine clays, being darker in colour and having a more pronounced stratification, but most important of all is their low lime content and their association with peaty materials, characteristics which by no means apply to the marine clay.

Clays of this kind were seen only in the area underlain by Paleozoic rock on the northern portion of the rivers. Small patches occur on the Mattagami river just above low water level, overlying the pre-Glacial clay about half a mile below the foot of Long portage, and other similar deposits were seen on the Moose river in the vicinity of the gypsum beds. These clays occur also on the Abitibi river overlying the pre-Glacial lignite at Blacksmith rapid, but the most important deposit occurs on this river opposite the mouth of Big Cedar creek.

The last-mentioned clay deposit rises to 20 feet above river level, and is overlain by the yellowish flood plain silts. It consists of alternate layers of olive and dark grey to black plastic ,stoneless clay. It appears to contain no fossils, but has rusty streaks and films of peat between the clay layers. The layers in the upper parts are folded and contorted, probably by the shoving of river ice. Small remnants detached from the main body were also seen on the opposite bank of the river and resting on the boulder clay. Clay of this kind seems to have been deposited in depressions or glacial kettles in the boulder clay surface, and was accompanied by swamp growth.

The fact that the lime is to a considerable extent leached and that there are evidences of plant growth indicates that these clays were deposited long after the land had risen above sea level.

There may be many small occurrences of similar clay in the interstream areas where their presence might be indicated by shallow ponds of water or depressions covered with forest growth. It is only when the streams cut through them that their location is revealed.

The swamp clays should not be confused with clays of similar outward appearance already described as underlying the till sheet, as these clays are not leached, neither do they contain plant remains. The swamp clays are differentiated in the same manner from the surface stratified clay deposited in front of retreating ice sheets.

### Flood Plain Silts

Immediately overlying the marine clay bed of the coastal plain is a deposit of one to ten feet of yellow-weathered interstratified silt and sand carrying small fresh water shells. Frequently streaks or thin beds of gravel are included in the silts, and occasionally small well rounded stones or boulders are scattered in an irregular manner through the bed, giving it the appearance of a layer of till at the parts where the stones occur.

The silts appear to be continuous along the top of the banks throughout the lower 100 miles or so of the Abitibi and Mattagami rivers. In some places the marine clay has been worn away by the river and replaced by flood plain silts. They are very porous and lacking in plasticity, so that they are easily washed away if not held in place by tree roots. During the excessive wet weather in August they formed a thick yellow mud running down the bank of the Abitibi river a short distance above its mouth.

These silts were deposited shortly after the rivers began to cut down on the glacial deposits, probably when the land ice had altogether disappeared, so that they are of post-Glacial age. The whole series of Glacial, pro-Glacial and post-Glacial deposits is illustrated by section measured on the Mattagami river:—

| | |
|---|---|
| Yellowish stratified silt and sand | 3 feet. |
| Dark grey stoneless, plastic clay, marine | 7 " |
| Grey, fluvio-glacial sand | 10 " |
| Compact, blue grey silt | 15 " |
| Till | 5 " |
| Corniferous limestone | 25 " |
| Total | 65 feet. |

The above section was taken on the west side of the Mattagami river just above the iron ore deposit at Grand rapids, and the following section was measured a mile further down stream on the same side.

| | |
|---|---|
| Stratified, yellowish silt | 8 feet. |
| Marine clay | 8 " |
| Till | 5 " |
| Fluvio-glacial silt | 5 " |
| Fluvio-glacial sand and gravel | 20 " |
| Till to river level | 30 " |
| Total | 76 feet. |

The bank of the Mattagami opposite the mouth of the Missinaibi river consists of:—

| | |
|---|---|
| Stratified, yellowish silts and sands | 4 feet. |
| Brownish till | 6 " |
| Fluvio-glacial sands and gravel to river | 50 " |
| Total | 60 feet. |

That part of the island above water level on which Moose Factory is built is composed entirely of silts, and the silts are thicker in this vicinity than they are up stream.

Only two species of fossil shells appear to be included in the silts, but they are of frequent occurrence.

## Economic Aspects of the Glacial Series

### Till or Boulder Clay

*Agriculture.*—Various reports dealing with the agricultural possibilities of the region and the forest resources have been published by the Ontario Bureau of Mines and Department of Agriculture. Attention has been already drawn to the fact that glaciation has made large areas of the region underlain by pre-Cambrian rocks available for cultivation and human habitation which otherwise would have been barren stretches. The great sheet of till brought southward from the Hudson Bay basin has been moulded over the inequalities of the old rocky land surface and finished with a fairly level surface suitable for agricultural purposes.

The soils on the surface of the drift sheet vary with the texture and composition of the subsoil, and where this is sand or gravel the soil is of little or no value for agriculture. The greater part of the area, however, is underlain by the boulder clay, and this produces rich clay soils in which stones for the most part are not numerous.

There is very little difference in composition between the soils of these northern areas and those in southwestern Ontario betwen lakes Huron and Ontario. Both are stony soils, high in lime, produced by a boulder clay derived principally from limestone areas. The essential difference as regards agriculture is that the southern areas are deeply leached and contain more humus, while in the northern areas leaching has been comparatively slight and the amount of humus in the soils is much less.

*Brick and tile.*—At many points on the banks of rivers and in railway cuttings. the boulder clay appears to be stoneless. This appearance is due to weathering of the surface to a uniform yellowish grey colour and the small stones not being visible on account of their coating of clay.

Examples of this kind are seen on the railway cutting between Fauquier station and the bridge over the Groundhog river, as well as in several gullies in the vicinity of Cochrane. These clays have been mistaken for brick clays, but a close inspection almost invariably reveals the presence of pebbles or coarse grit.

It is possible to make brick out of clay containing a limited number of pebbles provided they are not limestone, but an analysis of the pebbles on the shore of the Groundhog river, just below the railway, showed that half of them were limestone. The same condition prevails over the greater part of the territory traversed by the National Transcontinental railway.

The trouble with limestone particles embedded in brick clay is that they burn to quicklime, which subsequently expands on absorbing moisture and spalls the burned brick containing them. Experiments have proved that limestone grains larger than those passing a 30-mesh screen will cause trouble in burned brick, but as it is not economically possible to wash or grind clay for the manufacture of common brick, the clays containing limestone are always avoided by brickmakers.

When leaching proceeds actively for a sufficiently long period, much of the finely divided lime is carried out of the clay, and the limestone pebbles are dissolved to a certain depth below the surface. This has happened on the surface of boulder clays in southwestern Ontario, where a foot or two of clay is available for red brick or tile. The leaching accomplished in northern Ontario in post-Glacial time is quite limited in depth, which accounts for the high lime content and the pebbles mostly intact at the surface.

There are occasional patches of nearly stoneless clay on the boulder clay surface where a little sediment has been deposited in small ponds which are now dry. These deposits consist of banded black and yellow clay which might be used for the manufacture of common buff brick. They are generally small in area and also of little depth, since stony clay is almost sure to be encountered below them.

Most of the boulder clay in the region makes an excellent puddling clay for engineering work, as it is highly plastic and absolutely impervious to water when hard packed.

The large areas of stoneless stratified clay[1] suitable for brick and tile making lie to the southward of the National Transcontinental railway. These clays occupy a wide basin extending from Lake Timiskaming nearly to the height of land, where the rock ridges mark the northern limit of the basin. Beyond the height of land another basin underlain by clay opens out and extends to Porquis Junction on the T. & N. O. railway.

### Marine Clay

The marine clay which occurs in the northern portion of the region adjoining James bay is quite plastic, and has good drying and working qualities. On account of its high lime content it burns to a creamy coloured, porous body, so that while it would make a good building brick it is quite unsuited for the manufacture of vitrified wares, it being easily fusible. The marine clay is not entirely stoneless, hence care would have to be exercised in order to select those parts which are free from pebbles.

The surface of this clay passes below water-level at tide-water, consequently, in the vicinity of Moose Factory it is seen only when the tide is low. It presents a different aspect here from that on the upper reaches of the river, where it is higher above water-level and subject to oxidation. The clay at tide-water is bluish in colour and its plasticity is low. It behaves like a silt, inasmuch as it has a punky wet body which is short in texture and difficult to mould, but it might be made into brick by the soft mud process.

Two samples selected for testing, one being of the blue clay at tide-water, and the other from the brownish oxidized clay overlying the gypsum beds 40 miles further up stream, burned to very nearly the same kind of product, but the difference of the working qualities in the raw state was very pronounced. Both samples showed a few small white soft specks on the surface after burning, which denoted the presence of limestone particles in the clay.

### Swamp Clay

This type of clay was sampled from the deposit which occurs on the east side of the Abitibi river near the lower part of Blacksmith rapids, where the section seen above high water level is as follows:

| | |
|---|---|
| Yellowish flood plain silt | 3 feet |
| Stratified, blue grey to black, peaty clay | 5 " |
| Rusty gravel | 1 foot |
| Yellowish boulder clay | 2 feet |
| Black and light grey clay with lignite fragments | 2 " |
| Total | 10 feet. |

The peaty clay which is the second member from the top of this series was the material sampled. It contains coarse rock particles, lignite dust, and peaty mate-

[1] A full account of the physical properties and uses of these clays is given by the writer in the Summary Report of the Mines Branch (Ottawa) for 1917, pages 102-106.

rial, but its working and moulding properties are good. When burned to a temperature of 1850 deg. Fahr. it produces a pale red, porous body with a normal shrinkage. If burned to 1950 degrees the body becomes vitrified and of a dark red colour, but the shrinkage at this temperature is excessive. The clay softens and deforms at about 2000 degrees Fahr.

This clay would be suitable for the manufacture of common red brick or field drain tile, but not for any higher grade of ware. There are a few small particles of limestone present in this clay, but apparently not enough to spoil the burned ware.

The most extensive deposit of this kind of clay in the vicinity occurs opposite the mouth of Big Cedar creek, lower down the river, described below.

There are several patches of this kind of clay overlying the fire-clay beds on the east shore of the Mattagami river below Long portage. It varies in colour from greenish grey to black and is well stratified. The black beds carry thin layers of lignite fragments and are very plastic and smooth to the feel, so that it is difficult to distinguish it in the field from the black beds among the fire clays on which it lies.

The black swamp clay which was sampled was exceedingly stiff and soap-like when wet, and was hard to work. It burns to a dark-red hard body at a temperature of 1850 degrees Fahr. The shrinkage is excessive, and fire cracks develop in the burned body. If burned at too fast a rate it bloats and becomes cindery owing to its high carbon content and the density of the body, which prevents the oxidation of the carbon. This clay would be useless for the manufacture of burned clay products on account of its numerous defects.

Immediately underlying this material, which is of comparatively recent origin, is a light-grey pre-Glacial fire clay of the highest quality, so that in the lapse of time the worst and the best of clays have come to rest together.

### Flood Plain Silts

The yellowish stratified silt which overlies the marine clay on the lower reaches of the river has very little coherence because of its lack of plasticity. It is also interstratified with sand, which still further reduces its plasticity, and in places scattered pebbles and gravel streaks put it outside the range of practical brick making.

At certain points, however, where the sand content is low and pebbles are absent, it might be used for the manufacture of common building brick, but it appears to be a dubious proposition at best.

A certain percentage of the silt might be added to the marine clay to advantage, as the latter is highly plastic. The silt would help to make the clay more easily workable and quicker in drying.

### Sand and Gravel

The region as a whole appears to be inadequately supplied with materials for road making and for structural purposes, as sand and gravel occur only in isolated areas, not always conveniently situated to where they are most required. Furthermore, owing to the persistence and thickness of the boulder clay sheet, rock outcrops at the surface are so rare that stone from this source is seldom available

Sand and gravel is locally abundant, however, along the lines of glacial drainage, these deposits being usually indicated by the ridges and cup-shaped hollows which break the generally level surface of the region. Such deposits often stretch out for miles in a belt of no great width, so that they are within wagon-hauling distance of a considerable area. These gravels and sand hills are usually of no value to the farmer for purposes of cultivation, but they constitute reserves of great importance to a community and are eagerly sought after by railway companies.

The material furnished by glacial morainic ridges and knolls and their immediate vicinity is sand, gravel, cobble stones and boulder accumulations. As the composition of these moraines is frequently variable, some prospecting and test-pitting may be necessary in order to find the grade of material sought for. An excavation opened for sand often quickly changes to gravel, or the reverse may happen.

In some cases fluvio-glacial sand and gravels occur buried under a thin sheet of till where the surface indications give no clue to their presence. Then it is only on the cut banks of streams or in digging wells that their existence is revealed. The forest growth often indicates the character of the underlying material, as dry knolls covered with a growth of jack pine usually indicate a sand or gravel deposit.

Reference has been made to two well-known extensive accumulations of sand and gravel in the settled portion of the region adjacent to the National Transcontinental railway, and also to deposits met with on the rivers further north. The resources of the great interstream areas in this respect are as yet unknown. Two extensive surface sheets of gravel are known to occur on both the Abitibi and Mattagami rivers just at the contact between the pre-Cambrian and Paleozoic rocks. The gravels reach from Otter portage on the Abitibi river to below Sextant portage, a distance of five miles. About five miles of gravels are seen on the Mattagami at Long portage. It is scarcely possible that this sheet of gravel extends unbroken over the area between the two streams, but if not, it is quite likely that there are other similar patches of coarse gravels there.

These gravels appear to be well suited for railway ballast as well as for structural purposes.

It is rare that glacial sands are found pure enough to be used in the manufacture of glass. Although the glacial sands of this region are composed mostly of quartz grains, they also carry so many particles of mica and iron that they are altogether too impure to be used as glass sands.

Many of the deposits of glacial sands in this region are suitable for the manufacture of sand-lime brick. These brick are made by adding about 6 per cent. of hydrated lime to the sand, pressing the mixture into brick shapes in a machine and steaming them in air-tight cylinders for eight hours.

Sands suitable for moulding purposes in iron foundries were not observed in this region, but it is possible that future development may reveal them.

### Refractory Pre-Glacial Clays

The presence of fire clays and refractory pottery clays in northern Ontario was first made known by the explorations of E. B. Borron, who took a sample of clay "hap-hazard" from the bank of the Missinaibi river and had it examined by

Prof. H. H. Croft, of Toronto University. In Prof. Croft's opinion it was "nearly if not quite, equal to the Cornish clay used in the manufacture of English porcelain."[1] These deposits were visited in 1903 by J. McIntosh Bell, who mentions them in his report.[2] A chemical analysis is given in this report, but no physical tests appear to have been made.

A large section of the fire-clay deposits on the Missinaibi, above the mouth of the Wabiskagami river, were examined and staked by Messrs. H. Curran and W. T. Calkins, of Montreal, in 1911.

In 1916 the attention of C. M. McCarthy, of Elk Lake, was directed to certain peculiar clays on the bank of the river during a journey up the Mattagami from James bay. Mr. McCarthy revisited and staked claims on the deposit in the following year. He also collected samples of all the various beds he could find by boring and trenching, and submitted them to the writer for testing. The results of

*Photo by M. Y. Williams.*

View of east bank of the Mattagami river below Long portage. Mesozoic fire clays outcrop along the low part of the bank between the trees and the water. The high wooded portion of the bank is mostly composed of boulder clay.

the tests on these clays were published in the Summary Report of the Mines Branch for 1918, in which it was stated that one of the beds proved to be the most refractory fire clay yet found in Canada.

The occurrence of this high grade clay was verified by the writer during a visit to the locality in August, 1919.

The fireclays outcrop at intervals from beneath the river wash along the strip of sloping bank between low and high water levels, the greatest vertical height to which the clays rise being about eight feet.

[1] Report of E. B. Borron on his journey to and from Moose Factory in 1880. Ont. Sess. Papers, 1881.

[2] Ont. Bur. Mines, Vol. XIII, Pt. I, 1904.

Above this level rise the high banks of glacial clay. The clays are mostly brightly coloured pink, yellow and greyish white, a strong contrast to the monotonous drab glacial clays that are seen everywhere over the region.

A number of holes were bored at intervals along the strip of clay outcrops in order to ascertain the thickness of the clays and the variation in the beds. None of the holes put down went very deep owing to the fact that in every case a bed of white or pale yellowish sand was encountered which invariably let water into the bore hole sooner or later and stopped the operation. The following three examples summarize the results of the borings.

| | | Ft. |
|---|---|---|
| (1) | Bright red and grey mottled clay | 2 |
| | Yellow and grey mottled clay | 2 |
| | Black clay | 3 |
| | White clay | 1 |
| | Sand | 1 |
| | Water | |
| (2) | Dark grey, highly plastic clay | 3 |
| | White clay | 3 |
| | White sand with clay bond | 10 |
| | Water | |
| (3) | White clay | 3 |
| | Mottled pink and yellow clay | 2 |
| | Reddish pink clay | 2 |
| | Silty grey clay | 3½ |
| | White sand | 1 |
| | Water | |

An effort was made to find the clay at higher levels by boring through the glacial drift in the high banks. Five holes were started on terraces at different levels on the boulder clay, but none of them succeeded in getting down very far owing to the stones scattered through the clay. There are no surface indications of the fire clays in the slopes of the higher part of the bank, but then the constant slumping of the glacial clay and the thick forest and plant growth are sufficient to conceal any outcrops. The bottom of a small creek which enters the river not far from the fire clay outcrop was followed up, but although the little stream had cut deeply into the glacial clays it did not reveal any fire clay beneath them.

These deposits are situated 55 miles north of Kapuskasing, the nearest point on the National Transcontinental railway.

*Properties and Uses.*—The following table shows the character of the various clays when burned in a commercial stoneware kiln to the softening point of cone 7.

| Number | Raw Colour | Burned Colour | Cone 7—1270°C. or 2318°F. | |
|---|---|---|---|---|
| | | | Per cent. of Total Shrinkage | Per cent. Absorption |
| 1 | pink | buff | 16 | 2 |
| 2 | buff | pink | 15 | 3 |
| 3 | orange | red | 12 | 12 |
| 4 | black | white | 20 | 6 |
| 5 | black | white | 9 | 15 |
| 6 | white | white | 12 | 12 |
| 7 | light grey | cream | 13 | 12 |

These clays fall into two groups, those that have a comparatively high iron content and those that contain little or no iron. The iron has an effect on the colour both in the raw and burned state, and lowers the refractoriness of these clays. The first group, however, are third grade clays as they do not deform until a temperature of 3074 deg. F. (cone 28) is reached, with the exception of No. 3, which deforms at 2786 deg. F. (cone 20), and hence is only semi-refractory.

The samples 5 to 7 are highly refractory, as they do not deform below temperatures of 3254 to 3290 deg. Fahr. (cones 33-34). and hence are No. 1 fire clays. This is the first record of the occurrence of No. 1 fire clays in Canada.

Owing to their variety of character these clays are suitable for a wide range of burned clay products. Numbers 1 and 2 become practically vitrified at cone 7, as indicated by the low absorption of the body. but they have a very high shrinkage which would require to be corrected by the addition of some refractory non-plastic material, such as the pure quartz sand which underlies the clays. These clays are suitable for the manufacture of stoneware goods and sewer pipe or other vitrified products as well as fire brick.

Clays Nos. 5, 6, and 7 are high grade materials which would be suitable for retorts, crucibles, or fire brick, when used in the crude state. They could be used in the manufacture of sanitary porcelain, wall and floor tiles, or for table ware. For the latter purpose, however, they would have to be washed in order to free them from the coarser quartz particles.

Trials were made of the washed white clay in order to obtain a clue to its behaviour in a white pottery body. This body consisted of a standard porcelain mixture:

| | |
|---|---|
| Mattagami clay | 50 per cent. |
| Ground quartz | 30 " " |
| Ground feldspar | 20 " " |

This mixture was made into a slip and cast in the form of small cups. These were fired to cone 10 in a commercial china kiln, then glazed and refined to cone 4. The body had an ivory tone under the glaze, but otherwise the pieces were good.

Whiteness could be increased by the addition of a small quantity of cobalt stain added to the clay. The following chemical analysis of the crude white clay was made for Mr. McCarthy by W. K. McNeill, Provincial Assayer of Ontario:

| | Per cent. |
|---|---|
| Silica | 53.10 |
| Alumina | 31.92 |
| Iron oxide | 1.52 |
| Lime | 0.51 |
| Magnesia | trace |
| Potash | .28 |
| Soda | .54 |
| Water | 12.35 |
| | 100.22 |

The chemical composition and physical properties of this clay are almost identical with those of the No. 1 fire clays of New Jersey.

So far as we know at present the occurrence of ball clay has not been recorded in Canada, but one of the beds, sample No. 4 in the table, approaches it in character. Like the English ball clay, it contains a quantity of lignite fragments and quartz sand which must be removed by washing. It is highly plastic and capable of bonding a large quantity of non-plastic material, such as feldspar and quartz, which is the function of a ball clay in a pottery mixture. It burns white in colour, vitrifies about cone 8 or 9, and is refractory. The total shrinkage of this clay when washed is 20 per cent. when burned to cone 7, which is rather excessive.

### Glass Sand

The white sands which underlie the clay beds are composed almost entirely of sub-angular and rounded quartz grains, with which is intermingled a small quantity of white clay.

A washing test made of an average sample of 10 feet in depth of this sand showed that it contained 15 per cent. of white clay.

The sand when freed from the clay was found to be of the proper texture for glass making, and the chemical analysis of 99.8 per cent. silica shows it to be of exceptional purity.

The white clay washed from the sand is very plastic and highly refractory, while it burns to a whiter colour than any clay in the overlying beds.

The sand contains enough plastic fire clay in its natural state to act as a bond when moistened and pressed into brick shapes. A brick of this description is known as gannister brick, its use being principally confined to lining steel furnaces. The test brick were subjected to frequent burnings up to a temperature of 3,000 degrees F., but they remained soft and friable, as the materials appeared to be too refractory to produce a fused bond. The addition of a little iron and lime oxide would be required in order to produce the necessary bond in firing.

About six miles below the foot of Long portage at the big bend on the Mattagami, another outcrop of fire clays occurs in the lower part of the bank of the river. The following beds were seen between the overburden of glacial clay and the river level:

| | Ft. |
|---|---|
| Stiff plastic bluish clay | 4 |
| Well indurated, yellowish sandstone, with abundant fossil plant remains | 2 |
| Light blue grey clay | 2 |
| Laminated bluish grey silty clay | 2 |
| Massive bed of dark grey micaceous plastic clay | 3 |

A little farther down stream a bed of hard black lignite with a woody structure accompanied by white and black plastic clays outcrops at intervals near the river level for a distance of 100 yards.

Only about two or three feet of these beds are exposed below the glacial drift, and from the upturned attitude of the lignite seam they seem to have slumped from a higher level. It is possible that the lignite and the white and black clays properly overlie the section given above.

The three-foot massive bed of micaceous clay at the bottom of the above section was the only one sampled for testing, as it looked the least promising from a refractory point of view it was assumed that all the upper beds were fire clays, as well as the ones accompanying the lignite which are similar to those occurring just below Long portage.

This sample, Lab. No. 673, has good plasticity and working qualities when wet and the shrinkage when dried was only five per cent. It burns to a grey colour and hard body at cone 7 (2318° F.) with 23 per cent. absorption and a total shrinkage of eight per cent. It is not affected when raised to a temperature of cone 26 (3000° F.) in a carbon resistance electric furnace, so that it is a fire clay.

Borings made in this locality in 1910 by M. B. Baker, show that the fire clays reach a depth below the river of 16 feet, but no lignite appears to have been encountered below the seam which outcrops on the river bank.[1]

### Age of the Fire Clays

As these clays occur in so remote a region, isolated from all other known deposits of a similar kind, it is of interest to compare them with clays of a like character which are used in the clay working industry at more accessible localities.

The Northern Ontario fire clays as far as known are all situated on the low and rather flat area of Paleozoic rocks which lie between the great area of pre-Cambrian rocks and Hudson bay. The bottom of the fire clay beds was not seen at any point where they were examined, as they extend below water level and borings failed to get through them.

The Paleozoic rocks found nearest to the clays were those of the upper Devonian, and it is very likely that the fire clay beds rest directly on these upper Devonian rocks.

The fire clays are all transported fine-grained sediments, and as the name implies they are fairly pure materials, free from an excess of fluxing impurities such as iron, lime, magnesia, and alkalies. Thin seams of well indurated, woody lignite accompany the clays, but so far as seen these are never thick enough to be of economic value. A bed of pure coarse-grained quartz sand in which is intermingled a small percentage of white clay, accompanies the fire clays in one locality.

These materials are undoubtedly of pre-Glacial age, but of more recent origin than upper Devonian. They are approximately fixed in age by certain fossil plant remains in a bed of sandstone included in the clay beds at a point about six miles below the foot of Long rapids on the Mattagami river. A collection of these fossils was submitted to the paleobotanists of the United States Geological Survey, who state that the beds are certainly not younger than Kootenay, but may be older.

Certain clays which occur in the Musquodoboit valley in Nova Scotia are identical in colour and texture to some of the Mattagami clays. The Musquodoboit clays are pre-Glacial, but younger than the lower Carboniferous rocks which underlie them. These clays are mined and shipped to St. John, N.B., for the manufacture of stoneware pottery.

The Nova Scotia clays are very similar to the lower Cretaceous clays which occur so extensively on the Atlantic coastal plain in New Jersey, and which are

[1] Rep. Ont. Bur. Min., Vol. XX, Part I, 1911, p. 236.

used in many branches of the clay working industry. Large quantities of the New Jersey clays are annually shipped into Canada, where they are used for fire clays in the iron working industries or in the art schools for modelling.

Until further evidence to the contrary is available the fire clays on the Mattagami river are designated Lower Cretaceous, and the beds will be described as the Mattagami series.

### Prospecting for Fire Clays

Enough has been said about the qualities of these clays to show that they are of high grade and of extremely rare occurrence in the Province of Ontario, or indeed anywhere in Central Canada.

As already stated, small bodies of these high grade clays are visible at low water stages on the Mattagami river, and at about forty miles to the west of this locality on the Missinaibi river the most extensive known deposits of fire clays in the region are to be found.

There are no occurrences of fire clays reported from the Opazatika, a tributary of the Missinaibi which intervenes between that river and the Mattagami, but then they have never been sought for on that stream.

In all probability the fire clays were originally spread over the large area extending between the two streams or beyond them, but glaciation must have removed some of the beds or scooped out the whole formation in places.

The clays as far as we know never overlapped the pre-Cambrian rocks, but are confined to the area underlain by Paleozoic rocks.

The persistent cover of glacial drift and forest growth retards considerably any prospecting of the interstream areas, and the only thing to be done there is to put down borings at a venture in the hope of tapping the underlying fire clays, so this practically confines prospecting to the river banks for the present, until some nearer approach to the deposits is made by railway transportation.

Their distinctive colour is the principal clue to be used in prospecting for these clays, as they present a strong contrast to the monotonous drab of the ever present glacial clay. Dilute acid is a convenient field test, but it is not final, as some clays which do not show effervescence may not be fire clays. This test, however, prevents the burden of carrying useless samples.

The excessive overburden of glacial drift is one of the chief drawbacks to the exploitation of these clays. In regions where similar clays are mined it has been found that it is possible to remove one foot of overburden for every foot of good clay obtained, but it is not profitable to remove more than this.

### Kaolin

Residual clays are the result of certain processes which break down the structure of rocks and soften them in situ. Weathering and leaching by surface and ground waters appear to be the most active agencies in the formation of residual clays, but this alteration has in some cases been effected by pneumatolysis, which is the action of heated, chemically active gases ascending from below.

The principal rocks yielding residual clay are granites, felsites, porphyrites, basalts, tuffs, slates, argillaceous quartzites and sandstones, and impure limestones.

The residual clay most highly valued in the industries is kaolin or china clay. This material is white in colour, both in the raw and burned state, and is highly refractory, resisting the action of heat up to the softening point of cone 34 (1810° C.). The chemical analysis of such a clay yields little more than silica, alumina, and water. When iron, lime, magnesia, titanium, and alkalies, which are fluxing impurities, show in any appreciable quantity in an analysis the material begins to deteriorate in value, and although a clay with as high as seven or eight per cent. of these impurities may be refractory and might be used as a fire clay, it would not be a kaolin in the industrial sense.

The principal users of kaolin or china clay are the paper makers and potters, but it has many minor uses. Whiteness in colour, fineness in grain, and refractoriness are the essential qualities required for these uses. Clays which appear pink or reddish yellow or grey in colour in the field may be useful in some branch of the clay working industry, but not in those where whiteness in colour is imperative. The varied colours of the raw clays are mostly due to the iron content, and these colours are generally intensified on burning.

When it is considered that there is only one known workable deposit of kaolin in Canada, it will be readily seen that such materials are of extremely rare occurrence in this country.

The absence of residual clays on the pre-Cambrian rock surface, where they are most likely to occur, is usually attributed to the scouring action of glaciation which is supposed to have removed all clays and partially kaolinized rock, so that nothing but the hard rock which was below the zone of weathering in pre-Glacial times remains.

Geologists, prospectors, or explorers, working over the area of pre-Cambrian rocks are all agreed on the comparative freshness and hardness of these rocks, wherever they are exposed to view, and that any slight weathering effects displayed on them are of post-Glacial origin.

There are cases where residual clays have been found in Ontario extending underground and protected between walls of hard rock such as the kaolinized diabase dikes in the Helen mine at Michipicoten, previously described by the writer.[1]

During his examination for the Bureau of Mines of the pre-Cambrian rocks exposed along the Mattagami river, J. G. Cross discovered a kaolinized zone of rock on the east side of the gorge about one and a half miles below the head of Long portage. According to the description given by him, the kaolinized rock extends over a width of about 400 feet in the bottom of a depression with unaltered rock rising on each side. The rock exposed along this portion of the river is principally garnet gneiss, but it is cut by several dikes, and a semi-kaolinized pegmatite dike is included in the kaolinized portion of the gneiss. The kaolinized rock is still fairly hard, and the original structure of the gness is retained. The garnets and mica are fairly well preserved, but the feldspar is completely kaolinized, so that the rock has a prevailing white colour.

A rock of this kind loses bond quickly at a further stage of decay and is then easily carried into the drainage channels, and its contents assorted by washing. It

[1] Rep. Ont. Bur. Min., Vol. XXIV, Part I, 1915, p. 214.

is this kind of rock that was the source of the fire clays in the Cretaceous measures lower down the river.

The sample of kaolinized rock obtained by Mr. Cross was only semi-refractory and would not stand up at the same high temperature as the fire clay, the fluxing impurities of the mica and garnet being responsible for lowering the refractoriness. This discovery of a considerable body of rock well on its way to being a kaolin is of importance, as it may lead to the finding of true kaolin in this region. The ever present overburden of glacial drift, however, which makes prospecting so difficult, has always to be reckoned with.

### Devonian Clays and Shales

The best exposure of Devonian clays in the region occurs on the Abitibi river in both banks of Long rapids. There are two types of clay present in this locality, a greenish grey, soft, highly plastic clay and a comparatively hard black shale.

The soft grey clay occurs on the west bank of the river just at the foot of the rapids, in an outcrop 360 feet long, rising to a height of 15 feet above the river. It overlies the black shale, and is interbanded with it at the contact where thin beds of hard black shale and soft greenish clay alternate for several feet. The solid black shale rises to the south from beneath the clay and reaches a height of 50 feet above the river, being continually exposed for about a mile before it is replaced by bituminous limestone which grades into cliffs of pure limestone.

The grey clay contains thin films of soft black clay which are apparently of the same composition as the underlying black shale. The clay deposit as a whole is very smooth, highly plastic and stiff when wet, but has good working qualities. The average sample selected burned to a pale red, porous body at 1750 degrees Fahr. without undue shrinkage. It is darker in colour, shrinks more and has a harder body when burned to 1850 degrees. It vitrifies at 1950 degrees, but the shrinkage on vitrification is excessive. The clay deforms at the softening point of cone 4 (about 2200 degrees).

The products made from this clay would not be greatly superior to those made from the glacial clays, and it would give more trouble in working and burning. It evidently contains bituminous matter, as it bloats and becomes cindery if the burning is not done slowly. It is not a fire clay or even semi-refractory.

The black shale which overlies the clay varies from a rather blocky structure to thin papery layers. It carries a certain amount of bituminous matter and numerous crystals of iron pyrites.

The small sample of this shale collected for sampling was quite plastic when ground and mixed with water, so that its working qualities for tile or brick making are good. It burns to a light red porous body at the lower temperatures, and it becomes darker and shrinks excessively at higher temperatures.

It seems easier to expel the carbon from this shale during the burning than from the grey clay, possibly on account of the coarser grained structure of the shale which renders oxidation more effective.

As the black shale is not refractory and is a rather indifferent material in other respects, it is not of much interest to the clay worker.

Outcrops of both the black shale and the greenish-grey clay occur on both sides of the Mattagami river about four miles above Grand rapids. The amount of material exposed in this locality between the river level and the overlying glacial drift is too small to be of economic importance, and was not tested at this point.

The greenish-grey clay described above is very similar to a deposit at Thedford in Lambton county, Ontario, which was at one time worked for the manufacture of field drain tile.

Both the black shale and the grey clay are included in the Hamilton formation of the Devonian.

### Silurian Clays

Light red coloured shale of the Salina formation of the Silurian outcrops on the second Grey Goose island in the Moose river. This is a clay shale, but it is of little value for the manufacture of burned clay products, as it usually contains an excessive amount of lime, so that the resulting bricks are too porous and weak to have much structural value. There is a thick bed of reddish clay in this locality resulting from the weathering and leaching of the shale, which is a more promising material for use than the hard fresh shale.

### Ordovician Clays

The Ordovician is one of the most important clay-bearing areas in southern Ontario, the formations known as the Queenston and Lorraine being the members worked for the manufacture of clay products.

The equivalent of the Lorraine shale was not seen at all in northern Ontario, and the only outcrop of Queenston shale seen occurs just below Sextant portage on the east bank of the Abitibi river. The section of rocks exposed here is described in detail in the report by Dr. Williams. The Queenston shale at this point is of reddish brown colour and sandy texture. It is quite plastic, however, when ground and mixed with water, and hence is suitable for the manufacture of either stiff mud or dry pressed building brick or hollow ware. This shale both in the raw and burned state is precisely the same as that used at Hamilton, Milton, and Streetsville in southern Ontario for brick and tile making. The Queenston shale on the Abitibi river is inaccessible for use, because it is overlain by too great a thickness of other rocks.

Red shale beds occur in rocks of Ordovician age found in the Paleozoic series along the T. and N. O. railway in the area north of lake Timiskaming. The only known outcrop of these shales is near the highway between Haileybury and New Liskeard, but their presence is revealed wherever boring has been done in this vicinity.

This outcrop has been referred to as the "iron formation" and consists of rather massive hard red shale which weathers into a plastic red clay. Small samples of the shale and overlying clay were collected by H. S. Hume, of the Geological Survey, and submitted to the writer for examination.

This shale is rather gritty and has very little plasticity when ground and mixed with water, so that it would be difficult to work it by the plastic process, but it can be made into brick shapes by pressing the material in a semi-dry condition.

The outstanding feature of this shale is its refractoriness, as it does not begin to soften below cone 15, which is equivalent to a temperature of about 2600 degrees Fahr.

The weathered portion of the shale is quite plastic when wet and can be easily moulded into shape, but it does not stand quite as high a temperature as the hard unaltered shale. These conditions suggest a mixture of the hard and soft shale in which the latter acts as a binder for the former. Bricks of this kind could be used for cupola and stove linings or in any position where they would not be called upon to withstand excessively high temperatures. This mixture would also probably be suitable for the manufacture of vitrified wares such as paving blocks.

The quantity of materials available at the outcrop indicated above does not seem to be very large, but it is probable that the same shale occurs underlying the limestone beds in the escarpment southwest of Haileybury.

This is decidedly the most refractory clay material so far known in the Temiskaming region or even in southern Ontario, but, in refractoriness, falls far short of the clays of the Mattagami series already described.

## Clay Deposits in Limestone Cavities

There are several gaps in the limestone cliffs which outcrop on both sides of the Mattagami river in the vicinity of Grand rapids. The gaps mark the presence of sink holes, caverns and solution channels which were worn in the limestone beds by the action of running water.

These cavities were subsequently either partially or completely filled with various kinds of debris, including sand, gravel, silt, clay, cave earth, and peat. Iron-bearing meteoric waters sinking through the limestone have formed an iron-oxide cement for most of the loose material; iron in the form of carbonate has been added to the mass of cave filling, and portions of the limestone in the walls and floors of the caverns have been replaced by iron compounds.

Glaciation has eroded the roofs from some of the caverns and packed them and the open sink holes with as much glacial dirt as they would hold. The cutting down and washing of the modern river has laid bare a portion at least of the old heterogenous pre-Glacial filling in these ruined sink holes down to the floors.

A statement on the economic value of the ores of iron contained in these deposits is given in the report by Mr. Cross. The iron ores are only alluded to here on account of their close relationship in age to certain clays.

On the north side of the river near the foot of the rapids where the ruins of two sink holes occur, there are several nodular masses of iron resting on the limestone beds a little above low water level. The sink holes are about 500 feet in width, and are separated by a practically unaltered wall of limestone 100 feet thick. Some of the iron masses are firmly cemented to the limestone floor, but in other cases a thin layer of plastic blue clay or soft sandy shale lies between the iron and limestone, and at one point an irregular seam of lignite up to two feet wide is included with sandy clay in a vertical crevice of the limestone below the iron ore. There are wavy bands and partings of sand and clay among concretion-shaped masses of iron ore in the upper part of the deposit.

The hole furthest down stream contains the largest masses of clay. The clays are about ten feet in thickness and are included between two masses of iron ore. The horizontal extent of the deposits could not be determined on account of a heavy mantle of sliding glacial drift from the overburden, but a face of about 100 feet in width of clay is exposed. While most of the clay is light grey in colour, there are orange and small bright red patches as well.

The clays are mostly fine in texture, non-calcareous, highly plastic and smooth when wet, resembling the stoneware clays in many respects. At one part of the deposit the clay has become somewhat indurated and has taken on a shaly structure.

Only one of the four samples collected from this deposit had the refractoriness of a stoneware pottery clay. This was a light grey variety, which stood up to cone 15 before softening. The others failed at cone 12, 9, and 5 respectively, consequently no part of the deposit seems to be refractory enough to be considered fire clay. Clays of this kind, however, would be suitable for many kinds of furnace work, such as stopping or repairing, or for mortar for laying fire brick in positions where very high temperatures were not in use.

The most extensive deposit of iron ore occurs in the limestones at the upper end of Grand rapids on the south side of the river. The western rim of the sink hole containing the iron deposit is eroded down but the eastern rim is intact, at least the lower portion of it is. A deposit of clay occurs between this rim and the iron body.

The bottom portion of the clay, at water level, is nearly white and contains a thin seam of well indurated black woody lignite. The upper clay has a bright yellow colour, is short in texture and looks like a colluvial clay; that is a clay which has been shifted only slightly from its place of origin, which in this case was presumably the surrounding limestone beds.

There is about ten feet in thickness of the yellow clay exposed below the overburden of glacial drift. This clay is fairly plastic and has good working qualities, but is not nearly so plastic and smooth as the clay underlying the lignite. It burns to a white body without much shrinkage. It is a good refractory material as it does not soften or deform at a temperature of 3000 degrees Fahr. (cone 26), but it is probably not so refractory as the clays below it. This yellow clay would make a good commercial fire brick.

The clays in the sink holes are derived from two known sources. The first is from the clays and shales overlying the Corniferous limestones in the cavities of which the beds in question were deposited. Although the black shales and greenish grey clays of the upper Devonian are not found at present overlying the limestones near the sink holes, they did exist there before removal by erosion. The washing down and slow leaching of the older clays would give exactly the kind of clay we find entrapped in the sink holes.

Another source of clay is from the limestone beds themselves. Nearly all limestones have impurities such as silica and alumina in their composition. When the limestone is dissolved the impurities remain behind as a clay free from lime.

Some of the limestone beds in the vicinity of the sink holes are porous and powdery, which is the first stage toward their final break down into clay.

Plant growth appears to have been abundant at the time the clays were laid down as indicated by the presence of lignite beds. The slight content of acid that water derives from swamp areas hastens the solution of carbonate of lime in the rocks through which the water circulates.

The deposits as situated here have no economic value because the quantities present are too small and furthermore they carry excessive overburdens. They are of interest from the fact that they are survivals from a period long previous to the glaciation of the region and are of a type of deposit rare in Canada.

An outcrop of lignite and black clay occurs on the east side of the Abitibi river at the foot of Blacksmith rapid. Associated with the black clay and lignite is a small mass of Devonian greenish-grey clay. These materials have evidently been displaced and intermingled with glacial drift during glaciation, so that the outcrop is a confused mass, overlain by boulder clay.

The black clay is very smooth and plastic, burns to a pink colour at low temperatures and to a grey vitrified body at cone 7 (2318 deg. Fahr.). It fuses at cone 15, so that it is not a fire clay but only semi-refractory. This clay is probably similar to the small deposits found with lignite in limestone cavities, such as those described as occurring at the Grand rapid on the Mattagami river.

There are no limestone outcrops, however, now visible on this part of the Abitibi river. Nothing definite can be said regarding the age of the clay deposits in the limestone cavities, but they are certainly pre-glacial.

### Miscellaneous Clay Deposits

For several miles below the foot of the Grand rapids on the Mattagami river a few exposures of crumbling limestone outcrops are seen separated by boulder clay. Between the limestone outcrops and opposite the boulder clay are beds of lead-blue clay on both shores of the river, sometimes almost covered by boulders, but often bare and extending from low to high water level. Patches of light grey clay similar to that which accompanies the lignite seams are mixed with the lead-blue clays, but it is not certain whether or not these are only a lighter coloured phase of the same clay.

Another large patch of similar lead-blue plastic clay occurs on the east shore of the Moose river opposite the upper Grey Goose island. On the east bank of the Abitibi river between Coral portage and the yellow sands is another outcrop of the same lead-blue clay.

Minor deposits of these lead-blue plastic clays were seen at several other points on the rivers, being noticeable on account of their difference in colour from the monotonous yellowish grey glacial clay, and from the fact that they always occur on the low part of the bank nearest the water.

Four small samples of this kind of clay were collected for testing from points far apart. The results of the tests showed a remarkable similarity as regards their properties. They were all very smooth and fine grained with good plasticity, behaving in the raw state like stoneware and modelling clays, but they contain enough lime to cause effervescence when dilute hydrochloric acid was dropped on them. They burned to a red colour and hard dense bodies at the same temperature and had the same fusing point.

It is difficult to determine the origin of these clays, but they may be merely refined glacial clays resulting from the processes of sorting and washing by the rivers.

They were only seen at or near river levels and always below high water mark. They are much smoother and contain less lime than the clay which forms the matrix of the till sheet, being also lighter in colour and standing a higher temperature before fusing. It is very probable that these clays are the washed product of the till sheet, reworked and shifted at various times by the river until they became fine in texture and their original colour bleached out.

These clays have little or no economic value, as they usually occur in positions difficult to work on account of water. They are of low grade from an industrial standpoint, being too easily fusible, and they are never in very extensive bodies.

Although these clays bear a strong resemblance to some of the clays in the sink holes in the limestones, they have this much difference that the sink hole clays are non-calcareous, and are not so easily fusible as the river bank clay.

Some of the fire clay beds in the Mattagami river have very nearly the same colour and texture as the above clays. The only field test that can be applied to distinguish them is the acid test. If a clay shows any effervescence under a few drops of dilute hydrochloric acid, it may be discarded if the quality sought for is refractoriness. On the other hand a clay may not effervesce and still not be refractory, but the test serves to eliminate the collecting of useless samples by the prospector and the burden of portaging them.

### Yellow, Orange and Reddish Sands

One of the most striking objects on the Mattagami river is the deposit of oxidized sands which occupy about a quarter of a mile of the east bank between the mouth of Pike creek and the iron ore deposit at the head of Grand rapids.

These sands extend below water level and vary in height from 10 to 25 feet. They are overlain only by a foot or two of stratified silts from which they are separated by a thin layer of rusty pebbles. The sands are composed entirely of coarse quartz grains often with a cross bedded arrangement interbanded occasionally with streaks of pea-sized gravel composed mostly of quartz, although pebbles of the harder parts of pre-Cambrian rocks are also present. Occasionally pockets and streaks of micaceous clay are included, as well as rusty and disintegrated cobble stones.

The materials become coarser at the northern end of the deposit, finally passing into yellow gravels of cobble stone size ending abruptly against boulder clay.

The sands are compact enough to retain a fairly vertical face, but there are no cemented beds.

The colour of the beds varies from yellow to orange and reddish brown, and appears to be mainly due to the coating on the quartz grains and not to any fine material intermixed with the sands.

A similar deposit occurs on the west bank of the river opposite the above occurrence, and was evidently a portion of the latter before the river cut through it.

A smaller deposit of the same type of sands occurs a short distance below the foot of Long portage on the Mattagami river in the bank overlying the fire clay beds. The deposit is limited in width, being enclosed in boulder clay, but it is about forty feet thick. The sands are arranged in beds sloping down stream and contain a band of grey and yellow clay about a foot thick. Above the clay bed the materials are yellow gravels and cobble stones. The orange sand and gravels are overlaid by grey fluvio-glacial gravels with included lenses of boulder clay. A solid mass of hard grey gritty till carrying unusually large boulders caps the bank.

The largest deposit of orange sands in the region occurs on the east bank of the Abitibi river between Sextant portage and the head of Long rapid.

The sands here are about thirty feet thick and extend for a mile along the banks under a capping of boulder clay. The sands are composed almost exclusively of coarse angular to round quartz grains sometimes running as coarse as fine gravel. Angular fragments of disintegrated pre-Cambrian schist are mixed with the sand toward its base. The bottom of the sand deposit was not seen as it reaches down below water level.

The question arises concerning the place in the geological sequence to which these sands should be assigned. It is difficult to place them as pre-Glacial in view of the accepted theories regarding the scouring action of a continental glacier, such as passed over this region. Friable unconsolidated deposits like these sands would seem to have small chance of surviving glaciation. On the other hand, we are confronted with the strongly oxidized and residual character of the materials in the deposits, and their freedom from glacial dirt of any kind. If it is urged that the lack of cementing material would indicate a recent origin, it may be pointed out that there are sands of Silurian age on the Abitibi river with no more cementing material present.

Turning to the economic aspect of these sands, it would appear that their comparative freedom from materials other than quartz would suggest their use as a source of silica. It is probable that they contain too high a percentage of iron to be used as a glass sand, although washing would no doubt reduce this. As the texture of the sands is about right for glass making purposes, a few washing trials and chemical analyses would settle the question. There are no sands so pure as these in the Glacial series.

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END OF PART II.

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# TWENTY-NINTH ANNUAL REPORT

OF THE

# ONTARIO DEPARTMENT OF MINES

BEING

## VOL. XXIX, PART III, 1920.

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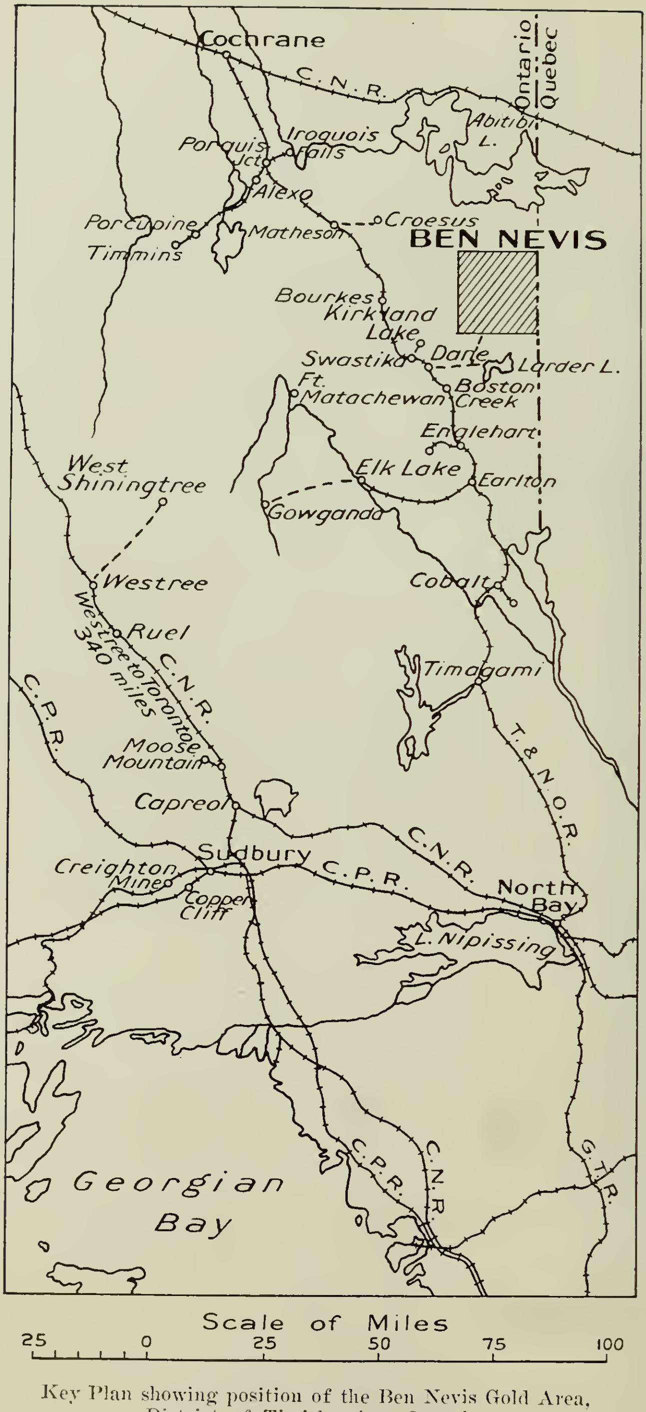


Key Plan showing position of the Ben Nevis Gold Area, District of Timiskaming, Ontario.

# BEN NEVIS GOLD AREA

By

Cyril W. Knight

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### Introduction

The Ben Nevis gold area lies midway between Larder lake and Lake Abitibi in the district of Timiskaming, contiguous to the province of Quebec, Fig. 1. The area being somewhat isolated, and requiring about two days from the railway to enter, and the time at the disposal of the party being limited, it was only possible to geologically map the locality in a general way, postponing details to the day when discoveries of more ore bodies are made. Work was begun on the twenty-second of July, 1919, and by the nineteenth of September of the same year seven townships had been geologically mapped. Of the seven townships Ben Nevis occupies the central part. Because of the rugged nature of some of Ben Nevis township, and because it occupies the central part of the area, this name is made use of in the title for the report.

The height of land between the St. Lawrence valley and Hudson Bay crosses some of the townships, at times being located on rugged mountains, and at other times on swamps or sandy plains.

The discovery of gold [1] in Larder lake in the summer of 1906, followed by a stampede of prospectors in the winter of the same year, caused much excitement, and many claims were staked. Prospectors in those days overflowed the Larder lake area and worked northward into the Ben Nevis country, resulting in the staking of some gold claims, particularly in the southeast corner of Katrine township. During the summer of 1919 there was a certain amount of activity in Katrine township, at the southeast corner, where some claims, which had been staked during the Larder lake boom, were being worked for gold, under option, by the Nipissing Mining Company of Cobalt.

The seven townships mapped have not as yet been subdivided into lots. It was therefore necessary, in examining the rocks, to run traverses across the townships, following as a general rule east and west or north and south courses. These courses were run by means of the compass and the distances determined by pacing. The courses were blazed on one or two sides of the trees, or were not blazed at all. Their location is shown on the map so that prospectors may know what parts of the area were examined and what parts were not. The township boundaries were practically all examined, as were also the boundaries of the surveyed claims in the southeast corner of Katrine township.

Most of the township boundaries were surveyed in 1911 by John E. Jackson, Ontario Land Surveyor. Jackson's boundaries were well cut out and blazed, and hence they were readily followed. The west boundaries of the townships of Tannahill, Ben Nevis and Katrine were surveyed originally as a meridian line in 1907, before the township lines were cut. This meridian line was not so readily followed, partly because it was surveyed five years before the township lines, and partly because the blazes were not so numerous as they were elsewhere.

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[1] "The Larder Lake District," by R. W. Brock, Ont. Bur. Mines, Vol. 16, 1907, Part 1, p. 203.

The interprovincial boundary between Ontario and Quebec, which constitutes the east boundary of the map, was surveyed in 1905, by T. J. Patten and F. C. Laberge. It was widely and thoroughly cut out, but in the last 15 years the underbrush has grown up thickly so that travelling along it is in places difficult and tedious.

## Acknowledgments

The survey of the lakes and rivers, and the locating of some of the hills and mountains were done by G. A. L. Gibson, under instructions from W. R. Rogers, topographer of the Bureau of Mines. Mr. Gibson was assisted by the following: Messrs. E. Howell, John Kirkconnell, and George Tyrrell. The geological party has associated with it Messrs. C. R. Elliot, J. E. Hunnisett, D. E. Kerr-Lawson and R. Presgrave. The writer takes pleasure in thanking these gentlemen for their interest in the work. The topographic party began work in the area about two weeks before the geological party, and finished their work about two weeks earlier. Had it not been for the work of the topographers, it is probable that less than half the area could have been geologically examined.

The thanks of the Ontario Bureau of Mines are due to the Argonaut Gold Mining Company[1] at Beaverhouse lake. Members of the party stayed at the company's plant on various occasions and were received with hospitality at all times. The party was also received with kindness by the Nipissing Mining Company at the claims which the company held under option in Katrine township, where the work was under the immediate charge of George Tucker. To Mr. Leo Ernhous, representing the Nipissing Mining Co., the Bureau is also under obligation for valuable information which he was kind enough to give.

## Prognostications

"Although few discoveries of economic minerals have been made in this territory it may reasonably be expected, judging from the character and variety of the rocks, that deposits of value will be found when the district is more carefully prospected, as it will be in a short time owing to the rapid settlement which is now taking place." (W. G. Miller in the Report of the Ontario Bureau of Mines for 1901.)

The above remarks were written nearly a generation ago, covering the territory between Lake Timiskaming on the south, and the height of land, between James Bay and the St. Lawrence valley, on the north. It is interesting and instructive to note that, since Dr. Miller suggested the possibility of valuable ore deposits occurring in this region, deposits of undreamed-of richness have been discovered. It is only necessary to mention Cobalt, Porcupine and Kirkland Lake to realize that the prognostications stated in the preceding paragraph have come true.

As part of the Ben Nevis area was included in the territory to which Dr. Miller's forecast referred, it is not unreasonable to believe that important ore bodies will be found in this or adjacent localities.

[1] Formerly known as "La Mine D'or Huronia."

View looking northward, township of Katrine. In the background are the mountains on the Height of Land between Hudson bay and the St. Lawrence valley. In the middle distance is Misema lake.

## Summary

The Ben Nevis area constitutes part of that great belt of Keewatin rocks which stretches across northeastern Ontario and includes such gold-producing camps as Porcupine and Kirkland lake. Since the Ben Nevis area is underlain by dark-coloured Keewatin lavas which are intruded by a few masses of syenite and feldspar-porphyry, it is a prospective field in which gold-bearing quartz veins of economic value may be found. Gold deposits occur in the country immediately south, namely: the Larder lake area.[1] They are also found in Gauthier township, immediately southwest of the area, including the Argonaut gold mine, and other deposits.[2] In both these areas, Gauthier township and Larder lake, auriferous deposits were being worked at the time this report was written, March, 1920. Gold-bearing quartz veins also occur north of the Ben Nevis area, in Holloway and Harker townships.[3]

The Ben Nevis map embraces an area of some 300 square miles and includes nine townships, two of which, however, Dokis and Elliot, were not mapped geologically. Parts of it appear to be practically unprospected, particularly Pontiac township. Other parts, such as the southeast corner of Katrine township, have been prospected more thoroughly, especially during and following the Larder lake boom in 1906. Already some interesting gold-bearing quartz veins have been found in the southeast corner of Katrine township. These discoveries were promising enough to induce the Nipissing Mining Company of Cobalt to option the claims in 1919. During the summer of that year this company did considerable trenching and sampling on these claims with promising results, a gang of 8 or 10 men being employed. The option, however, was not exercised.

There was little activity in the area with the exception of the work done by the Nipissing Mining Company. It may be added that there were probably less than a dozen prospectors in the field.

While in all probability the locality is one in which prospectors would preferably search for gold, still it may be pointed out that there is an intrusion of serpentine at the west side of Tannahill township. A somewhat similar intrusion elsewhere in Ontario, at the Alexo mine, has associated with it an economic deposit of nickel and copper ore; while chrome iron ore, platinum and microscopic diamonds have also been found associated with similar rocks in Reaume township, although not in paying quantities.[4]

## Access to Area

The area may be entered from Dane, a station on the Timiskaming and Northern Ontario railway 57 miles north of Cobalt. In the summer of 1919 there

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[1] Ont. Bur. Mines, Vol. 16, 1907, Part I, pp. 202-218, R. W. Brock; Vol. 17, 1908, pp. 10-11, N. L. Bowen. Geol. Sur. Can., Memoir No. 17-E, 1912, M. E. Wilson. Ont. Bur. Mines, Vol. 28, 1919, Part II, pp. 71-77, P. E. Hopkins.

[2] Ont. Bur. Mines, Vol. 26, 1917, pp. 252-257, A. G. Burrows.

[3] Ont. Bur. Mines, Vol. 28, 1919, Part II, C. W. Knight, A. G. Burrows, P. E. Hopkins, A. L. Parsons.

[4] Ont. Bur. Mines, Vol. 23, Part I, 1914, pp. 47-48.

were two boarding houses at Dane, a store, and a livery supplying teams for the purpose of hauling supplies and passengers to Larder lake and the Argonaut gold mine.

The well-known Larder lake road begins at Dane and leads eastward for about 12 miles, when it branches, one branch continuing easward to Larder lake, and the other running across Gauthier township about six miles to the northeast corner of the township, where the Argonaut gold mine, formerly known as La Mine d'Or Huronia, is situated. Along the entire 18 miles the road follows comparatively

Verna lake, Ben Nevis township.

level or gently rolling country, and is free from hills of any consequence. At the Argonaut mine canoes may be put into Beaverhouse lake, and the south part of Ben Nevis area may be entered in about an hour by canoe, there being no portages, except one over a dam at the Argonaut gold mine.

Access to the area may also be gained by way of Larder lake, making use of a canoe route which leads north from Larder lake by way of Bear and other lakes. This route, although used by prospectors in 1919, has some long portages which may be evaded by taking the route through the Argonaut gold mine.

If it is desired to avoid the long trip by wagon road from Dane to the Argonaut gold mine, it is possible to enter the northeast corner of the area, Dokis township, by way of La Sarre, in the province of Quebec, a town on the National railway 87 miles east of Cochrane. La Sarre has hotel accommodation, and is situated on a river of the same name. This river is canoeable southward to Lake Abitibi, a distance of about 7 miles. After crossing the east end of Lake Abitibi, passing on the way a Hudson Bay Post where supplies may be obtained, the Abitibi river is ascended for some nine miles, crossing one portage of about 3 chains. Duparquet lake is then entered, a body of water some six miles long. From this lake the canoe route leads up the Magusi and Abnageezy rivers to Dokis township, there being no portages. The canoe trip from La Sarre to Dokis township takes about two days under ordinary circumstances.

## Map Accompanying Report

Mention may here be made of the map (No. 29*e*) accompanying this report, since it has certain features which are not commonly shown on maps of the Ontario Department of Mines.

The exploration traverses are indicated by heavy dotted lines. These dotted lines show the actual parts of the Ben Nevis area which have been geologically examined. The areas between the dotted lines were not explored by our party. The object in showing the location of the exploration traverses in such a manner is to avoid any misunderstanding regarding the parts which were geologically examined. Prospectors and others interested will know that the parts between the dotted lines were not explored.

It will be noted that along the dotted lines there are brief notes, such as pillow lava, basalt, grey lava, rhyolite, volcanic fragmental, and so forth. These notes indicate the variety of rock seen at various points along the traverse lines. The term "grey lava" has been frequently used in these brief notes along the traverse lines. Our party found this term a convenient one for field use to describe those lavas of intermediate composition between such basic rocks as basalts, on the one hand, and rhyolites, on the other. Of course, some of the rocks called "grey lavas" may really be as acid as rhyolites, but it was felt that the general nature of this report did not justify lengthy technical descriptions, or the making of chemical analyses, which would definitely determine the exact nature of the rock. The report aims to give a simple, general account of the rock formations which prospectors may use without much difficulty.

Another term which was found useful in the field is "volcanic fragmental." This rock consists of angular fragments of lava varying in size from tiny bits to fragments a foot or two in diameter, perhaps averaging, on the whole, an inch or two in diameter. The rock is associated with various lavas, and was no doubt formed during the partial consolidation of the lavas, the partly consolidated crust breaking up as the lava flowed onward.

## Previous Work

There have been no geological maps of the area published. Although not a difficult part of northeastern Ontario to enter, it nevertheless requires from two to three days from the nearest railway stations to reach the more remote parts. Probably this inaccessibility accounts for the lack of geological information regarding the locality, W. J. Wilson being the only geologist who has worked across the area, and his report merely describes the canoe route in a brief way.

The country to the south, east and north of the Ben Nevis area, has already been mapped and examined geologically. That to the south—the Larder lake area —was mapped by R. W. Brock and N. L. Bowen in 1907,[1] and later in greater detail by M. E. Wilson.[2] The country to the east, in the province of Quebec, was also mapped by Wilson.[3] The territory to the north was mapped by the staff of the Ontario Bureau of Mines in 1918.[4] The area to the west is still unmapped geologically.

While there have been in the past no geological maps of the area published, it may be noted that W. G. Miller examined in 1901 some of the lakes in the southwest corner of the map, namely: Beaverhouse, Howard and Victoria.[5] Beaverhouse lake was also later referred to by W. A. Parks.[6]

In 1901, W. J. Wilson examined the canoe route across the south part of Ben Nevis, and also the main canoe route which runs northward across the area. His description of these routes is as follows:[7]

> Continuing the survey westward [from Labyrinth lake], I passed through a low, marshy river for two miles, then through a small grassy lake called Waterhen lake, then for a mile and a half up a river where a portage of nearly a mile leads into a lake called Wawagoshe, and from this a portage of a quarter of a mile passes over the Height of Land to the head waters of the Blanche river. The elevation where the line crosses the Height of Land is about 980 feet above sea level (aneroid). In passing over the portage into Wawagoshe lake, I noted some comparatively large trees, especially spruce and poplar. Some of the spruce measured sixty-seven inches in circumference, but west of the middle part of Wawagoshe lake the forest is all second growth, the country having been overrun by fire about thirty years ago.
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> The branch of the Blanche river which forms part of the canoe route is a very small stream near the Height of Land, but at a distance of a mile and a half it has become twenty feet wide and six feet deep. At a distance of four miles it expands into Snake island lake [Kinabik,] and a mile further into Misemikowish or Beaver House [lake Misema]. This is a narrow, deep lake extending west and north-west seven miles, with an arm running south six miles. The shores are high and rocky, the rocks consisting of massive diorites and schists, with numerous small quartz veins holding pyrite. The rock itself contains considerable pyrite in disseminated grains.
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> Structural lines which may represent the strike run nearly east-and-west, with the dip ranging from 75° to vertical. In places, however, the lines run north-and-south. A ridge of dolomitic rock containing iron forms a dam across the south end of the lake, causing a fall of about five feet. The branch of the Blanche river flowing south from this lake is a stream of considerable size, and I was told by the Indian guide that it is twenty to twenty-five miles long. There is a canoe route westward from Misemikowish [Misema] lake to Round lake, also one leading north across the Height of Land. I followed the latter over a portage of two chains into a narrow lake [Kennedy] one mile and a half long, then up a small stream one mile long, two small lakes, a short portage and a lake [Verna] two miles long to the Height of Land portage. As already noted on Wawagoshe lake the forest growth is all small, consisting chiefly of spruce, canoe-birch, poplar, and Banksian pine, the latter eight inches in diameter. This is the character of the forest growth to the south end of the Height of Land portage, where the brulé ends, and west probably to Round lake.

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[1] Ont. Bur. Mines, Vol. 16, Part I, 1907, R. W. Brock; Vol. 17, 1908, pp. 10-11, N. L. Bowen.

[2] Geol. Sur. Can., Memoir No. 17-E, 1912, M. E. Wilson.

[3] Geol. Sur. Can., Memoir No. 39, 1914, M. E. Wilson.

[4] Ont. Bur. Mines, Vol. 28, 1919, Part II, C. W. Knight, A. G. Burrows, P. E. Hopkins, A. L. Parsons.

[5] Ont. Bur. Mines, Vol. XI, 1902, pp. 214-230, W. G. Miller, "Lake Temiscaming [Timiskaming] to the Height of Land."

[6] Geol. Sur. Can., Vol. 16, 1904, pp. 216A-217A.

[7] Geol. Sur. Can., Vol. 14, 1901, pp. 119A, 120A, W. J. Wilson.

A portage of half a mile crosses the Height of Land, then a number of small streams and lakes which form the head waters of the Isabemagussi [Abnageezy] river were followed for over three miles. Here the canoe route leaves the main stream, which is blocked with driftwood, and a portage of two miles connects with another branch of the river. This 1 ascended for three miles, when a lake [Webster] two miles long was reached. From near the north end of this lake a portage of three miles is necessary to again reach the Isabemagussi [Abnageezy] river, which is now flowing east to Agotawekami lake, about twenty-two miles distant. All the rocks along this route are Huronian [Keewatin] and consist of greenstone and schists, with an occasional band of chert and conglomerate. The latter was seen on the last long portage one mile from the south end; strike N. 70° E.

The forest growth is generally heavy and was well seen on the long portages, where there are swamps densely wooded with tall, clear spruce ranging from six inches to one foot in diameter. On the higher ground the soil is a deep clay loam and vegetation is very luxuriant. Spruce, twelve to twenty inches in diameter is common, and poplars measuring two feet were seen; canoe-birch and other trees grow to a fair size.

The Isabemagussi [Abnageezy] river, at the north end of the three-mile portage, is fifty feet wide and seven feet deep, but the marks on trees, etc., along the banks show that when the ice is moving out the water is at least ten feet higher than at present (July 10).

Keith lake, Ben Nevis and Clifford townships.

The soil along the banks is a sandy, bluish-gray, stratified clay, resembling that found everywhere south of Lake Abitibi. The water is muddy, but some of the numerous streams it receives are clear and cold. Very few rock exposures are seen, but wherever they do occur they show the same Huronian [Keewatin] strata striking east-and-west. From the appearance of the soil and the luxuriance of the forest growth and vegetation generally it is clear there is a large area of excellent land for agricultural purposes on this river and its branches, also considerable quantities of pulpwood and saw-logs.

There are also some notes which accompanied the reports of the land surveyors who surveyed the township lines and the interprovincial boundary between Quebec and Ontario. The latter constitutes the east boundary of the Ben Nevis map, the southeast corner being near mile post 43 on the interprovincial boundary, and the northeast corner near mile post 61. Lake Abitibi is near mile post 72, beyond the confines of the Ben Nevis map. The interprovincial boundary was surveyed in 1905 by T. J. Patten and F. C. Laberge, and accompanying their report are the following notes regarding the character of the country, soil, and other matters:

The timber from the height of land to Labyrinth lake is principally jack pine up to twelve inches in diameter, and tall and clean, and would make good lumber for some purposes. With it there is some white birch and balsam of good size. Around Labyrinth lake there is some large white pine, scattered. There is also some large white spruce, balsam, cedar and white birch. From Labyrinth lake to Abitibi lake the timber is the same, but includes large poplar and balm-of-gilead, and in the swamps large black spruce and dry tamarac. Cedar is found around the lakes and streams, and much of it is unsound at the butt. Jack pine is found to twenty-four inches in diameter and is also clean, tall timber. Some large white pines, about twenty-four inches in diameter, scattered, were found on the 53rd, 55th, 56th and 63rd miles. Near the south shore of Abitibi lake there are also a few white and red pines. In some low spots black ash is found. To the east of the 52nd mile there is a fine tract of black and white spruce. None of the country traversed has been burned for a great many years. The most important character of the soil is that it is constituted for the greater part of clay which is well drained, and therefore after the forest has been cut good farming land will be developed in the valleys. From the 42nd mile to the 58th mile the country is hilly, and the rock crops out at every hill-top in the form of ridges and bluffs of a very broken character. From the 58th to the 68th mile, although rocky on the hills, the country is less broken, and the hills have more gentle slopes. From the 68th mile to Abitibi lake the line descends into a valley, principally good clay land. The general direction of the hills is east and west, and they are separated by valleys of from one-half mile to one mile in width, and these valleys are connected at intervals by hollows, gulleys or creeks, thus rendering them easily accessible from one to the other. The waters flowing in the streams and accumulated in the lakes are coloured by sediments, the more as Lake Abitibi was approached. In Lake Labyrinth the water is coloured slightly whitish, and only in Trout [Clarice] lake clear water was found. The other waters are coloured by the clay held in suspension."

Labyrinth lake, Trout [Clarice] lake and the smaller lakes abound in fish, principally pike, pickerel and bass. In Lake Abitibi the same fish are found, also lake trout and white-fish. Moose and red deer were seen, also bear tracks. There is also an abundance of smaller game.

## Character of the Country

The character of the Ben Nevis[1] area may be said to comprise two types of topography, the one rugged and mountainous, the other low, rolling and featured by sand plains and swamps. Much of the eastern and central parts of the area are of the mountainous type, while most of the western part is flat or rolling in character. The comparatively rugged and mountainous parts of Ben Nevis and Katrine townships are beautiful and picturesque, and form a strong contrast to the flat or rolling sandy plains of Arnold and Clifford townships on the west.

The highest mountains rise some 1,400 or 1,500 feet above sea level, and from the most prominent peaks some splendid and instructive views of the surrounding country may be obtained. The highest peaks are about 500 feet or more above the lakes and valleys.

The height of land between Hudson Bay and the St. Lawrence valley crosses the area, in part marked by the mountain ridges and in part by the low, sandy or swampy areas of the west.

The country is dotted with lakes, a series of these, namely: Beaverhouse, Misema, Howard, Kennedy, Anrey, Verna, Keith, Marten, Pmaws, and Webster, forming the main canoe route which crosses the country in a northerly and finally in a northeasterly direction, following this chain of long, narrow lakes connected with winding streams. There are log cabins on Wawagoshe, Misema, Marten, Verna, and Webster lakes. These are inhabited by Indians during the trapping season.

[1] Ben Nevis is the highest mountain in the British Isles, having an elevation of 4,406 feet above sea level. Every mountain of any size in Scotland is said to be visible from Ben Nevis.

A more detailed description of the topography of the seven townships comprising Ben Nevis area will be found in following paragraphs, beginning with Pontiac township in the eastern part of the country.

### Pontiac Township

The township of Pontiac was difficult to enter from our camp on Labyrinth lake. There were no prospectors or fire rangers in the locality during the time of the examination, so that no information could be obtained as to possible canoe routes into the township. It was therefore necessary to cut a trail about four miles long from the north end of Labyrinth lake, beginning about 40 or 50 yards

Jackpine forest, west of north end of Marten lake, Clifford township.

east of the interprovincial boundary between Ontario and Quebec. This trail, which has been called the Pontiac trail, runs northwestward and crosses the south boundary of Pontiac township, about one and a half miles northwest of Labyrinth lake, and a little less than a mile west of the southeast corner of the township. The topography of Pontiac is much more rugged than is that of Ossian to the south. There are several prominent hills separated by comparatively wide, and sometimes flat, valleys, the latter covered with clay, boulder clay and more seldom sand. To the north of Clarice lake—a beautiful sheet of clear water in the northeast part of the township—there is a prominent range of hills across part of which local forest fires have swept. In the south part of the township there are two prominent hills, with steep faces, about a mile to the northwestward of the third mile post. Other mountains occur in the central part of the township.

### Ossian Township

Ossian township consists for the most part of low rolling country with fine spruce swamps and unimportant hills. At the north part of the township, however, the country becomes more rugged. Ross mountain, for instance, at the northeast corner, rises into a prominent peak which is well seen from Labyrinth lake. Prominent hills also occur to the west and northeast of Mist lake—an attractive sheet of water in the northwest part of the township. A bird's eye view of Ossian may be had from a prominent hill which lies immediately northwest of the northwest corner of the township. This hill rises some three or four hundred feet above the nearby valleys, and a view from it shows that some of the hills at the northwest part of the township have a dome-like outline. A rough trail follows the west boundary of Ossian to the northwest corner. The rocks along this part of the boundary are basaltic in type, except northwest of Mist lake

Mount Chaminis, about three and a half miles southeast from the S.E. corner of Ossian township. This is one of the most striking mountains in central Canada.

in the province of Ontario, where an area of diabase and gabbro is found. A thin section under the microscope shows that this rock is much decomposed and contains some primary quartz. These rocks are all massive, with the exception of those in the vicinity of the third mile-post where they are altered to schists containing here and there some iron pyrites. Other schistose rocks occur in the interior of the township, their location being shown on the geological map.

### Katrine Township

The township of Katrine is rugged, possessing as it does a prominent range of mountains running northwestward across it. The height of land between the St. Lawrence valley and Hudson bay follows, in a general way, this range. The exact location, however, of the height of land has not been worked out in the township. From the highest peak on these mountains, which have been named the Workman mountains, a remarkable view of the surrounding country to the north, west and south may be obtained, particularly on a bright, clear day. The landscape looks like a vast plain, in which hills a hundred feet high scarcely make themselves discernible. Far off to the northward, a distance of twenty miles, the outlines of the stately Ghost mountains along the north boundary of Harker township may be readily seen, coloured a soft, hazy blue, and wonderfully silhouetted against the sky.

Away to the southeast, some 12 miles, rises one of the most remarkable mountains of central Canada, Mount Chaminis, with an elevation of about 1,525 feet above the sea.[1] Its striking profile, as viewed from the Workman hills, has an outline exactly like a haystack and, indeed, it is sometimes known by that name. It is in the province of Quebec immediately east of the boundary line between Ontario and Quebec, near the 40-mile post, and about three miles east of the northeast arm of Larder lake. The mountain was first described by W. G. Miller who saw it in 1901. Miller's description is as follows[2]:

> This mountain lies immediately to the east of the inter-provincial boundary and is the most striking feature in the topography of the district. During our work last summer [1901] we saw it for a distance of some miles from the east, south and west. It lies at the height of land and has the appearance, from whatever direction it is viewed, of a gigantic haystack, its well-rounded form standing up clear and distinct above surrounding hills. The spelling of the name is taken from a map made for me by an intelligent Indian who hunts in the district. This region has never been mapped, and I have seen no reference to the mountain in any publication.

The present accepted spelling of this mountain, namely, Chaminis, was adopted by the Geographic Board of Canada. The spelling originally given by W. G. Miller,[3] at the suggestion of an intelligent Indian, was Chanmanis. The late Aubrey White, Deputy Minister of Lands and Forests, who was familiar with the Chippewayan language, suggested that the true name of this elevation may be Kitchi-miniss, meaning "big island," from *Kitchi,* great or big, and *miniss,* an island, the hill rising to the eye from all sides as an island does from a lake.[4]

It may be added that the mountain has since been described by W. A. Parks, N. L. Bowen, and M. E. Wilson.

### Ben Nevis and Tannahill Townships

Ben Nevis township, which lies immediately north of Katrine, has a rugged range of mountains at the south end and also at the north end. The former constitute, in a general way, the height of land between Hudson bay and the St. Lawrence valley. The central parts are low, rolling country underlain by clay or boulder clay which is often wet and swampy. The mountains at the south end of the township have been named the Pushkin mountains, and they rise some 500 feet above Verna lake. The east face of this range, near Pushkin lake, is precipitous. At the north end of the township the prominent peak has been named Mount Lawson, from the top of which a bird's eye view of the township to the north, Tannahill, may be obtained.

Tannahill township consists almost wholly of low, rolling and partly swampy country, except for some hills at the south end. It has a lake, Webster, which

[1] Estimated by W. R. Rogers, topographer for Ontario Bureau of Mines.
[2] Ont. Bur. Mines, Vol. 11, 1902, pp. 218-219, W. G. Miller.
[3] Ibid., p. 218.
[4] Ibid., footnote, p. 219.

is about a mile and three-quarters long, occupying the southern part, while the Abnageezy river flows through parts of the northern end of the township.

### Clifford and Arnold Townships

The two remaining townships, Clifford and Arnold, occupy the western part of the area, and may be described together since they are somewhat similar. While there are some rocky hills in these townships, the country is, nevertheless, for the most part low and rolling, and is characterized by great sand plains on which a most beautiful growth of jack pine thrives. Travelling through these sandy jack pine areas is very easy, but from the prospector's point of view they are of little interest since the rocks are almost wholly covered. Only here and there do small outcrops of rock occur. In the central parts of Arnold township, to the west of Howard lake, there are some remarkable sand hills[1] the origin and nature of which the geological party did not have an opportunity to investi-

*Photo by W. R. Rogers.*

Columbus lake, looking west.

gate. These were mapped by the topographic party and are shown on the geological map. Clifford and Arnold townships, while they are characterized by sand plains, have, nevertheless, many swamps which make cross-country trips slow and tedious in many places.

### Canoe Routes

There are two canoe routes crossing the area. The most important one is part of the old and well known route leading north from Lake Timiskaming by way of the Blanche river, crossing the height of land between the St. Lawrence valley and Hudson Bay in Ben Nevis township, and thence down a series of lakes, streams and rivers to Lake Abitibi in the province of Quebec. That part

[1] These sand hills were noted by W. G. Miller in 1901. In his report on the area Dr. Miller remarks: "Northwest of the northern end of the lake high sand hills are seen, and a sand plain stretches for some miles west of this part of the lake, the plain being broken here and there by rocky ridges." Ont. Bur. Mines, Vol. XI, 1901, p. 222.

of this route which crosses the Ben Nevis area is reached by way of the Argonaut gold mine (formerly known as La Mine d'Or Huronia) at the northeast corner of Gauthier township, where canoes may be put into Beaverhouse lake and the south part of Ben Nevis area entered in less than an hour's paddle by canoe.

There are in all 13 portages in that part of the route which crosses the Ben Nevis area. Two of these are long, namely, the one running northeast of Marten lake which is two miles long, and the one running northeast of Webster lake to the Abnageezy river which is two and a half miles long. The other portages on the route are not more than half a mile long—most of them not more than a few chains.

### Beaverhouse Lake to the Abnageezy River

The main route is described in detail in following paragraphs:

Beginning at Beaverhouse lake, at the southwest part of Katrine township, it may be pointed out that there is no portage leading into Misema lake, but a narrow passage a few yards wide connects the two lakes. This passage may be rather puzzling to find for those who have not previously travelled the route. Misema lake is in the southwest corner of Katrine township, and is an attractive sheet of water surrounded by comparatively high hills, particularly around the south arm. The lake is followed for about a mile and a half, entering Howard lake at a narrows at the west side of Katrine township. Howard lake is some five miles long and very narrow, its width being not much more than half a mile at any place. It contains a few islands, and is surrounded by prominent hills; its shores have numerous rock exposures. There is a portage of two chains from Howard to Kennedy lake, a creek connecting the lakes with a waterfall of a few feet. Kennedy lake is less than a mile and a half in length.

From the north end of Kennedy lake a sinuous creek, lined with alder bushes, is ascended for about a mile as the crow flies, although, owing to its winding course, the distance to be canoed is much greater. A portage of one chain is encountered towards the north end of the creek. From this winding creek the route leads to a small lake or pond known as Petite lake, at the north end of which is a three-chain portage into Anrev lake, a sheet of water about a quarter of a mile long. At the east end of Anrev lake there is a sandy portage 15 chains long leading to Verna lake. The latter is a beautiful body of water, about a mile and three-quarters long, nestling among the mountains which in this part of the country constitute, in a general way, the height of land between the St. Lawrence valley and Hudson bay. At the northwest corner of the lake there are two Indian log cabins, and nearby a portage 40 chains long which crosses the height of land just referred to. The portage follows swamp practically the whole distance, although here and there low domes of rock rise out of the swamp. It may be said that at this portage the height of land is in swamp or muskeg. The portage leads to a tiny creek which may be canoed down stream four or five chains to a pond about 12 chains long. Another creek flows northerly, out of the north end of the pond, a few chains into Keith lake. The latter is over a mile and a half long, and is one of the most attractive lakes in the Ben Nevis area. Its shores, except at the south end, are rocky and picturesque, while to the west two bold and rugged hills are prominent features of the landscape. A sinuous creek flows northwestward out of Keith lake for about a quarter of a mile into Marten lake, a sheet of water about a mile long. On the northeast shore of Marten lake, about half-way up, there is a portage two miles long, running northeastward. This portage is, on the whole, level and in many places swampy, and, as a consequence, very wet in rainy weather. At the southwest end, where it leaves Marten lake, there is a more or less gentle rise for about half a mile. The only rock noted along the portage is about half a mile northeast of Marten lake, 25 feet north of the trail. This exposure is a basalt or other closely related lava. A mile northeast of Marten lake a small creek crosses the portage. Here there is a level sand plain about 10 chains long.

Webster lake, Tannahill township.

The northeast end of the portage terminates at a small stream, a branch of the Abnageezy, which is ascended for about half a mile to a 20-chain portage on the north side of the stream. This portage, which is for the most part dry and runs over a hill, is made necessary on account of rapids which occur in the stream. Above the rapids the creek becomes wider and sluggish, and supports a luxuriant growth of lily pads. The banks are low and lined with alder bushes. This creek is ascended to Pmaws lake, a swampy sheet of water lined with marsh grass and encircled with spruce swamp. The flat aspect of the country around the lake is relieved by a solitary cliff of rock on the south shore. From Pmaws lake the canoe route follows a sinuous creek into Webster lake, the shores of which, save for four low, rocky points on the south side, are flat and swamp-lined and the edges of the water are rimmed with marsh grass. Most of the lake is weedy, and the whole aspect of this sheet of water is not attractive. One is given a more pleasant sensation, when, on looking southward, he sees the rugged hills in Ben Nevis township, of which Mount Lawson rises some 500 feet above the lake.

The portage from Webster lake northeastward to the Abnageezy river is two and a half miles long. It begins about 10 chains up a small creek at the east end of the lake. On reaching the Abnageezy, by way of the portage, the canoe route follows this river. Five short portages are encountered on the way downstream, one in Tannahill township and four in Dokis township. These portages are old, not much travelled and not very well marked. They are described in the following paragraph by G. A. L. Gibson, who surveyed them in the summer of 1919.

The first portage occurs about twenty-five chains below the Webster lake portage, on the left going down stream, and may be easily missed. It is just a "lift" up the clay bank and down the other side, and cuts out a long bend in the river. There is a log jam in this bend of the river which necessitates two short portages on the right side. Of course if the first portage across the clay bank is taken, then the portages past the log jam in the bend of the river will not be met with; the log jam portages are not included in the five portages referred to. The second portage is two miles from the Dokis-Tannahill township line, and is caused by a short rapid with a fall of four feet, where the river widens to three or four chains. This portage is two chains long, and is on the right side of the river. The third portage is twenty-five chains farther down stream. It cuts across a point to avoid log jams, and is six chains long. The fourth portage is some two and a half miles below the previously mentioned one, and is four chains long. It is on the left, and goes over a rock twenty feet high to avoid a rapid with a fall of six feet. The fifth and last portage is the longest, some eight chains around the shores of a rapid. It is on the left side, going down stream, about a mile from the fourth portage, and about one and a half miles from the Quebec boundary.

Shortly after leaving Ontario and entering Quebec the Magusi river is reached, down which a distance of some 10 miles Duparquet lake is met with in the province of Quebec, and beyond the confines of the Ben Nevis map area. There are no portages between the Quebec boundary and Duparquet lake.

In the preceding paragraphs the main canoe route in the area has been described in some detail. It may be added that in very high water during early spring we were informed by an Indian that, in place of going by way of Webster lake, across the two long portages, it is possible to take a route which leads out of the northwest end of Marten lake, in the township of Clifford. At this end of Marten lake there is an Indian log cabin, a few chains to the west of which there is a 15-chain portage, partly over rocky ground, into Rat lake, a pond of water a quarter of a mile long. The west branch of the Abnageezy river flows northward out of Rat lake, and is canoeable northwardly for a mile and a half, a little beyond the north boundary of Clifford township. North of this to about the south boundary of Holloway township the Abnageezy is said to be navigable only in extremely high water in early spring. It is, however, navigable in Holloway township, the northeast part of Tannahill township, and in Dokis township.

### Misema Lake to Labyrinth Lake

The second canoe route in the Ben Nevis area is in the south part of Katrine and Ossian townships. It runs in an east and west direction and leaves the main canoe route, already described, at the east end of Misema lake in the southwest corner of Katrine township. From Misema lake a sluggish stream is followed eastward about three-quarters of a mile into Kinabik lake, a body of water about 50 chains in diameter. The portage from this lake is 13 chains long and is at the southeast corner of the lake. The portage leads to a small, sinuous creek, 40 feet above the lake. The creek is followed upstream for about half a mile, disclosing low, rocky hills covered with small jack pine, to a 3-chain portage. A feldspar-porphyry dike, striking east and west, is found on the portage. This dike is cut by a fresh-looking dike of diabase. From here, during seasons of

Wood and iron posts at 48 miles and 12 chains on the interprovincial boundary line between Ontario and Quebec. These posts are at the north end of Labyrinth lake. The Province of Ontario is on the left-hand side of the photograph.

high water, the creek may be ascended for about three miles to a small pond on the east boundary of Katrine township, near the southeast corner of the township. When the water is high there is only one portage, over a low dam which was built to raise the water in the upper part of the creek and make canoeing less difficult. The dam is found about two-thirds of the distance upstream. The stream is very sinuous and winding, and the water in places is sluggish and supports many lily pads. During dry seasons the stream is too low to allow canoes to go beyond the dam, and it is therefore necessary to use the portage which begins at the dam and follows low hills or open beaver meadows to the pond at the east end of Katrine township, a distance of more than a mile.

At the north end of this pond there are some claims with gold-bearing quartz veins, which the Nipissing Mining company of Cobalt had under option in the summer and autumn of 1919.

At the east end of the pond the portage into Wawagoshe lake begins. It is 35 chains long and crosses the height of land between the St. Lawrence valley and Hudson bay. The height of land at this particular point is only a few feet above Wawagoshe lake. The latter is less than a mile and a half long and contains half a dozen islands. In the summer of 1919 small mouth bass were abundant in this lake. The portage leading easterly out of Wawagoshe lake is at the northeast corner and is 65 chains long. The western two-thirds of the portage are over dry ground; the remaining part is low and swampy. The portage ends at a small creek, 10 or 15 feet wide, which is extremely sinuous, and passes through a low swampy country supporting a magnificent growth of spruce trees. There are a few places blocked with logs. The creek flows into Waterhen lake, a body of water less than half a mile wide and surrounded by flat country with very fine spruce. The distance between Waterhen lake and the east end of the portage last mentioned is little more than three-quarters of a mile, but it winds and bends so much that the distance to be paddled is probably more than two miles. The creek flowing out of Waterhen lake is not so sinuous and is 50 to 75 feet wide. It passes through flat swampy country supporting the usual growth of spruce trees.

Labyrinth lake is on the boundary between the provinces of Ontario and Quebec. The canoe route now leaves Ontario and enters Quebec. This report does not deal with the latter province, but it may be noted that the route leaves the north end of Labyrinth lake, and, following a series of rivers and lakes northward, Lake Abitibi is easily reached, there being few portages, and these being short. The "Kewagama" map, by M. E. Wilson, shows this route, together with the geology.[1]

## Geology

The entire area included within the Ben Nevis map is made up almost wholly of fine-grained lavas consisting of basalts or andesites, and to a less extent of rhyolites or other closely related volcanic rocks. These lavas are believed to be Keewatin in age. All of them are massive and are rarely altered to schists, except in a few isolated areas. This non-schistose condition of the Keewatin lava flows is evidently due to the absence of large intrusions of granite, syenite, or porphyry. Only in the southeast part of Katrine township is there an intrusion of rock of any volume, and this mass of syenite is but two miles long and less

[1] Memoir No. 39, Geol. Sur. Can., 1914, by M. E. Wilson, accompanied by Kewagama map, No. 93A.

than half a mile wide. There is also, in the northwest corner of Pontiac township, an intrusion of syenite apparently about half a mile long and a quarter of a mile wide; this intrusion may be somewhat larger since the party did not have sufficient time to work out its actual dimensions. Elsewhere throughout the area there are small dikes or other masses of feldspar-porphyry, quartz-porphyry, felsite and other rocks.

The rocks may be grouped according to the following table:

Pre-Cambrian.

| | |
|---|---|
| KEWEENAWAN | Diabase. |
| ALGOMAN (?) | Syenite, feldspar-porphyry, quartz-porphyry, lamprophyre. |
| PRE-ALGOMAN (?) | Serpentine. |
| KEEWATIN | Basalt, andesite, rhyolite, grey lavas, pillow lava, amygdaloids, volcanic fragmental rocks, rusty weathering ankerite rocks. |

### Keewatin Series

It was hoped that it would be possible to work out a continuation of the remarkable series of lava flows, presumably of Keewatin age, which was discovered in the summer of 1918, by the staff of the Ontario Bureau of Mines, in Holloway township.[1]

The latter township lies immediately to the north of the Ben Nevis area. While there are in the Ben Nevis locality many outcrops of lavas and volcanic fragmental rocks, nevertheless no place was found in which separate flows could be distinguished. This was probably due in part to the drift which largely covered the rocks, and also in part to the almost complete absence of fires, which burn the moss and vegetation entirely off the rock surfaces and thus expose the structures. Even where the rocks were not covered by drift, a thin film of moss or lichen would often obscure the structure. It is possible that should a forest fire sweep across the country a series of flows will be worked out similar to, and which will probably be part of, the remarkable flows in Holloway township. In the latter township it was shown, in the summer of 1918, that there are at least 14 lava flows having a combined thickness of 4,400 feet. How many more flows may exist in Holloway and adjacent townships is not known, but it is likely that the combined thickness is of enormous magnitude.

Without going into unnecessary details of petrographic description, it may be said that the Keewatin is made up for the most part of fine-grained basalts or andesites, often with pillow structure, together with more acid lavas consisting of rhyolite or closely associated types. Our work was too general to allow of detailed examinations; it may be said, however, that the rocks are similar to the Keewatin series described elsewhere in northern Ontario and Quebec by W. G. Miller, A. G. Burrows, P. E. Hopkins, W. H. Collins, M. E. Wilson, T. L. Tanton and others.

[1] Ont. Bur. Mines, Vol. 28, Part 2, 1919, pp. 9-17: C. W. Knight, A. G. Burrows, P. E. Hopkins, A. L. Parsons.

The term "grey lava," as explained elsewhere in this report, refers to those grey-coloured, fine-grained laves which may have an intermediate composition between rhyolites, on the one hand, and basalts, on the other. Some of these grey lavas, however, may be as acid as rhyolites. They are frequently met with in Ben Nevis area, their location being shown on the map.

The pillow lavas are of common occurrence in many parts of the area, and they are particularly well developed and exposed along the rocky shores of Howard lake.

The ankerite rocks may be seen at the southeast corner of Katrine township on claim H. S. 238, on the southwest face of the low hill immediately north of the small pond. Auriferous quartz veins occur on this hill. The ankerite occurs disseminated through the rock, and also in veinlets cutting the rock. The ankerite zone on this hill has a width of at least 50 feet. The origin of the material is not definitely known. M. E. Wilson, from a study of similar rocks in adjacent areas in the province of Quebec, comes to the conclusion that the ankerite, or ferruginous dolomite was probably deposited from solutions, the ankerite replacing the rocks.[1]

Amygdaloids are commonly found throughout the area, the acid, basic and intermediate lavas all showing this texture at times.

One of the most striking varieties of rocks encountered is the volcanic fragmental type which occurs here and there among the lavas. It is exposed on the portage across the height of land north of Verna lake, also north of Kinabik lake, and elsewhere, as shown on the map. These rocks are made up of angular, fine-grained, slag-like fragments of the same kind of lava as that with which they are associated. The fragments were probably formed during the time that the lava was flowing across the country. The flow would partly consolidate on the surface, and this partly consolidated crust no doubt would become brecciated and broken up as the lava continued to flow onwards. In Holloway township, north of Ben Nevis area, this fragmental material was found to occur on the surface of the lava flows, of which 14 were discovered. In Ben Nevis area, however, individual flows were not worked out, and consequently it was not possible to ascertain at what horizon the fragmental rocks occurred in any particular flow.

### Structure of the Keewatin

The Keewatin rocks in Ben Nevis area constitute, it is believed, a tremendously thick series of lava flows, similar to the flows in Holloway and Harker townships, immediately north of the area. The rocks have all the characteristics of lavas, such as amygdaloidal textures, pillow structures, fine-grained and slag-like textures, flow textures, and so forth. Possibly more detailed work will some day disclose the presence of the various flows, thereby working out the structure. The absence of any great masses of granitic or other intrusions makes the possibility of the working out of the structure more hopeful than it would be if the lavas were intruded by great masses of granite or other rocks.

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[1] Can. Geol. Sur. Memoir No. 39, pp. 65-70; also Memoir No. 103, pp. 124-127.

### Pre-Algoman (?)

At the west side of Tannahill township there is an area of serpentine, the size of which was not worked out. Judging from other similar masses elsewhere in northeastern Ontario the rock may be of Algoman age. A thin section, examined under the microscope, shows it to consist mainly of serpentine, together with subordinate quantities of hornblende and plagioclase.

### Algoman (?)

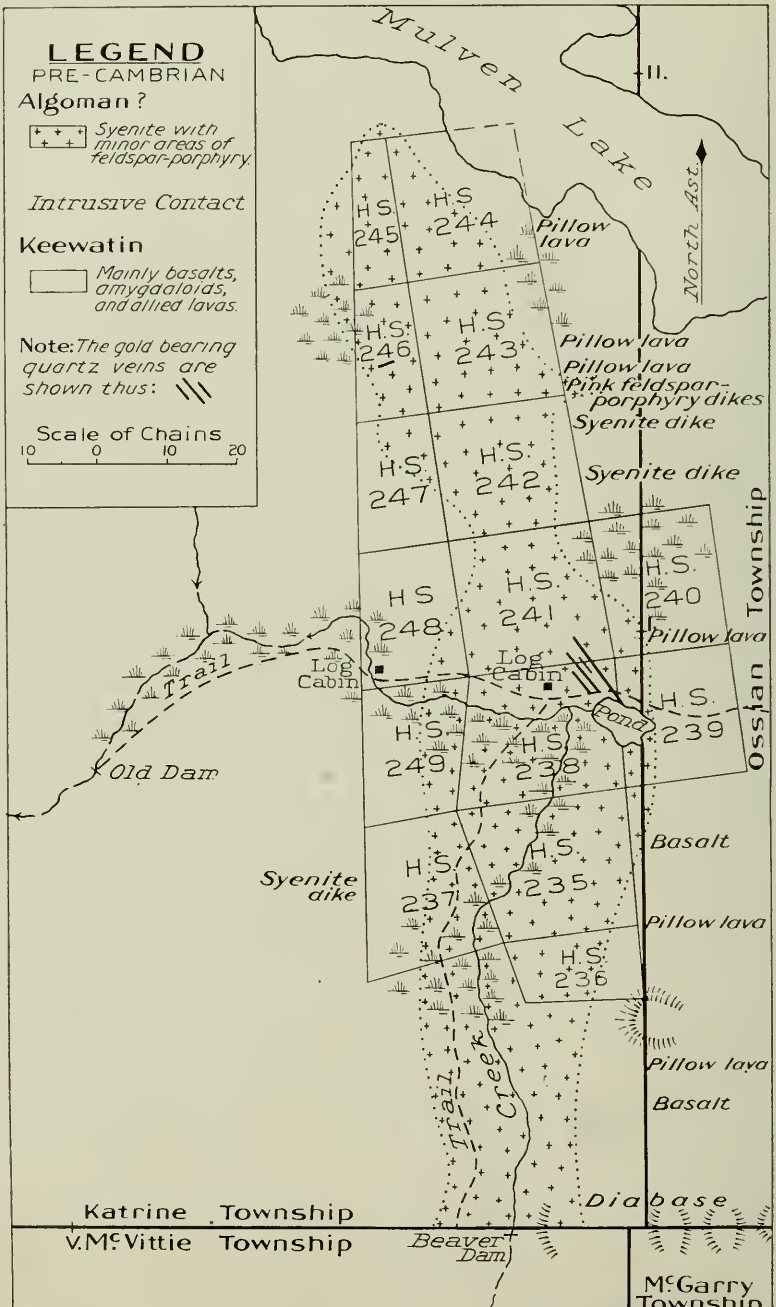
There are two intrusions of syenite in the Ben Nevis area which are classed as probably Algoman in age. The larger occurs at the southwest corner of Katrine township; it is about two miles long and half a mile wide. The rock is for the most part medium in grain, although it varies considerably in this respect. The northern part is, on the whole, finer in grain than the southern. Parts of the mass are fine-grained. At times the rock becomes quite basic, due to an increase in the pyroxene or hornblende. At about 15 chains north of number three post on claim H.S. 245 the fine-grained syenite or felsite becomes very basic, and contains inclusions of rocks having fine to coarse-grained textures and varying much as to composition and character. One angular fragment, eight inches long, of very coarse diabase was noted. At the northeast corner of H.S. 242 dikes of coarse, pink feldspar-porphyry cut Keewatin pillow lava. The syenite is also cut here and there by small dikes of feldspar-porphyry.

A thin section, examined under the microscope, of the syenite, described in the preceding paragraph, from the southwest corner of H.S. 238, shows the rock to be a hornblende-syenite, medium in grain. One grain of pyroxene was noted. The feldspar, while fairly fresh, is somewhat cloudy due to the presence of kaolinite. The feldspar is in part an acid variety of plagioclase; some of it, however, is not banded and is probably orthoclase. Zonary banding occurs in some of the feldspars. A little quartz was noted. Another thin section of the syenite at the northeast corner of H.S. 238 shows the rock to be a mica-syenite.

The other intrusion of syenite, at the northwest corner of Pontiac, is a coarse- to medium-grained rock containing pink or grey feldspar. At certain points the rock becomes basic looking—almost as basic as a gabbro or diorite. Near the edges it is fine-grained. The geological party did not have time to determine the exact outlines of this syenite. It may possibly be larger than shown on the map. There appears to have been little prospecting around this intrusion. It would seem that prospecting in the vicinity of such intrusive rocks might result in the discovery of economic deposits of gold.

A thin section of this syenite was examined under the microscope. It proved to be a quartz-syenite. Some of the quartz is in micrographic intergrowth with the feldspar. The feldspar is badly decomposed and is cloudy. Epidote and chlorite are found, apparently as secondary minerals after some coloured constituent. A little biotite is present. Judging from the character of this thin section it may be that part of the rock is a micropegmatite.

Examples of lamprophyre, in dikes or small intrusions, were found on the south end of Wawagoshe lake, and at the east end of Mulven lake on the portage. Thin sections from these two places were examined and found to be hornblende-




Map showing area of syenite and feldspar-porphyry and location of gold veins in the southeast corner of Katrine township, Ben Nevis area.

lamprophyre. The specimen from Mulven lake contains some secondary calcite. These lamprophyres are somewhat similar to the lamprophyre at the Argonaut gold mine, in Gauthier township, immediately north of Beaverhouse and Ava lakes.

There are numerous dikes of quartz-porphyry and feldspar-porphyry cutting the Keewatin throughout the area. The location of some of these dikes is shown on the map. They are also supposed to be Algoman in age.

### Keweenawan

Dikes of fresh diabase, probably of Keweenawan age, cut the Keewatin and also the feldspar-porphyry dikes. These diabase dikes are probably the youngest rocks in the area. One of them occurs on the second portage half a mile southeast of Kinabik lake, where it is found intersecting a feldspar-porphyry dike. An outcrop of fresh-looking diabase also occurs on the south shore of Verna lake. These diabase intrusions resemble the diabase dikes which cut the Nipissing diabase at Cobalt and elsewhere.

### Pleistocene

Most of the Ben Nevis area is covered with deposits of boulder clay, bedded clay, sand, and gravel. The sand plains and hills in Arnold and Clifford townships are worthy of note.

There has been little detailed work done on the Pleistocene deposits of Northern Ontario. When the geological history of the Glacial period in Northern Ontario is written it will make an interesting chapter in science.

## Description of Gold-bearing Quartz Veins

Although, on the whole, the rocks in the Ben Nevis area are little disturbed or altered to schists, it may be pointed out that this condition need not discourage prospectors in their search for gold-bearing quartz veins. It is true, of course, that in the nearby Porcupine and Kirkland lake gold fields the rocks are, indeed, highly disturbed. Those prospectors, however, who are familiar with the Croesus gold mine in Munro township, about 20 miles to the northwest of the Ben Nevis area, will recall that the Keewatin lavas, in which gold veins occur there, are not greatly disturbed.[1] It is possible that similar conditions to those occurring at the Croesus may exist in the Ben Nevis area.

The only part in which active operations were being carried on in the summer of 1919 was at the southeast corner of Katrine township, on claims which were originally staked during the Larder lake boom, and which were restaked[2] in 1919. The Nipissing Mining Company of Cobalt had certain of these claims under option in 1919, although the option was not finally exercised. The claims are in an area of Keewatin which is intruded by a mass of syenite about two miles long and less than half a mile wide. The veins of quartz occur in the syenite at the east side of the intrusion near the Keewatin rocks.

[1] Ont. Bur. Mines, Vol. 24, 1915, Part I, p. 172, P. E. Hopkins.

[2] The lines of the restaked claims do not, unfortunately, follow the lines of the old claims which were surveyed by an Ontario land surveyor. The map on page 22 shows the old claim lines, no actual survey having as yet been made of the new claims.

The claims on which the Nipissing was doing most work were: H.S. 238, H.S. 239, H.S. 240, H.S. 241. During the time that the geological examination was being made the Nipissing Mining Company had a gang of eight or ten men at work in trenching and sampling and doing some blasting. A log cabin and three tents were on the property and the work was in charge of George Tucker.

The veins on which most of the work was being done occur on a hill which rises some 35 feet above a shallow, weedy pond about an eighth of a mile in diameter. The rocks on the southwest face of this hill are impregnated with ankerite, or other iron-bearing carbonate, which has caused them to become rusty.

There are four main veins on this hill, striking about north 25° west magnetic, and dipping about vertically. These veins vary in width from a few inches to 4 or

Camp on Tucker claims, Katrine township.

5 feet or more. One of them has been traced at least 400 feet, and is probably longer.

The veins consist mainly of quartz, and contain also iron pyrites, copper pyrites, specularite, galena, and at times considerable ankerite or other similar carbonate. Fragments of pink syenitic-looking rock commonly occur in the vein.

The Bureau of Mines party did not sample these veins, but the results of the sampling operations by the Nipissing Mining Company were kindly made known. It was stated that the highest values in gold were obtained from a small vein on the face of the hill, known as No. 1 vein. Some shots had been put in this vein at a certain point, exposing 16 inches of vein material. This 16 inches consisted of 4 inches of quartz in the centre, the remainder consisting of red, fine-grained syenitic material, impregnating greenish-grey rock matter. The west side of the vein material showed stringers of quartz, one-half to two inches wide. This vein occurs in a fine-grained, dark grey rock containing plates of brown mica about a quarter of an inch long. A thin section of the grey rock, examined under the microscope, showed it to be a mica-syenite.

A sample of the vein was taken across a width of a foot from a point at which some shots had been put in. This sample was said to contain thirty-six dollars of gold per ton. The rusty, weathered vein on the surface was said to carry higher values than this.

Many samples were taken from this and other veins, on the property, including the four veins on the hill referred to, and it was stated that, while the distribution of the higher values in gold was erratic and disappointing, there were no assays made which showed the absence of gold, values of one dollar, two dollars, or three dollars of gold per ton being obtained. The galena was found to carry a few ounces of silver per ton. No free gold was seen in any of the veins, but gold could be obtained on panning.

The Bureau's party took one grab sample from a part of vein No. 1 which was highly impregnated with iron pyrites. This sample was found by W. K. McNeill, Provincial Assayer for Ontario, to contain $35.20 in gold per ton of ore.

The origin of the veins described above is probably connected with the intrusion of syenite in which they occur. After the syenite had consolidated, or almost consolidated, fissures were formed in it, and dikes of pink or red feldspathic material were injected. Later on these dikes were fractured and opened up and quartz was deposited, forming the quartz veins. These veins often hold numerous fragments of the pink, feldspathic material.

In addition to the claims described in preceding paragraphs there are other claims in the immediate vicinity on which prospecting and assessment work was being done.

## Distribution of Other Quartz Veins

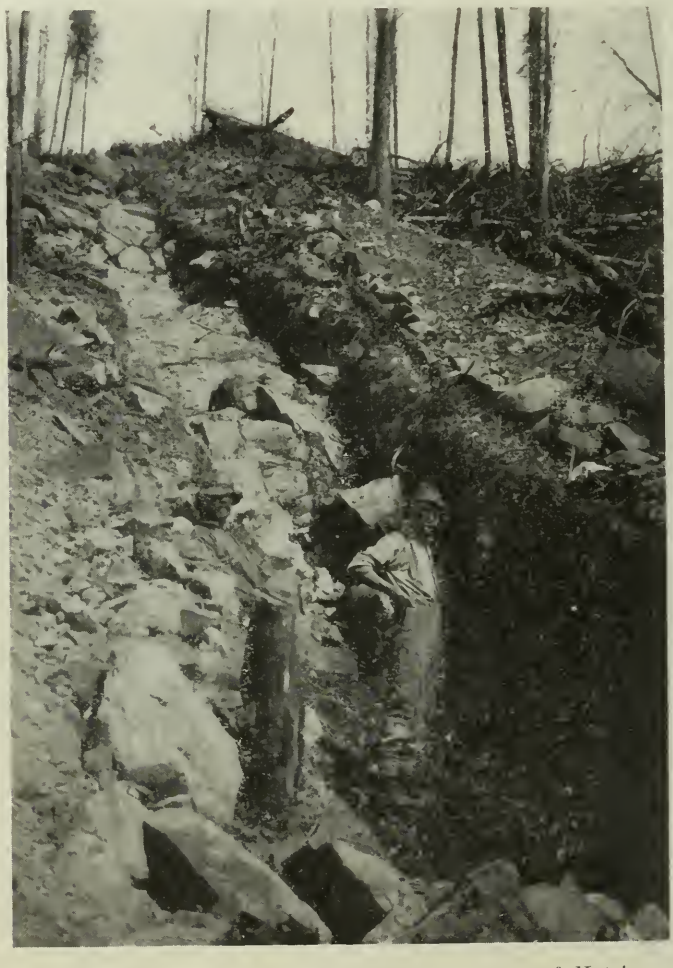
Although no gold-bearing quartz veins have as yet been discovered which have shown to be rich enough to pay, nevertheless it is of interest to note that there are a relatively large number of veins in the area. Those best known occur at the southeast corner of Katrine township and have been described in preceding pages.

In Pontiac township there is a quartz vein about a mile and a half north of Sunrise lake. It occurs near the top of a prominent hill, and its location is shown on the map. The vein is resting almost horizontally, is about 150 feet long, some 12 or 15 inches wide, and is not mineralized with iron pyrites or other sulphides.

Members of the geological party found a quartz vein in the northeast corner of Ossian township while cutting the trail, which begins at the north end of Labyrinth lake. The vein is found running across the trail at a distance of about three-quarters of a mile northwest of Labyrinth lake, its position being shown on the map. Like the vein described in the preceding paragraph, this one lies in a nearly horizontal position, say at 10° or 15° from the horizontal. It strikes northeastward and is about a foot wide. It contains little or no sulphides. Other quartz veins occur in Ossian township, about a mile north of Waterhen lake, and on the south shore of Wawagoshe lake.

Besides the veins already described at the southeast corner of Katrine township, there are others known to occur in this township. One of these is found about two miles northeast of Kinabik lake. It is about 5 inches wide and strikes northwestward with nearly vertical dip. Another vein occurs about the same distance north of Kinabik, just south of the stream. The location of both these veins is shown on the map. There is also a quartz vein a short distance north of the north arm of Howard lake on the township line.

In Ben Nevis township there are small quartz veins near the southwest corner, also about a mile and a quarter south of the northwest corner on the township line, and about a mile and a half southwest of the northeast corner of the township.



Trenching on claim H.S. 238, at southeast corner of Katrine township.

There is a quartz vein several inches wide near the east end of the 20-chain portage at the northwest corner of Ben Nevis township, on the east branch of the Abnageezy river. It is about six feet long and lies about 25 yards north of the portage, and occurs in a greyish-green amygdaloid on a low hill.

In Arnold township there are many small quartz veins, particularly along the shore of Howard lake. Others are found in the western part of the township about a mile northward from the north arm of Victoria lake; the location of these veins is shown on the map. They occur on small, low knolls of rock rising out of the sand plains. At the northeast corner of Arnold township immediately west of Cor lake there are numerous quartz stringers exposed on a bare hill. The rock is a grey schist striking eastward and dipping to the south at an angle of 70°.

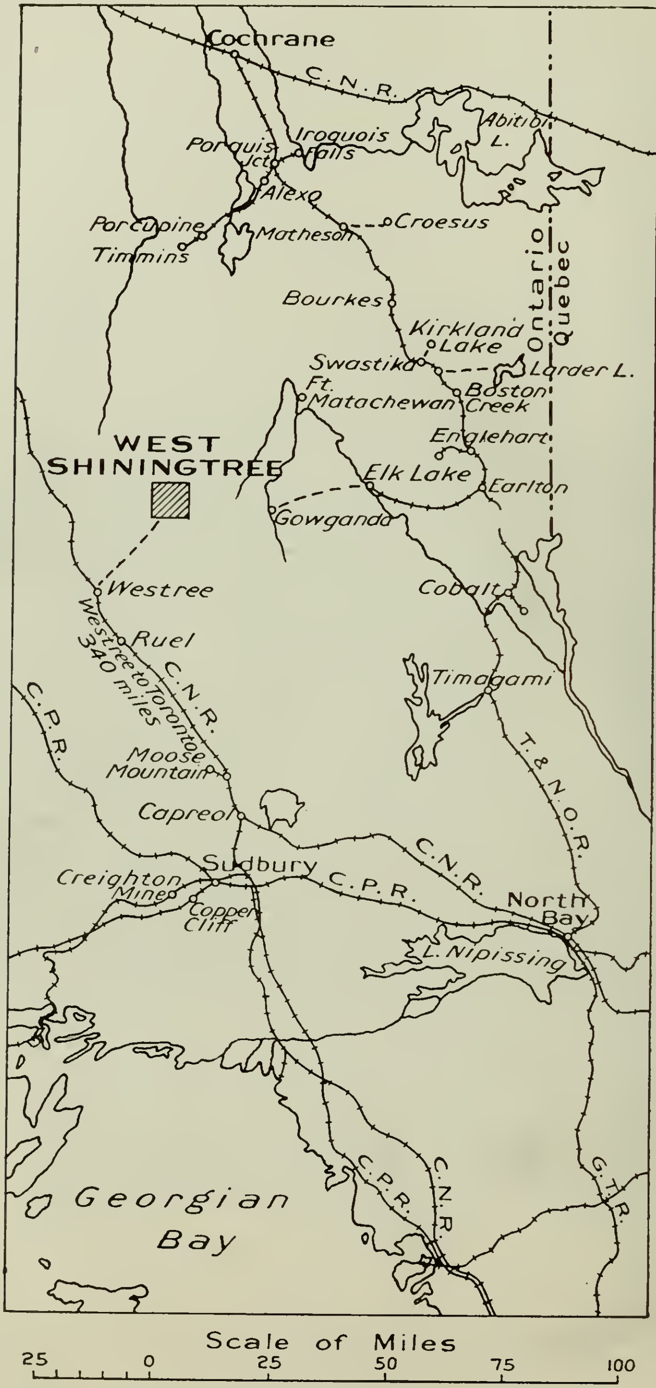
## Character of Quartz Veins

Some of the gold-bearing quartz veins in the area occupy fissures, showing crushings several hundred feet long and up to several feet wide, as for example, the veins at the southeast corner of Katrine township on H.S. 241 and H.S. 238, which were under option to the Nipissing Mining Company in the summer of 1919.

Geological and topographical survey party in camp on Misema lake.

Another type of quartz vein appears to occupy joint planes in the rocks. An example of this variety may be seen on Wawagoshe lake near the southeast bay on the shore. The vein is six inches wide and strikes northeast with a vertical dip: a shot has been put in by prospectors.

A third type of vein in the Ben Nevis area appears to occupy torsion cracks. These veins are short, and do not seem to have economic possibilities unless they are found in great number and close together. They are usually not longer than six feet and from one to four or five inches wide. None of them were found to contain appreciable quantities of iron pyrites or other sulphides. Examples of the torsion crack type of quartz vein may be seen along the shores at the south end of Howard lake in Arnold township.




Key map of part of Ontario showing West Shiningtree as related to other mineral areas of northern Ontario. The broken lines represent wagon roads.

# WEST SHININGTREE GOLD AREA

By

Percy E. Hopkins

## Introduction

A preliminary examination of the geological and economic features of the West Shiningtree Gold Area was made by the writer during four weeks in September, 1919. Unfortunately, during that short period the weather was very wet: nevertheless, practically all the known gold deposits were visited. Accompanying the report is a coloured geological map on a scale of 40 chains, or one-half mile, to the inch, which may be of value to those who may prospect or visit the area or engage in development work. This map is produced largely from map No. 153A, accompanying Memoir No. 95, by W. H. Collins of the Geological Survey of Canada, and also from R. B. Stewart's map in the Twenty-second Report of the Ontario Bureau of Mines.[1] A few changes in the geology were made, and some additional mapping was done in the vicinity of recent discoveries. The forest fire in July, 1919, laid bare much rock which had hitherto been covered, thus facilitating the work. Acknowledgments are due K. B. Heisey, student in mining from the University of Toronto, for his able assistance, and to the mining men and prospectors of the area for their kind hospitality and the information they supplied.

## Summary of Economic Possibilities

Since the first discovery of gold in 1911, when the railway was sixty miles distant, numerous other finds have been made in parts of four townships. The railway now passes within twenty miles of West Shiningtree lake, and is connected by a wagon road with most of the properties. Freighting in summer is still quite expensive. Not only the poor transportation facilities, but also conditions during the war period, have retarded mining development; hence very little underground exploration has been done.

Gold occurs in numerous deposits, some of which are quite large, but in many of them the precious metal is not concentrated sufficiently to pay for working, while in others it is irregularly distributed. A few small pockets of high grade ore have been found on half a dozen properties, but this does not necessarily signify that these will make mines, since the other portions of the veins may contain little or no gold. According to the manager's reports on the Herrick, ore shoots of considerable size are indicated by surface sampling, by sinking and sampling a 50-foot shaft, and by diamond drilling. The Ribble vein, which outcrops on the Wasapika, has also been exposed on the Miller-Adair claim, and is traceable for about one-quarter of a mile on the Foisey, being in all over a mile long and of a satisfactory width. The manager, Geo. R. Rogers, reports that the outcrop of this vein on the Wasapika shows 800 feet of $9.00 ore

[1] Mr. Stewart's examination of the area was commenced in the autumn of 1911, immediately after the discovery of gold, and completed in 1912; Mr. Collins' report and map were based on field work during the same years.

across four feet, while in addition a cross-cut on the 100-foot level showed 23 feet of schist and quartz, assaying $7.20 in gold per ton. One-half mile south of the Wasapika, on the Miller-Adair, there are also indications of ore in the Ribble vein on the surface; and further south still, on the Foisey, the vein is large, and carries visible gold. Shoots of ore may occur in various places along the Ribble vein, but it will not necessarily all be ore.

A few properties in the area have promise, but they are still in the prospect stage. Whether they will become mines or not will only be determined by further developing the veins underground and sampling the same.

It may be said that during the geological examination of a deposit such as one of iron or copper, it is often possible to form some idea regarding its value; but in the case of gold deposits it is usually more difficult to do so, systematic sampling being required. It is not the practice of the Bureau of Mines to undertake systematic sampling of gold or other deposits, this being naturally the function of the technical or professional men employed by the property owners.

### Location

The townships[1] of Asquith, Churchill, Fawcett and MacMurchy, near the western side of the Timagami Forest Reserve, are known collectively as the West Shiningtree gold area. Other townships might be included, since somewhat similar geology extends sixty miles north to Porcupine. West Shiningtree lake, near which gold was first discovered, and from which the area received its name, lies near the west central part of the area. It is reached from Westree, a station on the Canadian National[2] railway, 80 miles north-west of Sudbury, and 340 miles by rail north of Toronto. A 20-mile wagon road connects Westree with West Shiningtree lake, over which stage and freight teams operate. Trails and corduroy roads extend as far as five miles beyond West Shiningtree lake to the various prospects. There are also water routes with portages necessitating a day's trip from either Westree or Ruel stations. Another means of entering is to use the wagon road for thirteen miles to the halfway house on the Opikinimika river, and the water routes for the remaining portion, thus avoiding the worst part of the road.

### History

Gold was first found in the area in August, 1911, on the Gosselin property, W.D.1151 (2196), which lies on the north line of Asquith township between the second and third mile posts. At that time the railway was 60 miles distant. A few days later gold was found five miles easterly on the Jefferson claim 2504, now the Atlas, on lake Wasapika, MacMurchy township. Other discoveries have been made from time to time, some of which were quite rich. The most recent finds are on the west side of lake Michiwakenda, in Churchill township, on the Cochrane, Gold Corona and Knox claims, the last-named being better known as the Herrick and Churchill properties respectively. The Ribble vein which the Wasapika company is developing has been found to extend into the Miller-Adair and Foisey claims, to the south.

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[1] Township outlines were run in 1909 by J. W. Fitzgerald, O.L.S.

[2] The line referred to was formerly the Canadian Northern, now part of the Canadian National railways.

Exploration work in the area consists for the most part of stripping, sinking shallow test pits and sampling. Some diamond-drilling has been done on the Herrick. One shaft has been sunk beyond 100 feet, viz., the 130-foot shaft on the Wasapika, there being a 50-foot cross-cut at the 100-foot level.

The nearest post office, Coyne, is located at Westree. Owing to the recent discoveries and improvements in transportation facilities, there has been increased activity, particularly in the Wasapika section. No gold has yet been produced apart from what has come from a few high-grade samples, and the area is still in the prospect stage. The recent forest fires have facilitated prospecting in parts.

## Topography

Broadly speaking, the country is a rocky plain-like area at an elevation of approximately 1,400 feet above sea level. The relief is slight, the highest peaks being not more than 250 feet above the lowest valley. Lakes are numerous; Mr. Collins found seventy-two lakes in seventy-two square miles examined, and three of these were each five miles long. The height of land, separating the waters of the Great lakes from those of Hudson bay, skirts the western and northern parts of the area. A large proportion of the forest has been completely burned, leaving the rocks well exposed over large areas. The covered portions have only a thin coating of glacial sand and gravel. The average magnetic declination is about ten degrees west of north.

West Shiningtree lake is remarkable for its irregular shape, numerous bays and long shore line, as well as the low relief of the surrounding land.

## Literature

Prior to 1911, when gold was discovered, there was little known geologically of the area except in a reconnaissance way.[1] Immediately after the discovery R. B. Stewart briefly examined the geology and character of the deposits[2] for the Ontario Bureau of Mines. During the following summer, 1912, Mr. Stewart continued his examinations and published a brief report, accompanied by a very useful sketch map.[3] W. H. Collins, of the Geological Survey of Canada, who was also in the area at the time of discovery investigating the Onaping region, published an advance photographic map of the Shiningtree section, to accompany his summary report.[4] Mr. Collins also spent a part of the following summer, 1912, in the West Shiningtree area proper. His report and detailed coloured map of Churchill and Asquith

[1] In 1909, W. R. Rogers, topographer of the Bureau of Mines, during an exploratory trip westerly from Gowganda, made a rough traverse of West Shiningtree lake, a plane table traverse of lakes Okawakenda and Michiwakenda to the north, also a compass and micrometer survey of the Opikinimika river to the south of the area. Map No. 21d, published in 1912, incorporated the results of this work.

[2] West Shiningtree Gold District, by R. B. Stewart, Ont. Bur. Mines, Vol. XXI, 1912, Part I, pp. 271-276.

[3] West Shiningtree Gold Area, by R. B. Stewart, Ont. Bur. Mines, Vol. XXII, 1913, pp. 233-237.

[4] Geology of Onaping Map-Sheet, Ontario; Portion of Map-area between West Shiningtree and Onaping lakes—Sum. Rep. Geol. Surv. of Can., 1911, pp. 244-252.

townships accompanies his general report on the whole area.[1] Several general articles have appeared in various mining journals from time to time by R. E. Hore and others.

### General Geology[2]

The compact rocks are all pre-Cambrian. They have been glaciated and are well exposed, being only thinly covered in places by glacial sand and gravel. The following table gives the rocks in the order of their supposed relative ages, the oldest being placed at the bottom.

PRE-CAMBRIAN.

KEWEENAWAN.
Quartz and olivine diabase dikes and sill remnants.

ALGOMAN?
Granite porphyry, quartz porphyry and felsite (granitic in places).
Granite, gneissic in places.
Lamprophyre.

PRE-ALGOMAN?
Serpentine.

*Intrusive Contact.*

KEEWATIN.*
Conglomerate, arkose and slate (partly of pyroclastic derivation) and tuff.
Iron formation.
Rhyolite, trachyte and hornblende andesite.
Pillow andesite and basalt, diabase, agglomerate, carbonate-, chlorite-, hornblende- and sericite-schist.

* Some of the sediments including parts of the Iron formation may belong to the Timiskaming series.

The older rocks of the area belong to the Keewatin. They consist dominantly of volcanics—andesite, basalt and rhyolite, with subordinate amounts of rusty carbonates, green schists, Iron formation, and sediments partly of pyroclastic origin. Some of the well water-sorted sediments may be Timiskaming in age. Intruding the schist complex are several igneous rocks, viz., dikes of serpentine, quartz porphyry and felsite, batholiths and stocks of granite and gneiss, dikes and stocks of lamprophyre granite porphyry, and dikes and sill remnants of diabase. All the intrusives may be of pre-Algoman or Algoman age except the later diabase, which is Keweenawan in age. The gold deposits occur largely in the basic schists, but they have been found in all varieties of rocks except the serpentine, granite-gneiss and Keweenawan diabase. There is even a possibility that gold will be found in the granite. The various rocks will be briefly described in the following paragraphs.

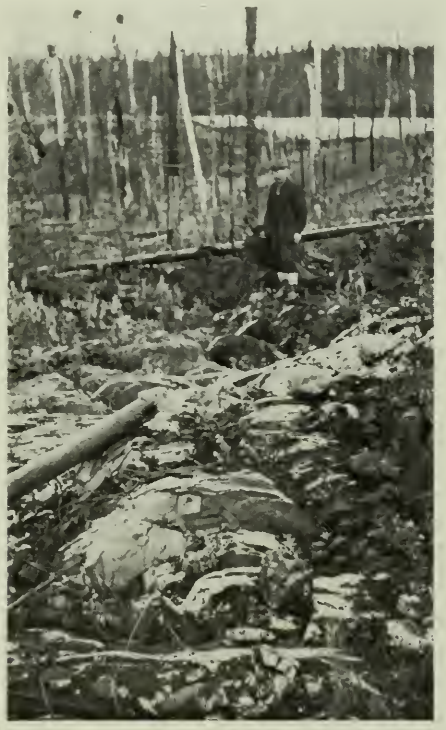
### Keewatin

*Pillow Lavas, etc.*—The basic pillow lavas comprise basalt, andesite and probably dacite. The pillow structures or snowshoe-like outlines which are so prominent, denote that these rocks are surface flows. The rocks are at times massive, but usually somewhat schistose, and greatly altered and folded. The more pronounced

[1] Mem. No. 95, Onaping Map-Area, by W. H. Collins, Geol. Surv. of Canada.

[2] The geology will only be briefly described owing to the writer having spent most of his time in studying the gold deposits. A detailed description of the geology is given by W. H. Collins in Memoir 95, above mentioned.

schistosity is along narrow east-west vertical zones, and it is in these zones that some of the gold veins occur. During the alteration the rocks have been changed to hornblende, chlorite and sericite schists, particularly when in close proximity to the granite masses. The greenstone near the granite contact on the Burke claim at Granite lake has been changed to a hornblende-chlorite schist, but still retains the pillow structure. Owing to the resemblance of the ellipsoidal andesite and the other basic volcanics they have all been grouped together. There are, however, bands of rusty-weathering greenish carbonates, extending for three miles from the Gosselin property to Stewart lake, which could be differentiated in detailed mapping. These rocks closely resemble in appearance those in Deloro township,



Quartz veinlets in rusty carbonate on claim No. 2325. Gold occurs in some of the stringers.

at Larder lake, and Opasatika lake in Quebec. They are intersected by quartz stringers which sometimes carry visible gold and in many places are intruded by granite porphyry. A sample of the massive green carbonate from the Clark claim, No. 2277, Asquith township, was found by W. K. McNeill, Provincial Assayer, to be an impure magnesium-iron-lime-carbonate. The green colour is probably due to ferrous oxide; a trace of nickel is also present. Other impurities are quartz and sericite.

Portions of the agglomerate may represent the broken ropy surfaces of certain lava flows. Accompanying the pillow lavas in places are banded "sugary" quartz and pyrite of the Iron formation type, which on analysis sometimes contain a little gold.

*Rhyolite, Trachyte and Hornblende Andesite.*—These rocks occur as irregular flow-like masses in various parts of the area, particularly in the northern part of Churchill township, just beyond the map area. Mr. Collins has described the trachyte and andesite in great detail in Memoir No. 95. The rhyolites in the vicinity of the Herrick are grey, green and sometimes pink in colour, and frequently have a porphyritic structure. Amygdules are not common, but a few were seen at the south end of Michiwakenda lake. Some of the porphyries and granites

Contorted jaspilyte near the northwest corner of claim No. 4534, on the west shore of Michiwakenda lake.

in the southeast part of Churchill township may be connected with the rhyolite group. Under thin section the rhyolite consists of quartz and feldspar phenocrysts in a fine ground mass of the same minerals with chlorite and carbonate. The rhyolites are similar to those in Kowkash and other areas. The flows pass gradually upwards into fine-grained ash rocks and finally into water-sorted slate, greywacké, Iron formation and conglomerate, the last containing numerous rhyolite fragments.

*Conglomerate, Iron Formation, etc.*—Mr. Collins regards these sediments, which occupy four or more square miles, simply as a series of assorted volcanic débris laid down in water during a long period of volcanic activity. Those seen by the writer are partly pyroclastic and closely associated with the Keewatin. Others, however, are much fresher-looking and resemble the Timiskamian in other areas of the Province. The rocks have been greatly contorted and now stand on edge. The pebbles in the conglomerate are dominantly porphyritic rhyolite and chert, with some white quartz and an occasional granite pebble. The slates contain and are interbedded with lean Iron formation, viz., banded magnetite, hematite, chert, sugary quartz and jasper. At a point on the west side of Michiwakenda lake and one mile south of the portage into lake Okawakenda are two or three

Outcrop of serpentine on the east shore of Gosselin lake, Churchill township, showing hexagonal-like columnar structure.

narrow bands of granitic rock six inches in width, which lie between and parallel to the contorted layers of jaspilite. Gold quartz veins have been found in the conglomerates and slates on the Herrick near a lamprophyre intrusion, and also in an Iron formation band extending across the Cochrane and Gold Corona claims. It would therefore seem reasonable to assume that all these sediments are worthy of prospecting for gold near points where they have been intruded by lamprophyre or acid rocks.

### Pre-Algoman (?)

*Serpentine.*—Only two exposures of serpentine were found, viz., on the east shore of Gosselin lake and on the south side of Green lake. They are probably altered peridotites which immediately preceded the acid rocks of the Algoman epoch. In the former locality the serpentine has taken on a beautiful surface weathering, showing hexagonal outlines as shown in the illustration.

[1] M. P. III.

### Algoman (?)

*Lamprophyre.*—A reddish-grey lamprophyre with mica phenocrysts and large chloritic inclusions occurs as sills or dikes cutting the rhyolite and sediments in the vicinity of the Herrick property. A somewhat similar outcrop, occurring on the Churchill-MacMurchy boundary line 20 chains from the south end, appears to be a differentiation phase of the granite. Under thin section the lamprophyre on the Herrick shows biotite phenocrysts largely altered to chlorite, and a few altered feldspar crystals in a groundmass of the same materials with apatite, magnetite and much carbonate and other secondary minerals. The rock resembles the Kirkland lake lamprophyre, and is important, since it forms the wall rock of a large portion of the Herrick gold vein.

*Granite.*—The granite in the southern parts of Asquith and Fawcett townships is the northern part of a large hornblende-biotite-granite batholith which is feebly gneissic in places. Directly east of the Burke property on the east shore of Granite lake, is a coarse, massive, pink biotite granite.

*Granite-Porphyry, Quartz-Porphyry, Felsite, etc.*—The granite-porphyries, or granodiorites, are probably apophyses, or small offshoots, from the large granite masses, and may be Algoman in age. They often occur in the vicinity of many of the gold showings in Asquith township, which suggests some relationship between the two. The amount of albite, orthoclase and quartz present in the porphyry varies from place to place. Frequently the orthoclase phenocrysts are over an inch across. Quartz veins carrying gold values occur in the porphyry.

The light-coloured rocks in southeast Churchill township included with this group comprise quartz-porphyry or rhyolite, granitic rocks, feldspar– and granite-porphyry, which grade at times into each other, thus making it difficult to separate them in mapping. They are quite massive and fresh-looking, and cross-cut at times the green schist; nevertheless, some of the quartz-porphyries may be connected with the rhyolites already described. Certain gold-bearing deposits lie in the green schist not far from the north and east contacts of this group of rocks in southeast Churchill. The quartz-porphyries are light grey or pink. The numerous quartz and occasional feldspar phenocrysts stand out prominently in the dense fine-grained groundmass. The granitic rocks, which are at times in sharp contact with the quartz porphyries, are mauve in colour and have a fine and even grain. The microscope shows quartz, acid feldspars, biotite, apatite, chlorite and magnetite. In places the granite becomes lamprophyric and porphyritic.

On the Atlas a quartz-porphyry, now a sericitic schist, has intruded the slates and contains inclusions of the same.

The felsites are fine-grained, white weathering rocks which contain altered feldspar, quartz, chlorite and sericite, etc. Some exposures appear to be altered rhyolites, while the outcrops on the Gosselin, which contain gold-bearing veins, are closely associated with the porphyry. Two small felsite dikes were seen cutting the gold veins, viz., on the Buckingham claim and on the south part of the Moore MacDonald (2276).

### Keweenawan

*Diabase.*—The quartz and olivine diabase is the latest rock in the area, and resembles the Nipissing diabase at Cobalt. It occurs as narrow north-south trending dikes and as small sill remnants. The outcrops are so numerous that only a small percentage of them have been mapped. Occasionally, as shown on claim 2566, Wasapika lake, the diabase is porphyritic, having altered green feldspar phenocrysts up to two inches across. Most of the gold-bearing veins have been cut by diabase, and usually without being displaced, as shown on the map. The diabase has had no influence on the gold formation and is, if anything, a hindrance to gold-mining. It has, however, been responsible for certain calcite veins carrying cobalt bloom, smaltite and silver in small quantities.

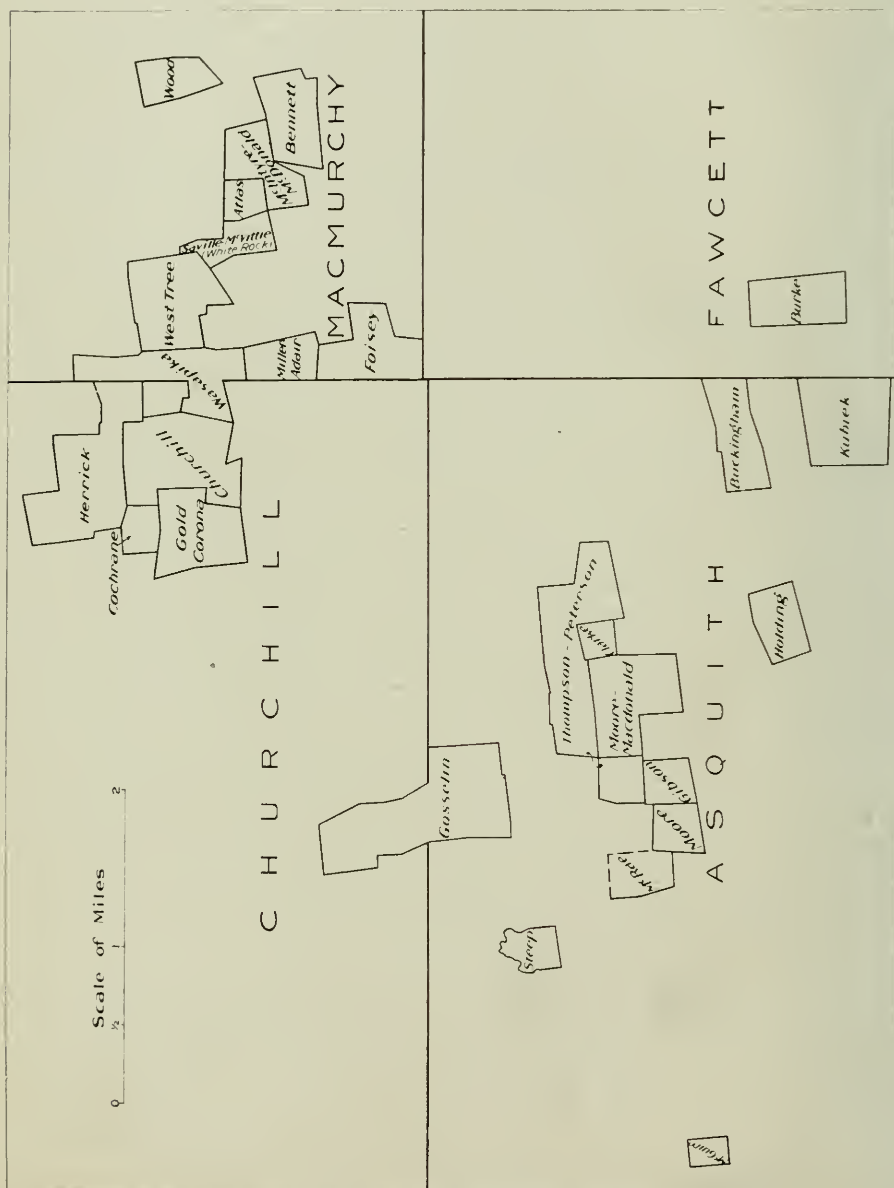
Some silver prospects in the vicinity of Shiningtree lake, which lies four miles to the east of the southeast corner of the map-sheet, have been described by R. B. Stewart[1] and W. H. Collins.[2]

### Mineral Deposits

The gold-bearing quartz veins, many of which are shown by a red colour on the accompanying map, have been found in all the rocks of the area, with the exception of the granite, serpentine and diabase. They occur largely in the old basic volcanics, as in the case of the "Ribble" vein. A vein carrying gold on the Churchill property passes from altered basalt into a rhyolite or porphyry. Gold occurs in quartz cutting Iron formation on the Cochrane and Gold Corona. The Herrick vein passes from conglomerate and slate into mica lamprophyre. Coarse gold was seen on the Clark claim in quartz stringers, which cut rusty-weathering green magnesium-iron-calcium carbonate. On the Gosselin, the gold occurs partly in the porphyry and felsite or rhyolite. Spectacular showings in a nearly transparent quartz on the Holding claim are entirely in amphibolite or hornblende schist. Most of the deposits in the vicinity of West Shiningtree lake and easterly to the Buckingham occur in bluish grey quartz veins and lenses in shear zones in altered basalt, andesite and rhyolite. There is another type of deposit comprising banded tuff with pyrite or alternating layers of slate and pyrite, resembling Iron formation. This type is usually found to contain only small quantities of gold. Examples may be seen on claims number 2545, 2433 and 3664.

The veins usually strike east and west, although some persistent and important ones run north and south, the dips in all cases being from vertical to 45° from the horizontal. They vary in width from 50 feet to a few inches, and are often traceable for long distances, although short veins also occur. The Ribble vein can be followed for about one mile, and is probably much longer. The mineral deposits, which frequently occur along old faults, consist of lenses of quartz, several feet wide, with stringers of quartz running into the sides, or there may be numerous quartz stringers and small veins in a wide mineralized rusty schist zone. The gold, which occurs native and at times contains small quantities of silver, is found in dark seams in the fractured quartz, with calcite, sericite, talc, chlorite and pyrite. Such minerals as chalcopyrite, molybdenite, pyrrhotite, barite, galena, tourmaline

[1] The Shiningtree Silver Area, Ont. Bur. Min. Rep., Vol. XIX, 1913, Pt. II, pp. 187-194.
[2] Summary Report, Geological Survey of Canada, 1911, p. 251.




Sketch map showing the relative locations of the various West Shiningtree properties mentioned in this report.

and specular hematite are present in certain deposits. Quartz is frequently white or bluish grey. Pyrite is usually abundant in the adjoining schist, but, on the whole, scantily distributed in the quartz. Veins are little faulted, but they have been subjected to all degrees of folding and brecciation. Great pressures have been applied from the north and south, hence the rocks have developed into schists with nearly east-west strikes; the north-south veins, like the Ribble, Herrick and Gold Corona, have been compressed lengthwise, and thus greatly folded and in parts brecciated. The east-west veins are little folded, having been compressed on the sides, while the veins with an intervening strike like the Saville, which runs northwest-southeast, are less folded and less broken than the north-south veins, but more so than the east-west veins. Most of the gold deposits are cut by diabase dikes, usually without being displaced.

A study of the geology and ore deposits would suggest that the gold-bearing veins are closely associated with the dikes of lamprophyre, granite-porphyry, felsite and rhyolite, which are here classed as probably being Algoman in age. The presence of albite in the Bennett ore body, and the feldspar and tourmaline in the Westree and other deposits, are suggestive of a relationship between the deposits and the granite or pegmatite dikes. The ores were probably derived from solutions associated with and following the eruption of the Algoman rocks, and prior to the Keweenawan diabase intrusion. Where the veins extend into Iron formation or rocks rich in sulphides, there is usually an enrichment in gold. In the vicinity of West Shiningtree lake and easterly to Granite lake, many additional gold-bearing quartz veins will in all probability be exposed by further trenching.

No gold has yet been produced apart from what may have come from a few high-grade samples, some of which might be called bullion. The encouraging results obtained on a few properties will probably lead to mining being conducted on a larger scale. There seems no reason why the veins which have a satisfactory length and width should not extend to considerable depth. One would also expect to find the values underground much the same as they are within a foot or two of the surface, since any oxidized or weathered surface zone has doubtless been removed by glaciation. All the rock formations are worthy of prospecting except the granite and diabase. Gold may even be found in the granite, although this rock has not yet, generally speaking, proved very favourable for gold in northern Ontario. The intersection of veins with Iron formation or pyrite formations should be a favourable place to look for enrichment. The Iron formation or pyrite formations do not usually form gold ore bodies themselves, unless cut by numerous secondary quartz veins.

## Description of Various Deposits

### Wasapika Area

At present the working properties are situated in the vicinity of the Wasapika, which lies about four miles northeast of West Shiningtree lake. Underground work is being done at the Wasapika and Westree, diamond drilling at the Herrick, and surface prospecting on the Atlas. The various properties are described in alphabetical order in the following paragraphs.

*Atlas* (2504).—The Atlas property, which is situated on the south part of Wasapika lake in MacMurchy township, was originally the Jefferson claim, on which gold was first found in this section. The rocks comprise pillow lava, and a few slaty bands, the northerly one being intruded by a quartz porphyry schist. All these rocks, including the gold-bearing veins, are cut by several Keweenawan diabase dikes. The "Evelyn" vein is merely banded slate and pyrite, with some quartz, six feet in width, which strikes northwest and dips 70° to the southwest. Rich gold specimens came from pockets in the slaty band near points of intersection with east and west quartz veins. Cobalt bloom occurs in the vein, and smaltite and native silver were reported to have been found. The deposit, however, is of no apparent value from a silver point of view.

The east-west veins, nearly vertical, are lenses of quartz up to three or four feet wide, with quartz stringers running in places out into the rusty schist walls

Outcrops of gold-bearing quartz veins on the Atlas. A tunnel has been commenced on one of the veins. September, 1919.

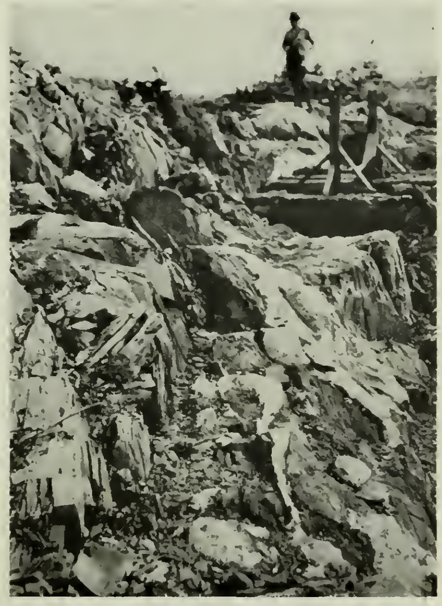
(page 15) and are about 200 feet long. Gold has been found in two such veins. Development work consists of trenching and a few test pits. In September 1919 a tunnel was commenced in the hillside, in an endeavour to prospect at that level a gold-bearing quartz vein which outcropped on the hilltop some 60 feet above. Three men were employed in the work.

*Bennett* (2544, 2507).—These claims are situated to the southeast of Wasapika lake. Striking northwest-southeast and nearly at right angles to the general schistosity in that area is a shear or fault zone from three to eight feet wide and 400 feet long, in which are small lenticular veins of quartz, associated with which are the following minerals: albite, talc, sericite, calcite, pyrite and gold, the pyrite being more abundant in the rusty schist than in the quartz. A 50-foot vertical shaft has been sunk on the deposit. Many samples with visible gold can be found on the dump. It is reported that there is a rich ore shoot here which is 75 feet long and two feet wide on the surface. The rocks are largely altered green basic volcanics, with which is associated a narrow slaty band. These rocks and the vein have been intruded by a narrow diabase dike.

Since leaving the area it is reported that gold has been found on the Kingston claim, No. 3715, which lies immediately south of the Bennett.

*Churchill* (3773, 3774, 3741, 4044).—The Churchill Mining Company owns four claims to the southwest of Michiwakenda lake, Churchill township. The principal showings, which were discovered by J. A. Knox, are on claim 3774. Two veins from two to three feet wide occur in the rusty pillow lava schist. They have

Gold-quartz deposit outcropping on the Atlas above the tunnel. September, 1919.



Ore body comprising auriferous quartz veins and mineralized schist on the Bennett claim. September, 1919.

been traced for 200 feet or more in a direction slightly north of east, the dip being 75° to the south. Towards the west the veins come together and pass into a porphyritic rock. Towards the east they have been faulted, the easterly portions being thrown 20 feet to the south. A 40-foot shaft has been sunk on the north vein, which was reported by Mr. Knox to average in the shaft 38 inches in width. Gold could be seen in various parts of the veins, usually occurring in fractures, with pyrite and other dark minerals.

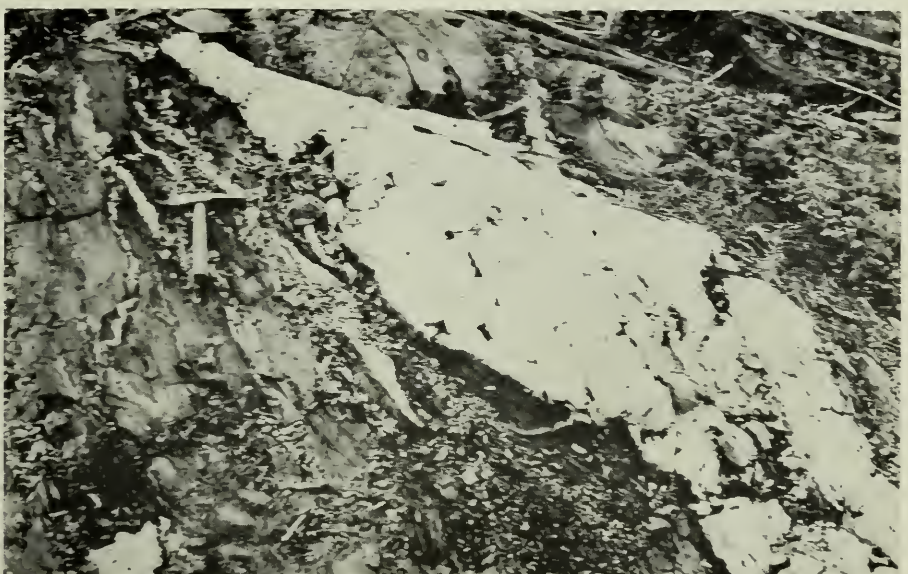
*Cochrane.*—The Cochrane claim (3712) lies northwest of the Churchill group. On the western part of the claim, within 100 feet of the west line, gold has been found in a vein one foot in width striking northeasterly, in porphyritic greenstone. A few hundred feet northeast of this showing, a white sugary quartz vein about 10 inches in width, cuts across banded Iron formation. The quartz contains much finely disseminated pyrite and numerous small particles of gold.

*Foisey* (3544, 3545, 3772, 4075).—These claims lie in the extreme southwest part of MacMurchy township, one-half mile south of the Wasapika property. A vein similar in appearance to the Ribble vein on the Wasapika, and probably a continuation of the same, has been exposed by trenching for about a quarter of a mile on 3544 and 3772. Part of the vein is to be seen on the westerly edge of a rocky bluff. The vein cuts across the general schistosity of the altered pillow lava. It has been greatly folded, and apparently dips at a high angle to the west. Considerable gold could be seen in some of the large lenses, nevertheless samples from certain sections across the vein contained no gold. No underground work has been done as yet.

Camps on the Herrick. September, 1919.

*Gold Corona.*—Claims 3577, 3578, 3645 and 3671, lying west of the Churchill, constitute the Gold Corona, formerly the Queen of Sheba. A vein some eight feet wide, and apparently dipping 70° to the west, has been exposed, by trenching, along the east boundary of 3645. The vein has been folded and brecciated, with small offshoots extending out on either side, one of which contains gold. Some of the veinlets in the banded Iron formation also contain visible gold. A third vein has a northeasterly strike, and where it passes through the banded Iron formation, gold could be seen. The sulphides in the iron band were probably the precipitating agent for the gold.

*Herrick* (4105, 4106, 4107, 4096, 4097, 4098).—The Herrick property lies largely on the west side of the south end of Michiwakenda lake, in Churchill township, and adjoins the Wasapika on the northwest. In 1918 J. A. Knox discovered gold on claim 4105, in what has been called the "Kingsley" vein. This vein occurs in an old vertical fault, and has been traced in a north-south direction for 1,000 feet through conglomerate slate, rhyolite and reddish lamprophyre. The quartz, which is usually accompanied by calcite, varies in width from a few inches to a few feet. The quartz in the lamprophyre frequently occurs in the form of several irregular stringers over a width of 8 or 10 feet. The quartz and porphyritic lamprophyre are usually brecciated, thus resembling somewhat the Kirkland Lake deposits. Visible gold, usually accompanied by pyrite, calcite, chlorite and talc, occurs in dark seams in the quartz. A 50-foot shaft, which is



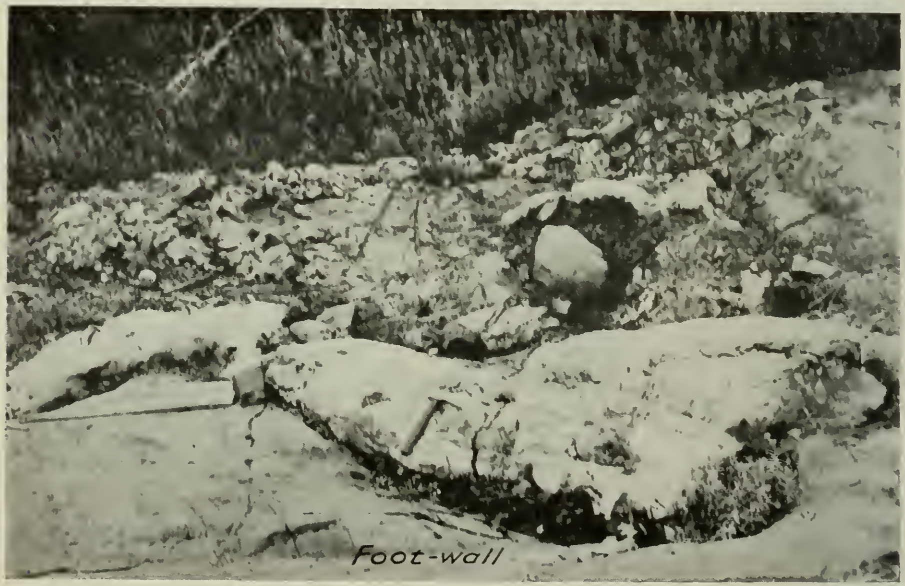
Gold-bearing quartz lenses on the McIntyre-McDonald claim, No. 2565.

now filled with water, has been sunk on the vein, which was reported by the manager to carry high values across an average width of four and one-half feet. The quartz from the dump contains visible gold; the wall rock at the shaft is greywacké. Owing to the high cost of getting in supplies by wagon in summer, shaft sinking was discontinued for the time and exploration done by diamond drilling. Three diamond drill holes, averaging about 450 feet each, were put down during the fall of 1919. The writer did not see all of the vein core, but according to Geo. R. Rogers, who is in charge of operations, the cores showed a good width of vein, carrying fair values in gold. The property is held under lease from the Crown[1] by F. C. Sutherland & Co., Toronto. A plant will probably be installed during this winter, and further development work done by shaft sinking and drifting. At the time of writing about 15 men were employed.

[1] Title for mining claims in the Timigami and all other Forest Reserves in Ontario is by way of lease, not patent in fee simple. See Mining Act of Ontario, sections 45, 46.

*McIntyre-McDonald* (2565-2566).—Several quartz veins and lenses, some of which contain gold, have been exposed on claim 2565, which lies on the south shore of Lake Wasapika between the Atlas and Bennett claims. One of the veins has been traced in a northeasterly direction for 600 feet, the width varying from four feet to one inch. At a point near where the vein passes into claim 2566 a 50-ft. shaft has been sunk. About 350 feet north of this shaft a 55-ft. shaft was sunk on a small rich lens by C. M. Colvocoresses, who had the property under option in the autumn of 1912. The lens is 100 feet long, two feet to three inches wide, strikes a little west of north and dips to the east. A few bags of ore were shipped for testing purposes. Gold can be seen in quartz on the dump.

*Miller-Adair* (3698, 4008).—The Miller-Adair prospect lies immediately south of the Wasapika, and north of the Foisey. The vein on the Foisey has been traced for about 150 feet into claim 3698. It cross-cuts the pillow lava schist at an angle




A near view showing the folded character of the "Ribble" vein on the Wasapika. The hanging-wall part of the deposit is composed largely of quartz and mineralized schist.

of about 45°, and in many ways resembles other parts of the Ribble vein. No gold was seen, but it is reported on good authority that surface sampling indicated ore over a width of about five feet. Three moiled samples were found by the writer to yield fair values in gold.

*Saville-McVittie* (2535, 2536).—These claims, which were staked by T. Saville, lie between the Atlas and West Tree, in MacMurchy township. A lenticular vein, averaging about three feet in width and known as the Saville vein, has been traced northwesterly across the claims for one-half mile, and passes on to the West Tree. The quartz varies from a mere stringer to six feet in width, with stringers running into the rusty wall rock. The vein has not been folded to such an extent as has the Ribble vein. In places the quartz is rosy and banded, and some gold could be seen in the dark seams in pyrite, tourmaline and other minerals. Some parts of the vein, however, are known to have low contents of gold. Two vertical shafts, 40 and 65 feet deep, respectively, and 1,000 feet apart, have been sunk on the vein. The rocks are largely pillow and amygdaloidal lava.

It is reported that the name of the property had been changed to White Rock, and that supplies were being taken in over the snow with the intention of doing further exploratory work.

Headframe over the Wasapika shaft. The "Ribble" vein outcrops in the distance. September, 1919.

*Wasapika* (2529, 2530, 3765, 3771, 4078, 4108).—The greatest development in the area has been done on the Wasapika property, which lies to the south of Michiwakenda lake, along the MacMurchy-Churchill township boundary.

The operating company is known as the Wasapika Consolidated Mines Ltd., and is capitalized at $6,000,000.00. The Ribble vein, which is being developed on this property, constitutes one of the important deposits of the area. Gold was discovered in this vein during the latter part of 1912 by two prospectors, who were grubstaked by A. Ribble. T. R. Jones, of the Buffalo Mine, Cobalt, had an option on the property, and did some stripping and sampling. Shortly after, in 1916, Geo. R. Rogers took over the property, and has been developing it ever since. At present, December 1919, there is a 130-foot vertical shaft with a 60-foot cross-cut at the 100-foot level. Poor transportation facilities and lack of capital have retarded development considerably. The company, however, will continue sinking and will drift on the 100- and 200-foot levels.

The vein, which dips at about 60° to the west along the western edge of a bluff, has been stripped in a general north-south direction for about 2,500 feet, having an average width of approximately five feet. The bluff forming the foot-wall of the vein is a green chloritic pillow lava schist and stands 20 or 30 feet above the western hanging wall which is composed of somewhat similar but softer schist, containing much pyrite, calcite and other secondary minerals. The wall rocks and vein have been much altered by great pressures exerted from the north and south, causing the Ribble vein to be compressed lengthwise, intricately folded and crushed. The deposit lies in a schist zone, and is comprised of numerous quartz lenses up to four feet wide, and irregular narrow veins of crushed quartz, cut by narrow veinlets of pink calcite. The gold usually occurs in narrow, dark seams in the quartz, with carbonate, pyrite, sericite and occasionally copper pyrites. The gold in the vein was probably present when the great folding and crushing took place. Pyrite, on the whole, occurs scantily in the quartz, but is abundant in the form of cubes in the intervening schist. The higher gold content is found in the quartz, rather than in the mineralized schist. Gold, in small particles, can be seen in various parts of the vein, on the surface, and in the cross-cut at the 100-foot level. At times the gold is quite pale in colour, due to the presence of silver.

The results of the preliminary surface sampling by Geo. R. Rogers, as given in the *Canadian Mining Journal* of August 15, 1918, show that at that time "18 carefully moiled samples taken at intervals across the full width of vein (average 50 inches) for a length of 150 feet, gave $10.10 per ton in gold. Another part of the vein, 120 feet distant, gave $8.00 in gold, across 49 inches, for a length of 280 feet." Since then Mr. Rogers reports that further surface sampling has proven an additional 300 feet of $9.00 ore, in which case there would be 800 feet of $9.00 ore across about four feet. The cross-cut on the 100-foot level shows a width of approximately 23 feet of mineralized schist and quartz veins, and small particles of gold can be seen in some of the quartz lenses near the centre of the cross-cut. The deposit is wider at the 100-foot level than it appears to be on the surface. Assay results across 23 feet of the quartz and schist in the cross-cut were reported by Mr. Rogers to run $7.20 in gold per ton. One grab sample of the quartz taken from the cross-cut by the writer, gave gold $4.00 and silver $4.00, while another sample of the mineralized schist gave no values in gold. The higher assays come from the four or five feet of quartz on the foot-wall side of the deposit.

The surface buildings consist of a small steam plant, blacksmith shop, portable saw mill and camps. Geo. R. Rogers is president and manager of the company, and Martin Hassett superintendent.

*West Tree* (2531, 2532, 2542, 2543).—These claims, formerly known as the Caswell, were optioned several times, namely, by C. D. Chisholm, J. Knox, Gold Banner Company, and Dominion Reduction Company, before being taken over by the West Tree Co. The property adjoins the Wasapika on the east, and lies on either side of the narrow southeast bay of Michiwakenda lake. The rocks are largely altered diabase, amygdaloidal lava, pillow lava, and ash rocks, with carbonate schist in the vicinity of the veins. The veins and rocks are cut by narrow diabase dikes. The gold-bearing quartz veins occur in the more schistose bands up to 20 feet wide which strike slightly north of east and dip vertically. The individual quartz veins in the zone are numerous, but short and narrow, varying from an inch to a foot in width. On the whole there is more schist than quartz in these zones. The gold usually occurs in dark seams in the quartz containing carbonate, talc, sericite, chlorite, and pyrite. Other minerals present are feldspar, tourmaline, molybdenite, and chalcopyrite.

Some spectacular gold samples came from an open cut and shaft on one of these shear zones in the south part of claim 2543 and on the east side of the lake. The workings were partly filled with water at the time of inspection; however, the rich samples apparently came from a vertical pipe-like deposit formed at the intersection of the shear zone, which is 15 feet wide at this point, and a slaty pyrite band. The slaty band, which is three feet wide, has been faulted, the south part being

Workings on the West Tree, formerly the Caswell, September, 1919. Some extremely rich gold samples came from the open pit across the lake.

thrown approximately 15 feet towards the lake. The shear zone has been traced easterly for 300 feet, having an average width of about five feet: but apparently there are little or no values in the eastern portion of the lode.

On the west side of the lake, 350 or 400 feet distant from the old workings, a 67-ft. shaft (September, 1919) has been sunk on a similar zone, possibly a continuation of the same. The stringers pinch out, however, at a point 100 feet west of the shaft. The larger quartz vein, which varies from an inch to a foot and occasionally two feet in width, contains considerable finely disseminated gold. In sinking, this vein passed into the north wall at a depth of 64 feet, at which point there is also a flat fault. In other parts of the shaft there are numerous, nearly parallel, vertical stringers. Samples across the shaft were reported to average $8.00 in gold. The company intends to continue this southwest shaft to the 100-ft. level, from which point a drift or level will connect with the workings on the northeast shore of the lake.

*Wood* (2622, 2623).—Gold was found by J. Knox on mining claim 2623, which lies about one-half mile east of Wasapika lake. On the north end of this claim there are two narrow east-west rusty schist zones which contain a few parallel quartz veins, all being cut by a north-south diabase dike. A little gold occurs in the north vein immediately east of the diabase, and in the south vein directly west of the diabase.

### West Shiningtree Area

Numerous discoveries of gold have been made in the southern part of the area in the vicinity of West Shiningtree lake and easterly to Granite lake. On most of these properties considerable surface work has been done but little underground work has been undertaken, and when visited all properties were idle. Visible gold may occur on other claims which have not been described. At any rate there are several deposits not mentioned from which gold can be panned or low assays obtained. A description of the deposits follows, taking them in order from east to west.

*Burke* (3767, 3786, etc.).—Messrs. Burke, Landagne, Cochrane and Bulloch have staked a group of claims on the west shore of Granite lake, Fawcett township. On one of these claims a large quartz deposit can be seen running north and south under the water near the mouth of Papoose creek. A portion of the vein was picked up by trenching in a swamp four chains to the south of the showing at the water's edge. A 20-ft. shaft was sunk on the creek bank, from which point a cross-cut was driven towards the creek for a distance of 78 feet. Mr. Burke stated that the cross-cut passed through 14 feet of quartz and schist which yielded considerable gold on assay. The dump shows much mineralized schist and quartz, a rough sample from which yielded $2.00 in gold per ton. Owing to the low land it is difficult to prospect the surface. The vein occurs in a fracture which cross-cuts the altered pillow lava and rusty carbonate schist at about right angles. Hence it is in many ways similar to the Ribble vein which outcrops about two and one-half miles to the north. The vein occurs in a fracture parallel to the Ribble vein, or it may possibly be a continuation of the Ribble, although the writer did not learn of any discovery in the intervening area.

*Kubiak* (4091, 4295, 4296, 4327).—These unsurveyed claims are situated directly west of the Burke, in Asquith township. The rocks comprise hornblende, chlorite and carbonate schists, (altered pillow lavas) which have been intruded by Keweenawan diabase. Much trenching has revealed several large schist areas containing numerous lenses and veins of bluish-grey quartz, some of which are quite large. Gold can be seen in several of these veins, but not sufficient sampling has been done to show whether the gold is in paying quantities or not. Much of the schist next the quartz is green in colour and usually barren in gold. About seven chains westerly from the pit, shown on claim 4327, is a narrow calcite vein carrying considerable cobalt bloom in hornblende schist.

*Buckingham* (2407, 2461, 3664).—These claims, which lie between Stewart and Seagers lakes, were staked by J. Peddle and have since been sold or optioned to several parties. On claim 2461 an 85-ft. shaft, inclined at an angle of 60° to the south, has been sunk on a vein five feet wide carrying considerable visible gold. The deposit appears to end, or pass into stringers, immediately east of the shaft.

but the vein can be traced intermittently to the west for about 1,000 feet, except where it is intruded by narrow dikes of diabase or felsite. The wall rocks are pillow lavas altered to hornblende, chlorite and carbonate schists. The deposit comprises a quartz vein from one to three feet wide, with some stringers carrying gold on both the hanging wall and footwall. Numerous showings of gold occur along the surface of the vein for 100 feet or so to the west of the shaft. Quite coarse gold came from a pit 275 feet west of the shaft. There is no trouble in picking gold samples from various parts of the dump. A grab sample from the dump yielded $5.20 gold per ton. The visible gold invariably occurs with talc in fractures in the quartz. Other minerals present in these seams are pyrite, dark calcite, hornblende, tourmaline and occasionally chalcopyrite.

Shaft on the Holding deposit, September, 1919.

The plant consists of a boiler of the locomotive type, a 2-drill compressor and a steam hoist. Work was suspended in the spring of 1919.

*Holding* (3508, 3118).—The Holding property, which is controlled by R. I. Henderson, of Toronto, is located south of MacDonald lake in Asquith township. Gold was discovered near the centre of these claims in September, 1912, by R. Holding, of Chapleau, Ontario. The deposit consists of numerous parallel quartz stringers, up to four inches and occasionally one foot in width, in amphibolite or hornblende schist. The deposit is several feet wide, and has been trenched for about 200 feet in a northeast-southwest direction. Certain parallel layers of schist contain an abundance of crystallized pyrite. The quartz is of a white, nearly transparent type, and contains a little copper pyrites and talc and gold in a few places. An inclined shaft, at an angle of about 70° to the southeast, has been sunk on the mineral zone to a depth of approximately 50 feet. At a depth of 30 feet a 10-ft. drift was put in to the southwest and some rich gold samples obtained. Although rich samples have come from some parts of the deposit, nevertheless many other parts were found on assay to contain no gold.

A pump operated by a gasoline engine was used to keep water out of the shaft.

On the adjoining claim to the north, 2424, Chas. Speed reported that he found gold associated with copper pyrites in transparent quartz veinlets similar to the Holding.

*Clarke* (2277).—The Clarke Bros'. claim lies directly north of MacDonald lake. Near the centre of the claim is a rusty weathering green carbonate, impregnated in places with iron pyrites and containing a network of quartz veinlets. Gold could be seen in some of the quartz stringers. The rock is an iron-magnesium-lime carbonate, with considerable silica, alumina, and a trace of nickel. A narrow slaty band was observed in the carbonate. On the northern part of the claim the carbonate is cut by red and grey granite-porphyry, and near the contacts are large lenses of quartz somewhat similar to those on the Gosselin and carrying feldspar, galena, chalcopyrite, pyrite, talc and sometimes gold and other minerals.

*Thompson-Peterson* (2306-2312).—Gold has been found on several claims in this group, but all the showings were not examined by the writer. On 2308 and 2310 the gold is contained in a rusty carbonate near the granite porphyry, as on the Clarke claim. Quite large quartz masses occur frequently near these contacts. The showing in 2312 may be a continuation of the one on the Moore and MacDonald claim 2275, which is described below.

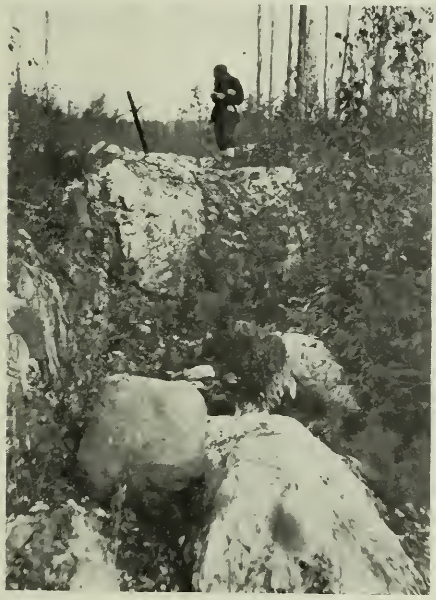
*Moore-McDonald* (2275, 2276, 2279).—"These claims are situated in the vicinity of Moore lake. Several east and west shear zones, 60 feet or more in width, have been located on the properties. The shear zone on W. D. 1164 (2276) has been traced for nine or ten chains. What is apparently a continuation of this one has been located on W. D. 1163 (2275) and on W. D. 1427 (2312). These shear zones contain many quartz veins and stringers, and are usually well mineralized with iron pyrites. The quartz is seldom over a foot wide and constitutes a small fraction of the mineralized areas. Much rusty leafy schist adjoins the quartz, and good colours can frequently be obtained from the material on panning. Considerable gold was observed in the quartz veins and stringers on W. D. 1171 (2279)."[1]

On claim 2276, directly south of the creek which flows from Moore into MacDonald lake, another lenticular vein from one to eight feet wide and dipping about 70° south, has been traced in an east-west direction for 500 feet. Numerous quartz stringers also occur in the hanging-wall, which is hornblende-chlorite schist, or altered pillow lava. A small grey felsitic dike, one inch wide, was observed cutting the vein. The quartz is usually bluish-grey in colour, and is cut by numerous transverse veinlets of white, nearly transparent quartz. Other portions of the quartz have a waxy, wet appearance. Pyrite, pyrrhotite and gold were seen in the vein.

*Gibson* (3560).—On the Gibson claim, which is situated on the east shore of West Shiningtree lake, there are two or more deposits somewhat similar to those described on the Moore and McDonald. They strike a little north of east and dip about 60° to the south.

[1] Report by R. B. Stewart, Ont. Bur. Min., Vol. XXII, 1913, Pt. I, p. 237.

*Moore* (3638).—This claim lies southwest of the Moore-MacDonald on the southeast shore of West Shiningtree lake. Gold can be seen at a point about 50 feet north of Moore's cabin, and near the water's edge. The deposit consists of veinlets and small fragments of bluish quartz in a zone 60 feet long and 10 feet wide, the intervening and enclosing material being hornblende schist. About 300 feet south of this deposit is a large zone of pyritiferous slaty tuff, hornblende schist and altered pillow lava, cut by a few bluish quartz veins up to one foot in width. The deposit has been trenched easterly from the lake for 200 feet, is 15 feet wide in places, and dips 70° to the south. Low contents of gold can be obtained on assay or by panning the rusty material.



Outcrop of gold-bearing quartz vein on the Gosselin claim, No. 2365.

A view of some of the larger quartz outcrops, some of which contain visible gold, on the Gosselin claim, No. 2195.

*McRae* (3792, etc.).—McRae island, which lies in the southeastern part of West Shiningtree lake, is composed of massive pillow lava (andesite), pillow-lava schist, hornblende schist and rhyolitic tuff. Considerable trenching was done along the shores of this island in 1919, which resulted in the uncovering of several east-west quartz veins and isolated lenses of quartz, some of which carry visible gold. In one 20-ft. section across a typical deposit there are 10 parallel quartz veins, each about 2 inches wide, cross-cutting the green schist at a small angle. Many showings of coarse gold and some feldspar were observed in one of the blue quartz veins. The intervening schist at this particular place is quite green and comparatively free from pyrite.

*Gosselin* (2193-97, 2365, 2366, etc.).—The Gosselin comprises several claims in the vicinity of the 3-mile post on the boundary line between Churchill and Asquith townships. It was on claim 2196 (W. D. 1151) that gold was first found in the area by Fred Gosselin, his partners being A. Frith and C. Speed. Victor Pakowsky, of Duluth, took an option on the property in 1912 and did considerable surface exploration, comprising hundreds of feet of trenching, sinking of several test pits and much systematic sampling. A 50-ft. shaft was also sunk on a narrow vein in felsite near the contact with green pillow-lava schist. Considerable gold could be seen in the vein near the collar of the shaft, and it was reported that gold occurred in various places throughout the shaft. The results of considerable surface sampling, however, showed the gold to be unevenly distributed. Little work has been done on the property since that time. A. B. Clark, of Toronto, is one of the principle owners.

The rocks consist of Keewatin altered pillow lava and rusty weathering iron-magnesium-calcium carbonate cut by felsite or rhyolite and granite porphyry of Algoman (?) age. The gold-bearing veins occur in all these rocks and in some of the contacts between the porphyry and older rocks. A large vertical quartz vein, from one to twenty feet wide, with offshoots, can be traced for 650 feet in a N. 15° W. direction from claim 2365 to a small lake on 2196. The quartz appears again on the north side of the lake on 2135 in the form of several large lenses along the same general direction for 450 feet. The largest of these quartz masses is 160 feet long and 65 feet wide at its broadest part, and contains a showing of gold. Directly west of this vein on claim 2135 there are parallel lenses in the schist, which carry visible gold. In the north-east corner of 2196 several large lenses of quartz containing gold occur in felsite. Usually the veins in the felsite and also in the rusty carbonate are in the form of numerous stringers distributed in an irregular manner. The quartz in these various deposits has a white or rose colour. It is frequently brecciated, and contains numerous tiny veinlets of transparent quartz which may have some bearing on the gold values. The richest values appear to be on the edges of the quartz masses. Gold was seen in many parts of the various veins. Pyrite and chalcopyrite are quite abundant in places. The deposits are large, and portions of them are fairly well mineralized and apparently warrant further development.

*Steep* (2434).—The Steep claim is situated on a point near the centre of West Shiningtree lake. In 1914 a shaft 100 feet deep, and inclined 85° to the south, was sunk on an east-west shear zone seven feet in width and occurring in pillow andesite. The broken rock was raised by a whim drawn by a team of four dogs. A lenticular vein of blue quartz up to one foot in width and several parallel veinlets of white quartz occur in the schist zone. The blue quartz has been fractured, the seams carrying zinc blende, galena, copper pyrites, pyrite, talc and native gold. Considerable gold can be seen in the blue quartz samples on the dump. Mr. E. Steep reported that at a depth of forty feet the vein was faulted and thrown seven feet to the south, and at a depth of 100 feet the blue quartz was one and one-half to two feet wide and carried visible gold. Favourable assays were also reported by Mr. Steep to have been obtained from samples taken across the full width of the schisted zone on the surface.

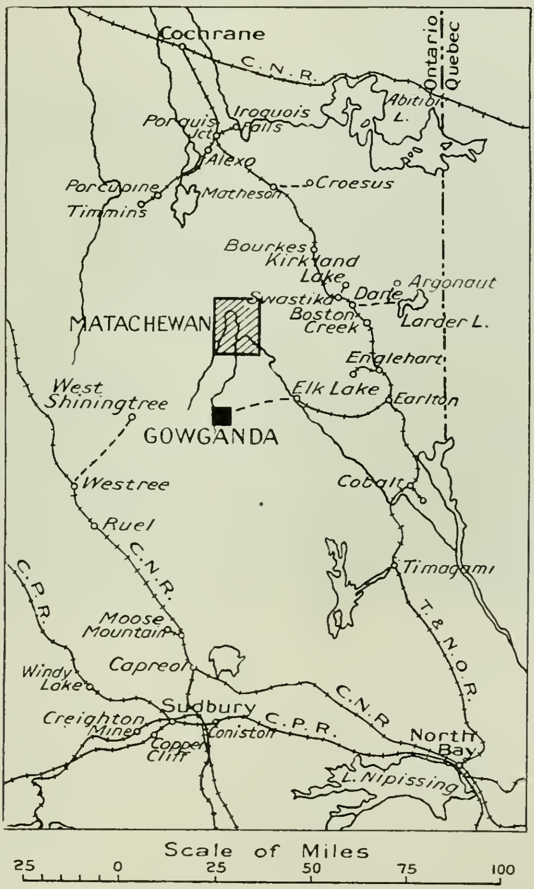
*McGuire* (3738).—The McGuire claim, which lies south of the southwest bay of West Shiningtree lake, was not seen by the writer. According to R. B. Stewart and W. H. Collins, there are several veins eight to ten inches wide, which strike east and west and dip to the north in a pyritous schist. Some rich samples of gold in quartz are said to have been obtained.

# MATACHEWAN GOLD AREA

By
A. G. Burrows

## Introduction

The Matachewan area is on the Montreal river, about 23 miles northeasterly from Elk Lake, the terminus of a branch line of the T. & N. O. railway. The camp is named from the Hudson's Bay Company's post at Fort Matachewan, on the Montreal river. It is reached during the open season from Elk lake by a water route; gasoline launches are used on long stretches of the Montreal river, with a short portage at Indian Chute, and a five-mile portage below Fox Rapids.




Key map showing location of the Matachewan gold area.

During the winter a sleigh road is used, partly following the same river. The chief interest in this district is at present centred in the development of the Matachewan gold mine.

The general geology of the area has been described in previous reports.[1]

[1] The Matachewan Gold Area. A. G. Burrows. Ont. Bur. Min., Vol. XXVII, 1918.
Geology of Matachewan District, Northern Ontario. H. C. Cooke. Memoir 115, Geological Survey, Can., 1919.

### Keewatin

The oldest rocks are of Keewatin age, consisting largely of lavas and fragmentals, which have been greatly altered from their original composition, many being now quite schistose. To the north of Davidson creek, in the townships of Powell and Cairo, the volcanic fragmental rocks are in the preponderance. They are greatly disturbed, the fine-grained ash rocks being highly tilted, and showing in places a crenulated structure along the strike. The ash rocks or tuffs are interbanded with altered basalts and other lavas, in which an indefinite pillow structure is occasionally seen. Some white-weathering schists were observed on the Davidson claim. To the north of the volcanic rocks there is a band of schistose conglomerate that can be traced from the west branch of the Montreal river easterly to Otisse lake. This conglomerate may be of Timiskaming age, but, for convenience, it is placed tentatively with the Keewatin.

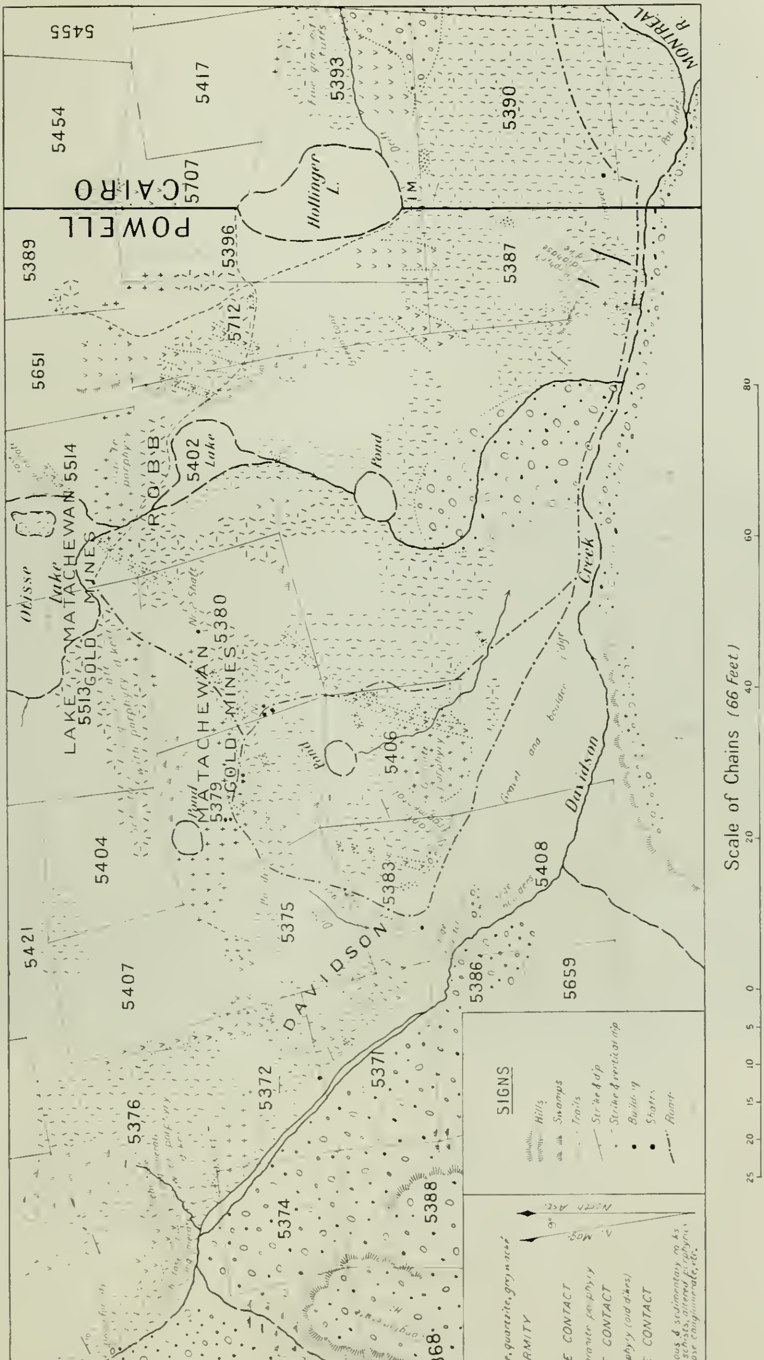
Scene at foot of Long portage, Montreal river, on route to Matachewan.

### Later Rocks

These old rocks are intruded by numerous dikes and stocks of syenite- and granite-porphyry. Dikes of serpentine were observed cutting the old schistose conglomerate along the Montreal river. Dikes of diabase intrude the porphyries and older rocks, while on the partly-eroded surface of all these rocks, conglomerate and related rocks of the Cobalt series have been deposited, and have been little disturbed.

### Acid Intrusive Rocks

The ore deposition is believed to have followed the intrusion of the syenite and porphyry, since these formations are in close association with the gold deposits, while the diabase dikes and conglomerate of the Cobalt series are later than the gold deposits. The acid intrusives occur at various points from the west branch




Geological plan of part of the Matachewan gold area.

easterly to Cairo township, the largest area being a mass of red syenite in Cairo and Alma townships. Numerous small masses of porphyry occur to the north of Davidson creek, and along the Montreal river, north of Matachewan Mines landing. Frequently the acid intrusives are massive and fresh in appearance, and again may be greatly altered and partly schistose. Some of the red porphyry shows distinct phenocrysts of feldspar. Such a rock is seen in the larger masses of orthoclase or syenite porphyry on the Davidson claims. A narrow dike of this rock intrudes older porphyry on claim 5376. A granite porphyry exposed in the central part of claim 5406, south of Matachewan gold mines, is greatly altered to schist, and is an older-looking rock than the syenite porphyry. A similar rock occurs on the east and west shores of the south bay of Otisse lake. A fine-grained, red hornblende syenite, quite massive, occurs on the west shore of the Montreal river, one-half mile north of the Matachewan Mines landing. Small outcrops of syenite were also observed

Quartz veinlets in syenite porphyry, Davidson claim, Matachewan.

farther up the river. Back from the river there is a heavy drift, and rock outcrops are infrequent, but outcrops of reddish intrusive rock are occasionally seen in the area west of the river to Otisse lake. It is probable that the different types of acid intrusives may belong to different periods of intrusion in Algoman times, during which time it is believed that most of the gold deposits of Northern Ontario were formed.

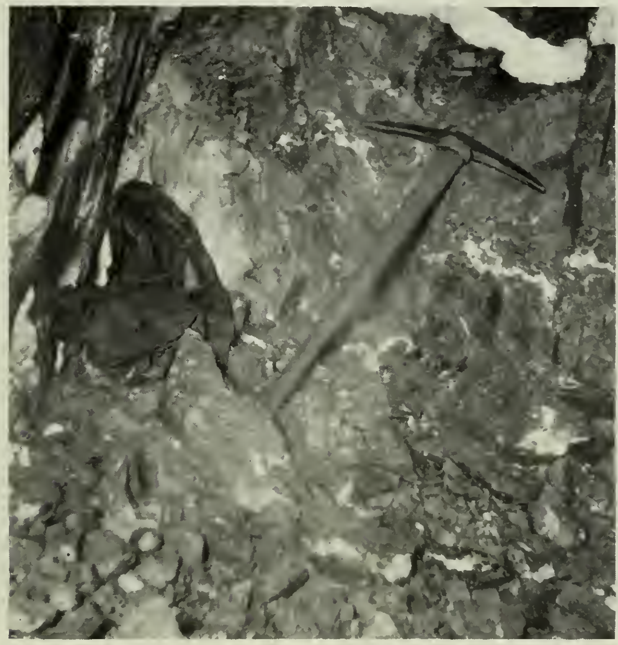
## Ore Deposits

### Davidson Claims

While the presence of gold-bearing veins in the Matachewan area has been known for several years, prominent attention was directed to the area by the discovery in 1916 of gold on the Davidson claims, in Powell township. During 1917 these claims were explored by means of trenches and several shallow cuts through the decomposed surface rock, and gold-bearing material found in several places; most work was done on irregular masses of quartz in a rusty weathering, greenish schist. Considerable surface work was also done on a red syenite or orthoclase porphyry intrusive, which is intersected by quartz veinlets in a more or less stockwork arrangement, with many of the veinlets roughly parallel. Some very good assays were obtained in parts of the porphyry intrusive, but no underground work has been done as yet on these claims.

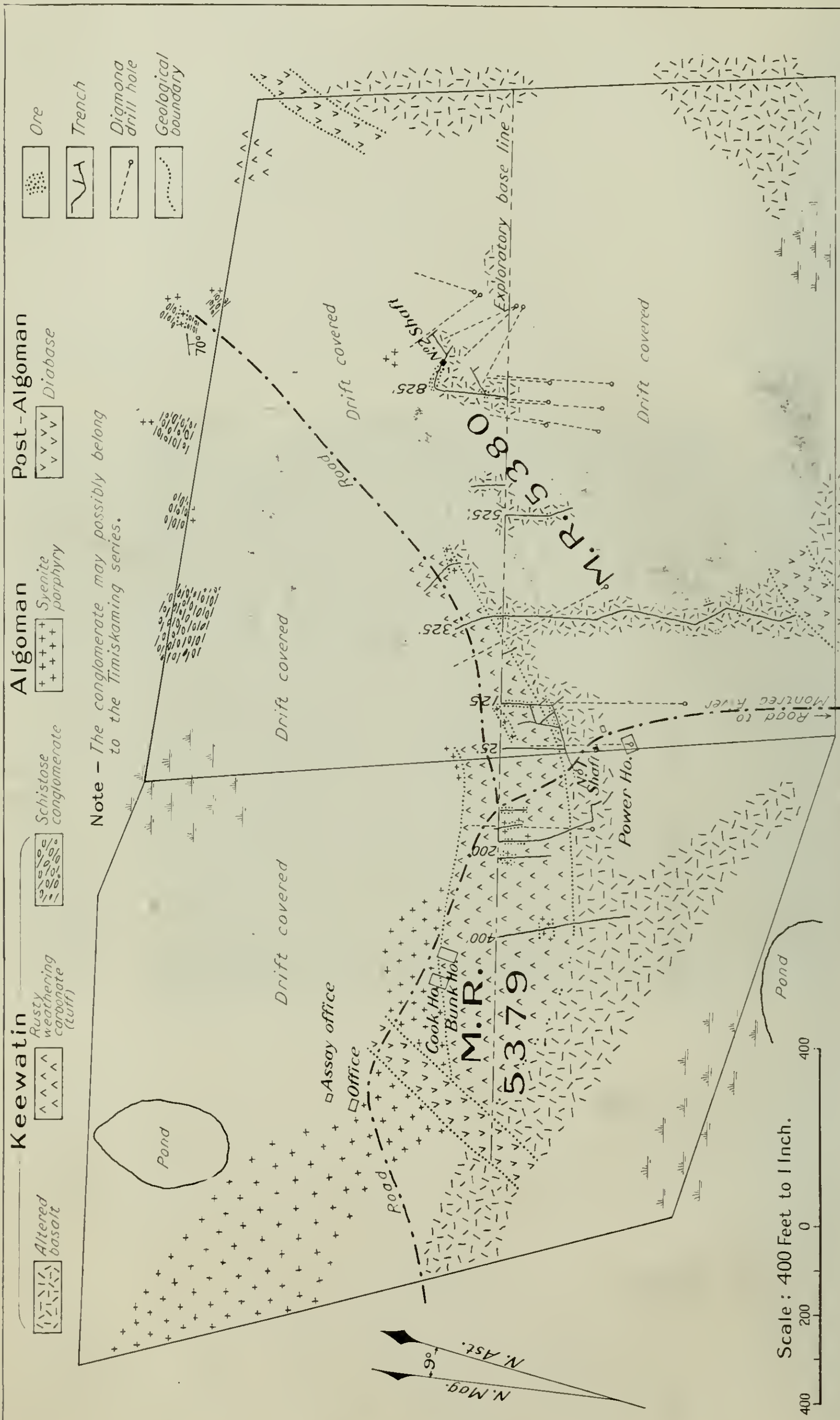
### Matachewan Gold Mines

Subsequent to the finding of gold on the Davidson claims, discoveries were made on the Otisse claim, adjoining the Davidson on the east. A small amount of



Face of drift, 170-ft. level, showing flat vein slightly faulted in mineralized zone, Matachewan mine.

prospecting was performed on the Otisse claims in 1917 by Samuel Otisse, who found gold in a number of places, either in hand specimens or by panning. His chief attention was given to the red porphyry, and a rusty weathering schist, that in fresh surface is light grey in colour, carries fine-grained iron pyrites distributed in it, and is infrequently cut by narrow quartz veins that carry some visible gold. It was not till early in 1918 that any extensive prospecting was performed on the property, when an option was taken by the Colorado and Ontario Mining Company, and later by the Matachewan Gold Mines. A systematic exploration was instituted by a regular system of trenches made along a base line that was established in a north-easterly direction along the trend of discoveries made by Mr. Otisse. As the claims are greatly covered with drift, very deep trenches were frequently necessary.




Detailed geological plan of Otisse claims, Powell township, now known as Matachewan Gold Mines.

after which shallow cuts were made to penetrate the oxidised surface, due to the oxidation of iron pyrites, and also of the iron in the carbonate. A number of separate ore shoots were indicated by this means. This trenching also revealed a number of small irregular porphyry bodies, only a few feet in width, of reddish and greyish colour, intruding the altered volcanics. The chief rocks in the vicinity of the ore bodies are dark-grey altered basalt and associated fragmental rock, which, when further altered by mineralizing solutions, are light grey in colour, and speckled with iron pyrites. To the north of the dark basaltic rocks there are light-greenish calcareous rocks, which frequently show a fragmental character, and are referred to by H. C. Cooke as rhyolite tuff. Whatever their original composition, these rocks are now readily recognized by their light-green colour,

Grey schist, with flat lying quartz vein, west of No. 2 shaft, Matachewan mine.

which becomes dark-green on exposure, and can be traced over several claims in a northeast-southwest direction. A sample of this rock from trench 125 was found to contain 30.4 per cent. of carbonate of lime, magnesia, and iron. To the northwest of these volcanics there is a broad band of reddish syenite- or orthoclase-porphyry, which appears to thin out toward the east into narrow dikes.

In addition to trenching, further prospecting was done by means of diamond-drilling, after which two shafts were sunk. No. 1 shaft was sunk to a depth of 170 feet vertically, and drifts were run on the 160-foot level along a mineralized contact between the basaltic rocks and the light-green calcareous rocks. In sinking this shaft a number of quartz veinlets dipping 20° to 30° northeast were encountered below 68 feet, showing mineralization of the basalt along the veins to 162 feet. Similar veins were encountered on the level. An illustration shows one of these veins slightly faulted. No. 2 shaft, 900 feet to the northeast, was sunk 30 feet following the dip of the ore shoot. As underground operations were found very costly, this work was discontinued until the advent of electric power, and further drilling was done in the vicinity of No. 2 shaft to indicate future underground exploration.

### Types of Ore

Several varieties of ore have been recognized in the workings. The most prominent is a light grey rock that has been altered from a dark basaltic rock, and is known as the Otisse ore. This carries abundant iron pyrites of small grain, much carbonate of iron, lime and magnesia, secondary feldspar, some sericite, and quartz in minute veinlets. A sample of this rock, as free from minute veinlets of quartz as could be obtained, has the following analysis: silica 37.78, alumina 14.68, ferric

View of plant, Matachewan mine.

oxide 1.44, ferrous oxide 2.50, lime 7.45, magnesia 2.90, soda 5.27, potash 0.25, carbon dioxide 6.95, water 2.00, iron pyrites 18.75.

This rock can be observed 75 feet northeast of No. 1 shaft, and at No. 2 shaft.

A somewhat darker rock, altered from basalt, occurs in trench 825, southwest of No. 2 shaft. A sample of this rock, impregnated with iron pyrites, contains: silica 33.62, alumina 20.68, ferrous oxide 3.22, ferric oxide 0.86, lime 11.48, magnesia 0.88, soda 5.42, potash 0.32, carbon dioxide 9.00, water 1.46, iron pyrites 12.94. A light-greenish rock containing considerable iron pyrites, from an ore zone in trench 125, contains: silica 31.14, alumina 15.44, ferrous oxide 3.37, ferric oxide 2.30, lime 10.92, magnesia 6.25, soda 3.90, potash 1.42, carbon dioxide 10.94, water 1.35, iron pyrites 12.96. These various rocks are cut by minute veinlets of quartz, which have acted as mineralizers, often hardly recognizable in hand specimens. Under the microscope the quartz veinlets are seen to carry feldspar and pyrite.

Several narrow dikes or irregular masses of red or grey porphyry occur in trenches to the west of No. 1 shaft. They intrude the light-greenish carbonate schist, and these, particularly the grey varieties, frequently carry high gold values. They are so irregular that it is impossible to connect outcrops revealed in trenches only twenty feet apart. The schist along the porphyry intrusions usually carries gold values, where there are quartz stringers and an impregnation with iron pyrites. The porphyry masses will sometimes grade from a reddish to a greyish colour. A grey porphyry from trench 200, where there is a gold mineralization, is distinctly porphyritic, containing large crystals of acid plagioclase in a fine-grained ground mass of quartz and feldspar, with much secondary carbonate in rhombic form, and cubes of iron pyrites. This rock is a syenite porphyry.

In places there are defined veins from an inch to six inches in width, which dip at a low angle, 15° to 20°, to the northeast. The general dip of the schist is to the south, while the strike is northeast-southwest to east and west. In places the altered and mineralized light grey schist is 10 to 25 feet in width. One mass of ore to the northeast of No. 1 shaft is 50 feet long with an average width of 20 feet. Two cross-sections of this ore showed assay values of $12.75 over 27.35 feet, and $18.31 over 22.75 feet. Another lens of light grey ore can be traced westward from No. 2 shaft, for 100 feet, into low ground. This ore averages about 10 feet in width. In trench 200 one section, 14.5 feet in width, of light-greenish calcareous and siliceous schist containing a band of grey porphyry showed an assay value of $20.25.

Usually where the schist is impregnated with pyrite and carries quartz veinlets it will contain gold values, although the work has shown that these vary considerably in the different trenches.

The chief metallic sulphide in the ore is iron pyrites which occurs more abundantly in the altered rock than in the quartz veins. The pyrite in the rock is usually very fine-grained, often being less than .25 mm. The pyrite in the altered greenish calcareous tuff is even finer grained than in the altered grey basalt. The pyrite in the quartz is frequently quite coarse; some crystals are 5 to 6 mm. in section. Copper pyrites occurs sparingly in quartz veins at No. 2 shaft. The tungsten mineral scheelite was observed sparingly in quartz from the same locality, in masses up to one and a half inches in length. Native gold is frequently observed in the low-dipping quartz veins, often along the margins of quartz and altered rock, and in minute, irregular quartz veinlets. It is also occasionally seen in the altered grey "Otisse" ore. The pyrite is auriferous, and some of the coarse crystals of pyrite from the quartz veins at No. 2 shaft, showing no visible gold, carry high values in gold.

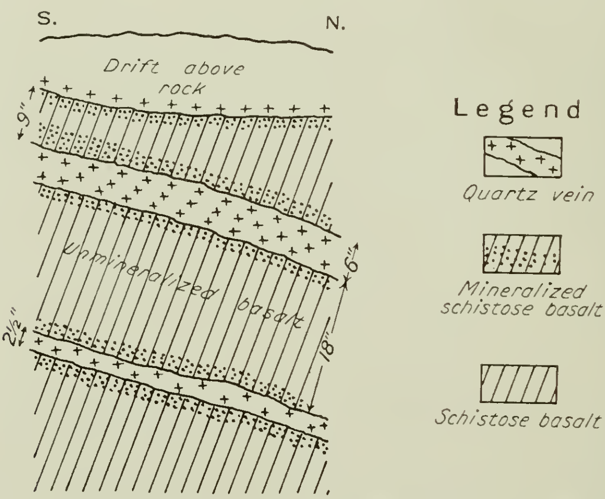
The alteration of rock along quartz veins can be well observed in a pit near the southwest corner of claim 5379, where the dark basalt has been altered for a few inches on either wall of a flat lying quartz vein that shows visible gold. The same condition occurs in an 8-foot pit, 100 feet east of No. 1 shaft, where there is a series of quartz veins in the basalt, with the alteration shown in the accompanying sketch.

In some localities the rock alteration has been very intense; good examples of this are seen in a body of ore 50 feet long by 20 feet wide, north of No. 1 shaft.

Here there are only a few small masses of dark-coloured basalt, while the altered grey rock carries numerous minute stringers of quartz, often less than a sixteenth of an inch in width, while the rock is heavily mineralized with fine-grained iron pyrites. A similar condition occurs in the vicinity of No. 2 shaft, where quartz veins several inches thick intersect the altered basalt.

H. C. Cooke[1] discusses the relationship of the red porphyry, grey porphyry and pegmatitic veins in formation of ore, pointing out that the red porphyry dikes have the least, and the pegmatitic quartz veins the greatest influence on the formation of the ore bodies. In the pegmatitic veins the feldspar is usually concentrated along the margins of the veins, although sometimes occurring irregularly in the quartz. While the best values are usually obtained where the quartz veins occur, occasionally there are pegmatitic quartz veins showing little or no values.

During the winter of 1919-20 in addition to diamond-drilling at the Matachewan mines considerable drilling has been done on the Robb claim, 5402, to the east of Matachewan Gold Mines, and on claims of the Lake Matachewan Gold Mines to the north and northeast.




Section 100 feet east of No. 1 shaft, Matachewan Gold Mines, showing part of west wall of shallow pit, illustrating mineralization along veins. Schists dip to the south and veins 15° to the northeast.

A number of claims in the vicinity had been partly prospected by surface trenching and shallow pits during the past two years.

The writer is indebted to T. J. Flynn, superintendent, W. H. Seamon, mining engineer, and E. Craig, in charge of surface exploration, at the Matachewan Gold Mine, for courtesies and assistance while at the mine.

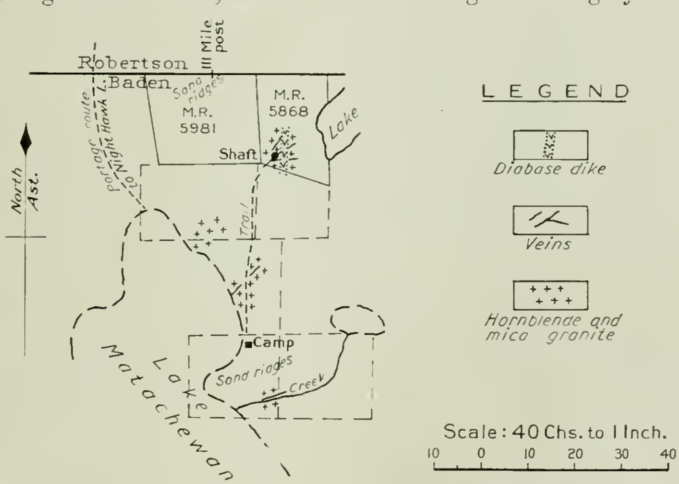
### Nelson Claims

The Nelson claims are located in Baden township, northeast of the northerly bay of the upper part of Lake Matachewan. They are staked on outcroppings of hornblende and mica granite, which protrude from the rolling sand ridges that

[1] The Origin of the Gold Deposits of Matachewan District, Northern Ontario, Economic Geology, Vol. XIV, No. 4, 1919, H. C. Cooke.

predominate in this part of the area. A number of quartz veins having a general northeast and southwest strike have been found on the property.

On Claim M.R. 5868, most work has been done on a series of veins about a quarter of a mile south of the north boundary of Baden. A shaft was begun on vein No. 1 which strikes north 61° east, and at the time of visit (September, 1919) was down 12 feet. The work showed 37 inches of quartz, interbanded with granite, with some pyrite, on the north wall. No visible gold was observed at the time, but Jas. Nelson states that a few feet deeper some coarse gold was obtained in quite rich specimens. The veins or lodes consist of narrow bands of quartz up to 15 inches in width, over an average width of about two and a half feet, with the quartz veins more or less continuous and branching roughly parallel to the strike of the lodes. The principal veins, No. 1 and No. 2, have been traced several hundred feet by means of trenches. Toward the east the series of veins is cut by a north and south dike of diabase, sixty feet in width. The granite is partly altered along the veins to a greenish colour, while the unaltered granite is grey or pink. The




Sketch showing Nelson claims, north end of Matachewan lake.

quartz in the veins frequently has a streaky character, due to inclusion of dark-coloured minerals in fine lines. About one-half a mile to the south-west another vein with similar characteristics is exposed, and has been traced down the bluff almost to the lake, where a tunnel into the hill has been begun.

On the south claim of the group, known as the Forest, there is a similar narrow quartz vein in the granite, which occurs in the bed of a creek between high sand ridges, and is traceable for several hundred feet. It contains a small amount of iron pyrites, and at one place a mass of well crystallized garnet, of the variety "andradite," showing isometric combinations, was observed. Some values in gold have been obtained in all these veins, and it is the intention of the owners to give them a careful exploration. The veins occur as shears in the granite and very probably are derived from it. The relation of the granite to the grey porphyrite that occurs to the south along the lake is not known, since they were not observed in contact. The granite is believed to be the younger rock. The presence of garnet in the veins indicates deposits formed at a high temperature.

### Barite in Yarrow Township

Several veins of barite have been located on a group of claims lying about three miles south of the north boundary of Yarrow township, on the west side of Mistinigon lake. The property, owned by the Ontario Barium, Limited, Toronto, includes four claims, G.G. 4222, 4223, 4328 and 4329. Most work has been done on a strong barite vein on claim 4223. This outcrops on the shore of the lake and strikes north 74° west. It is 5 feet wide at the lake, while 60 feet from the lake it is 13 feet in width. By means of trenches it has been traced at least 430 feet up the slope of a drift-covered ridge. At the farthest exposure, which was made through six feet of sand and gravel, a shaft has been begun where the vein is 11 feet wide. There are a few strips or "horses" of greywacké-conglomerate running with the vein, which are quite narrow relatively to the width of the vein.

The barite varies in grain, some being coarsely crystallized with cleavage faces an inch in width. Other portions are fine-grained, resembling greatly in appearance sugary quartz. The difference in grain gives the deposit a somewhat banded structure in parts. In colour the barite varies from a white to a faint pinkish, but all the material grinds white. A selected sample of barite carried 98.25 per cent. barium sulphate, while a channel sample taken by M. B. R. Gordon, from the surface, contained 81.24 per cent. barium sulphate. A sample of fine-grained barite taken by the writer carried 94 per cent. barium sulphate. As far as could be observed the deposit is free from sulphide minerals.

Barite also occurs in a vein a few hundred feet to the north on claim 4222 along the bed of a creek. Owing to the heavy overburden of gravel only a short part of the vein is exposed. Here the barite is separated into two bands, by a strip of greywacké, 7 feet 6 inches wide, the south barite band being 6 feet 4 inches and the north band 5 feet 10 inches wide. About 300 feet to the northwest there is a deep trench showing a strong barite vein that is probably part of that exposed in the creek. A sample of barite taken from the north vein by Mr. Gordon contained 77.14 per cent. barium sulphate.

As the claims are not surveyed, and the country is thickly wooded, the deposits have not been accurately located. From the amount of work done it is apparent that there is a large tonnage of high-grade barite. The country rock is greywacké and conglomerate of the Cobalt series. Granite outcrops on the east shore of Mistinigon lake.

Another large deposit of barite known as the Biederman, in Cairo township, has been described in an earlier report.[1] This occurs in syenite. If these deposits are of the same relative age the origin is not to be looked for in the syenite or granite, since these rocks are much older than the greywacké-conglomerate, which contains the veins in Yarrow township. A narrow vein of barite of honey-yellow colour, about four inches in width, occurs in Keewatin at the Matachewan mines. A few barite veins carrying native silver have been found in the Nipissing diabase in the Elk Lake silver area.

[1] Matachewan Gold Area. Ont. Bur. Min., Vol. XXVII, 1918, p. 237.

# ARGONAUT GOLD MINE

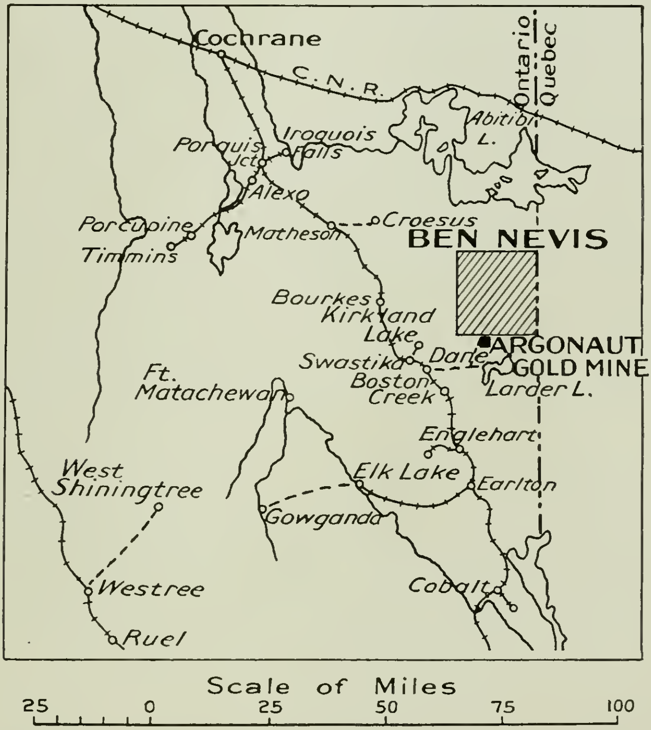
## (Formerly La Mine D'Or Huronia)

By

Cyril W. Knight

### Introduction

At the request of the management of the Argonaut gold mine the writer spent ten days during the summer of 1919 in examining and making a somewhat detailed map of the property. The previous map of the area, by A. G. Burrows,[1] was on a small scale—a mile to the inch—and included all of the township of




Key plan showing the location of the Argonaut gold mine, district of Timiskaming. The dotted lines indicate wagon roads.

Gauthier. Moreover, the report on Gauthier township by Burrows[2] being out of print, and the Argonaut gold mine having begun operations in the latter part of 1918, after having been closed for about two years, it was felt that the publication of a new report together with a detailed map would serve a useful purpose.

[1] Ont. Bur. Mines, Vol. XXVI, 1917, pp. 252-257.

[2] Ibid.

### Location

The Argonaut gold mine, operated by a company called Argonaut Gold, Limited, was formerly known as La Mine d'Or Huronia; the name was changed in 1919. It is located near the south end of Beaverhouse lake at the northeast corner of Gauthier township, district of Timiskaming. The property is reached by way of Dane, a station on the Temiskaming and Northern Ontario railway 57 miles north of Cobalt. From Dane the Larder lake wagon road is followed easterly for about 12 miles, after which a branch road leads north to the mine, which is about 18 miles from Dane.

### Previous Reports

The earliest references to what later became known as the Argonaut gold mine were made by W. G. Miller in 1901 for the Ontario Bureau of Mines, and by W. J. Wilson in the same year for the Geological Survey of Canada. Miller made a reconnaissance of the country between Lake Timiskaming and the height of land separating the St. Lawrence valley from Hudson Bay. During his trip he noted some rusty rocks at the foot of Beaverhouse lake. "About 50 yards," Miller wrote,[1] "east of the portage at the foot of Beaverhouse lake, on a continuation of the ridge which runs across the rapids, some blasting has been done, exposing dolomite with a little iron pyrites in the slate." This reference shows that prospecting had been going on in this part of the country at least five years before the Larder lake boom began in 1906.

W. J. Wilson's reference to the rocks at the foot of Beaverhouse lake is as follows: "A ridge of dolomite rock containing iron forms a dam across the south end of the lake."[2]

Three years after Miller and Wilson had made these preliminary examinations of the waterways, W. A. Parks made a reconnaissance of part of the same region in 1904; he also noted the "rusty and dolomitic rocks" at the foot of Beaverhouse lake.[3]

The first reference to the property after it became known as La Mine d'Or Huronia is by Burrows and Hopkins, who, in 1914, briefly described it as follows:[4]

> Gold-bearing quartz veins have been found in the northeast part of the township [Gauthier], just west of Beaverhouse lake, on claims now operated by La Mine d'Or Huronia. The quartz veins are narrow, but gold can be observed at a number of places. Magnetite, iron pyrites, and copper pyrites were observed in the veins. The country rock is Keewatin greenstone, which is intruded by narrow dikes of reddish porphyry.

In 1915 A. Paré examined the mine, then La Mine d'Or Huronia, for N. A. Timmins. During his work Mr. Paré made a detailed geological map of the property, showing the feldspar-porphyry dike, buildings, veins, etc. The examination was a very complete one, and a large number of samples for assaying were taken. The exact location of each of the samples was clearly marked by a large number in red paint. These numbers were still plainly discernible in the summer of 1919. The writer did not see a copy of Mr. Paré's report, which was not made

[1] Ont. Bur. Mines, Vol. XI, 1902, p. 223, "Lake Temiscaming [Timiskaming] to the Height of Land," W. G. Miller.
[2] Geol. Sur. Can., Vol. 14, 1901, p. 119 A., W. J. Wilson.
[3] Geol. Sur. Can., Vol. 16, 1904, p. 217 A., W. A. Parks.
[4] Ont. Bur. Mines, Vol. XXIII, Part II, 1914, pp. 31-32, A. G. Burrows and P. E. Hopkins.

public. There is a geological map in the office of the Argonaut gold mine, showing the veins, location of buildings, and the feldspar-porphyry dike which cuts across the property. The map accompanying the present report is based on this.

In the autumn of 1916 A. G. Burrows wrote the following brief report on the property.[1]

In the year 1912 gold-bearing veins were discovered to the west of Beaverhouse lake along an expansion [now called York lake] of the Blanche river. The prospectors who located the claims sold to a company which operated the property under the name "La Mine d'Or Huronia." Considerable prospecting was done on the ridge to the west of the Blanche river, and several narrow gold-bearing veins were located. These veins, usually only a few inches in width, are roughly parallel and strike N. 40° E. Reddish felsite or porphyritic material usually occurs along the walls of the veins, suggesting a relationship between the quartz veins and the porphyritic dikes. The sulphide minerals in the veins are iron and copper pyrites. Masses of copper pyrites, several pounds in weight, are sometimes met with, and these frequently carry small fragments of reddish feldspar-porphyry. Grains of magnetite can be observed in some of the vein material; calcite occurs in minor quantity. On the east side of the expansion of the Blanche river and a few hundred feet south of the mill there is a reddish felsite dike, about 14 feet in width, which has been traced some distance, with a strike of N. 170° W. In this dike there are veinlets of magnetite, which are usually parallel to the walls of the dike. One of these is about four inches wide, and is almost all magnetite accompanied by some copper pyrites and quartz. The dike occurs in basic Keewatin rock. Native gold occurs in several shows on the surface of this dike in minute quartz veinlets. A shaft was sunk to a depth of 102 feet in the porphyry dike.

Most of the work was done on the west side of the expansion. An open cut was made on one of the wider veins on the summit of the ridge, and from this cut some ore was sent to the mill. A shaft was sunk at the open cut to a depth of 65 feet. A tunnel was also driven from near the shore of the lake, and a shaft was sunk a short distance to the south of the 100-foot level, and a cross-cut run to the north to intersect veins which showed on the surface. Most of the ore treated in the mill came from the west side of the lake, and was trammed across the lake on a floating tramway.

The property has been operated intermittently for several years. A mill was constructed consisting of 15 stamps, a tube mill, Dorr classifier, three concentrating tables, two slime tables and a cone classifier. The concentrates were stacked for future treatment. The mill was run for a short time in the autumn of 1916. A sample of the fresh concentrates assayed $25.40 per ton in gold, and 5.69 per cent. in copper. The mill is electrically driven by power supplied from Raven falls, south of Larder lake.

In 1919 P. E. Hopkins gave a summary of the operations carried on at the property. His description is as follows:[2]

Gold was found in 1912 on claims L. 2586 and L. 2587, on the west shore of Beaverhouse lake, in Gauthier township. These claims were taken up by La Mine D'Or Huronia and have been worked intermittently ever since, except in 1915, when an extensive examination was made of the property by A. Paré for N. A. Timmins, who had it under option; the option, however, was not exercised. A. G. Burrows describes the quartz veins as being narrow and striking northeast in a greenstone cut by quartz porphyry dikes. Gold is visible, accompanied by iron pyrites, copper pyrites, magnetite and calcite. Gold also occurs in veinlets in the porphyry. Development work consists of numerous test pits, approximately 1,000 feet of underground work and considerable diamond drilling. The plant comprises a 15-stamp mill, a tube mill, Dorr Classifier, 3 concentrating tables, 2 slime tables and a cone classifier. Power was supplied for a time by the company's hydro-electric plant on Victoria creek, three-quarters of a mile distant, but owing to scarcity of water the plant could not be operated for long. By December 10th, 1915, a transmission line was completed from the Associated Goldfields and ample power obtained. The mill ran part of 1916, but the property was closed on December 2nd of that year, the total gold production being in the neighbourhood of $9,165. Operations were again resumed at the end of 1918.

## Production

The production for November and December of 1919, and for January and February of 1920 amounted to $9,926. Added to the previous production, as

[1] Ont. Bur. Mines, Vol. XXVI, 1917, pp. 255-256, A. G. Burrows, "Gold in Gauthier Township."

[2] Ont. Bur. Mines, Vol. XXVIII, Part II, 1919, P. E. Hopkins.

reported by Mr. Hopkins, the total output of gold from this mine up to the last-mentioned date was $19,091.

## Geology

The rocks in the neighbourhood of the deposits are pre-Cambrian in age and belong mainly to the Keewatin series. They are cut by a network of dikes or irregular masses of feldspar-porphyry, felsite and lamprophyre which are probably Algoman in age.

### Keewatin

The present conception of the Keewatin series in Ontario and the Lake Superior region is that it is made up of a great number of flows of lava. A series of these Keewatin lava flows may be seen, for instance, in Holloway and Harker townships, about 20 miles north of the Argonaut gold mine, where at least 14 flows occur, having a total thickness of 4,400 feet.

An attempt was made at the Argonaut property to ascertain whether or not a number of lava flows were present in the Keewatin. It was found, however, that it was not possible to recognize more than one flow in the neighbourhood of the deposits. Of course, if the flows are resting in horizontal or nearly horizontal position, then it might be found that, as shaft-sinking proceeded, other flows would be encountered with depth. If a flow of rhyolite, for instance, were encountered, it might exert some influence on the character of the gold deposits—beneficial or otherwise. However, some of the Keewatin lava flows are of great thickness, 600 feet or more, so that a change in the character of the rock might not take place for many hundreds of feet in depth. This statement does not, of course, take into consideration the dikes of feldspar-porphyry and other intrusions which intersect the Keewatin; these dikes are referred to later.

The Keewatin, as exposed on the surface and in the mine workings at the Argonaut property, is basalt or some other closely related lava. It is a dark green, fine-grained rock, which has at times a pillow structure and amygdaloidal texture. Pillow lava may be seen at the northwest corner of L. 2586. Although the Keewatin is, on the whole, massive, and seldom changed to a schist, it is nevertheless tremendously fractured, and intersected by innumerable cracks which cut the rocks at a great number of angles. While such changes are not common, it may be noted that in certain areas the Keewatin is altered to schist. One of these metamorphosed areas occurs at the rapids on Victoria creek on L. 2601. Not only is the Keewatin schistose in this vicinity, but the feldspar-porphyry dike is also schistose, showing that the rocks were altered, in part at any rate, after the intrusion of the feldspar-porphyry dike.

There is a small outcrop of banded cherty rock at the roadside on the west boundary of L. 2586.

### Ankerite

At the northwest corner of claim L. 2589 there is a band of ankerite rock 100 feet or more in width. It first outcrops at the dam at the foot of Beaverhouse lake and strikes to the southwest. This rusty rock was noted by W. G.

Map No. 29d.

# ARGONAUT GOLD MINE

(Formerly La Mine D'Or Huronia)

Townships of Gauthier and McVittie, District of Timiskaming.


*To accompany report by C. W. Knight in Volume 29, Ontario Bureau of Mines Report, 1920.*

Miller[1] in 1901 and by W. J. Wilson[2] in the same year, also by W. A. Parks[3] in 1904.

The ankerite band consists of Keewatin rocks through which the ankerite is disseminated in grains. The mineral also occurs in numberless, irregular veinlets which intersect the Keewatin in a most complex manner. These veinlets vary from fractions of an inch to several inches in width. Here and there are irregular stringers of quartz carrying pyrite and copper pyrites. The quartz veins are but a few inches in diameter.

Judging from the outcrop at the dam, the ankerite appears to be dipping towards the northwest. It would be unwise, however, to infer from the structure at the dam that the whole band of ankerite dips in that direction. It will require diamond-drilling or underground workings to find out definitely the direction of the dip.

Considerable trenching and blasting has been done along this band. Work was done on it long before the property was acquired by the Argonaut gold mine. As early as 1901 Miller stated that there had been some blasting. No work was being carried on during the summer of 1919.

A sample of the material was submitted to W. K. McNeill, Provincial Assayer, who determined it to be ankerite, a carbonate of iron, calcium and magnesium. This material occurs in a great many localities in northern Ontario. The ankerite at the Argonaut gold mine appears to be a replacement deposit in which the mineral replaces the Keewatin rocks. The origin of the solutions which carried the ankerite appears to be obscure.

The rock weathers readily, and turns a brownish, rusty colour on the surface.

There are other occurrences of ankerite on the property. The rusty schist at the rapids on Victoria creek in L. 2601 is impregnated with the mineral. There is also an occurrence on L. 2602.

### Algoman ?

Cutting the Keewatin there is a network of dikes consisting of feldspar-porphyry, felsite and lamprophyre. The age of these intrusives is uncertain, although they may be Algoman.

*Feldspar-Porphyry.*—One of the most prominent of these intrusives outcrops at the bridge over the rapids between Ava and York lakes. A similar rock, probably the same intrusive, outcrops about 200 yards to the southwest on the west shore of York lake, and continuing southwestward gradually turns west and finally northwest, forming a rudely horseshoe-shaped mass. This feldspar-porphyry, which, according to Burrows and Hopkins, resembles the Kirkland lake porphyry, has a pink colour and contains phenocrysts of white or grey to pink feldspar averaging from a sixteenth to an eighth of an inch in diameter, more or less. It is massive and non-schistose, except the northwest arm at the rapids on Victoria creek, where it is altered to a schist.

[1] Ont. Bur. Mines, Vol. XI, 1902, p. 223, W. G. Miller.

[2] Geol. Sur. Can., Vol. 14, 1901, p. 119 A, W. J. Wilson.

[3] Geol. Sur. Can., Vol. 16, 1904, p. 217 A, W. A. Parks.

Considerable diamond-drilling has been carried on, which discloses to a certain extent the underground structure of the feldspar-porphyry. The drilling appears to show that the northeast arm of the dike is dipping to the northwest. If this proves to be the case, then such a structure might have an important bearing on the character and size of the gold deposits, because the veins will, if they are persistent, encounter the porphyry at depth. Will the gold deposits be enriched when they encounter the porphyry at depth, or will they be impoverished, or will they not be affected at all? These are questions which are of vital importance.

A thin section of the feldspar-porphyry, examined under the microscope, shows that the phenocrysts of feldspar are in part banded and in part without banding. The mineral is cloudy and somewhat altered, the cloudiness being probably due to the presence of kaolinite. Hand specimens show that the matrix in which the phenocrysts occur is in places green and in places pink or red. The thin section shows the matrix to consist of feldspathic material partly decomposed to sericite and other secondary minerals. Chlorite also occurs in the matrix, which probably gives it a greenish colour at times. In addition to the phenocrysts of feldspar, there are also a few smaller phenocrysts which are now decomposed to sericite, epidote and other minerals.

The pink feldspar-porphyry was not observed in contact with the felsite or lamprophyre. The age relation between the porphyry and the other intrusives is therefore not known. A two-inch dike of feldspar-porphyry was, however, seen cutting the felsite.

There is also an outcrop of feldspar-porphyry on the southwest part of L. 2588, on the southeast face of the hill. It has phenocrysts of grey or pink feldspar as long as one-quarter to three-eighths of an inch. These crystals are set in a fine-grained pink matrix. This porphyry differs from the pink feldspar-porphyry west of York lake in having fewer and larger phenocrysts of feldspar.

*Felsite and Lamprophyre.*—The felsite intrusives form an amazing tangle of dikes between York and Ava lakes. Not all of them are shown on the map. The intimate association of the felsites with the auriferous veins leaves little doubt that there is some genetic connection between the veins and the intrusives.

A thin section of one of these felsite dikes at shaft No. 1 is described as being made up of quartz, feldspar and a few small grains of hornblende.

The felsite dikes appear to grade into lamprophyre. These lamprophyre intrusions, which often contain inclusions of basic rocks, occur for the most part northeast of Ava lake. Hornblende and pyroxene-lamprophyre are both found. Four thin sections of the lamprophyric rocks were examined under the microscope. The hornblende and augite occur in phenocrysts set in a matrix of feldspar which shows banding at times. Hornblende also may occur in the matrix. Quartz and biotite are found in subordinate quantities. These lamprophyre rocks pass into types which are more properly called syenites.

Many fine grained, small dikes, pink or grey in colour, cut the Keewatin rocks immediately north of the dam between Beaverhouse and Ava lakes. The Keewatin is considerably altered here, and epidote is developed in places near the larger intrusions.

#### Pleistocene

The north half of claims L. 2587 and L. 2588 and most of L. 2589 are covered with deposits of clay.

### Ore Bodies

The writer did not have access to the company's assay plans showing the value of the ore bodies, and can therefore express no opinion regarding the economic possibilities of the property. It may be remarked again, however, that the feldspar-porphyry is said by Burrows and Hopkins to be similar to that at Kirkland lake.

There are said to be more than a score of veins, all of them containing gold, on the Argonaut property. Some of the "veins" appear to consist mainly of felsite or feldspathic material in which occur magnetite, copper pyrites, pyrite and gold. Other veins are made up mostly of calcite, while still others consist mainly of quartz. It may be added that copper pyrites is a characteristic mineral in many of the ore bodies. Most of the veins strike northeastward and have more or less vertical dips. There has been about 1,400 feet of underground work done up to the spring of 1920.

Some of the deposits may be described in order to illustrate the character of the ore bodies.

Vein No. 1 A is at the southwest corner of L. 2587. A shaft, known as No. 2, has been sunk to a depth of 75 feet, and 125 feet of drifting has been done on the 50-foot level.[1] The shaft was full of water in the summer of 1919, but an open cut exposed the vein. At the southwest end of this open cut the character of the deposit may be examined. Commencing at the southeast corner of the open cut, it is seen that the first 13 inches consist of basalt which is intersected by veinlets of calcite and pink felsitic or feldspathic material, these veinlets being small fractions of an inch in diameter. This is followed by 14 inches of pink felsitic or feldspathic material containing much country rock. Calcite and copper pyrites are present in veinlets and in disseminated grains. Next comes a pinkish-white calcite vein two to four inches wide containing some copper pyrites; then seven inches of basalt containing veinlets of calcite; next a zone 15 inches wide consisting mainly of copper pyrites together with other material. This is followed by 30 inches of pink felsitic material with some basalt. Stringers of magnetite fractions of an inch wide cut the pink material. This gives a total width to the southwest face of the open cut of about 7 feet. It will be seen that quartz forms little or no part of this particular deposit. The large amount of felsitic or feldspathic material shows that there is in all probability some connection between the felsite dikes and the origin of the deposits.

Another vein, which was referred to as the "new" vein at the time of our examination in the summer of 1919, occurs about 100 yards south of the northwest corner of L. 2586, near a diamond-drill hole. This vein is not shown on the map accompanying the report. It strikes north 35° east and has been stripped for about 40 feet. The vein consists of magnetite, copper pyrites, quartz and pink feldspathic material. A section across a certain part of the vein was found

[1] Ont. Bur. Mines, Vol. XXIV, Part I, 1915, p. 145.

to be made up as follows:—there are first three or four inches of magnetite and copper pyrites which stand out sharply, on the surface, from the Keewatin wall rock and the next material to be mentioned. This latter consists of 13 inches of pink feldspathic substance together with some Keewatin wall rock. The next zone consists of five inches of copper pyrites and magnetite and some pink feldspathic material; this is followed by five inches of pink material. The total width of the cross-section is about 27 inches. It will be noted that there is little or no quartz in this particular cross-section of the vein. The pink feldspathic material is a prominent feature in the deposit, again suggesting the connection between the intrusions of felsite or feldspar-porphyry and the origin of the ore bodies.

The deposit on which shaft No. 1 has been sunk lies about 250 feet southeast of the mill and consists of a pink dike 14 feet wide described by A. G. Burrows as a felsite. It is made up of a fine-grained quartz-feldspar matrix in which occur a few crystals of hornblende.[1] A shaft has been sunk to a depth of 102 feet, and 12 feet of cross-cutting has been done on the 85-foot level.[2] This shaft was begun on a vein of magnetite four or five inches wide in the dike. Other small veinlets of magnetite are also found in the dike. A small amount of copper pyrites and quartz accompanies the magnetite. Native gold occurs in these magnetite veinlets. This felsite dike is part of a complex system of dikes occurring between York and Ava lakes. Some of these dikes are shown on the geological map accompanying the report.

The feldspar-porphyry, at the bridge over the river between York and Ava lakes, contains small stringers of quartz. It is stated that gold may be panned from the porphyry at this point.

The band of ankerite, running to the southwest of Beaverhouse lake, has had considerable trenching and blasting done on it in past years. No mining operations were being carried on along this band in the autumn of 1919. As a matter of curiosity the writer took a hand specimen of the ankerite for assay. W. K. McNeill, Provincial Assayer, reported that it contained $2.40 in gold per ton.

In the latter part of 1919 and the early part of 1920 the Argonaut gold company was concentrating its efforts on No. 3 shaft, which is at the north end of York lake near the shore. At the end of March 1920 this shaft had been sunk to a depth of 204 feet. On the 100-foot level a small amount of work had been done and lenses of ore encountered which were not sufficiently continuous to encourage further work. About 50 feet of drifting was done on one vein and 100 feet on another. On the 200-foot level these veins were cross-cut, the cross-cut being 170 feet long. The ore on this level was said to be higher in grade than on the 100-foot level. About 150 feet of drifting was done on the 200-foot level on one of these veins, No. 286, the latter apparently the equivalent of No. 186 on the level above. On the other vein, No. 216, a drift 100 feet long was run.

It is the intention of the company to cross-cut from the 200-foot level of shaft No. 3, southwest to intersect the feldspar-porphyry. At the end of March 1920 a cross-cut 120 feet long had already been run with that object in view.

[1] Ont. Bur. Mines, Vol. XXVI, 1917, p. 254.

[2] Ont. Bur. Mines, Vol. XXIV, 1915, Part I, p. 145.

Office and mill, Argonaut gold mine, looking east. Beaverhouse lake is in the distant background, York lake in the foreground.

Mine workings at Argonaut Gold, Limited, on west side of York lake. The mill is on the east side of the lake.

Stamps at Argonaut gold mine, Gauthier township, showing quadrant plate.

Mill at Argonaut gold mine, township of Gauthier.

## Origin of the Ore Bodies

It is probable, as suggested by A. G. Burrows, that the ore bodies owe their origin to the intrusions of felsite and feldspar-porphyry which cut the Keewatin. Indeed, some of the deposits are simply felsite dikes which have been mineralized by the introduction of copper pyrites, magnetite, gold and other minerals.

The geological history, in a general way, of the deposits appears to be somewhat as follows: the Keewatin rocks were fractured and these fractures were intruded by dikes, or irregular masses, of feldspar-porphyry, felsite and lamprophyre. After these intrusions had consolidated, cracks, in some instances, were formed in the felsites: then magnetite, copper pyrites, calcite and other minerals were introduced. It is quite clear that some of the calcite veins are younger than the dikes, since on claim L. 2586 a calcite vein cuts across a felsite dike.

## Milling Operations

The 15-stamp mill on the property was remodelled during the summer of 1919 by John E. Hardman. The plant, as it now stands, in March, 1920, is simply used for testing purposes. The intention is to construct a 300-ton mill. Mr. Hardman has very kindly furnished the writer with the following description of milling operations.

The mill was remodelled solely to act as a test mill, so that data might be obtained for the construction of a large mill that would successfully extract the largest possible percentage of the total values contained in the ores. The present mill was not intended to produce bullion commercially and permanently.

The mill contains 15 stamps of the ordinary pattern, each weighing 1,250 pounds; these drop 100 times per minute and discharge through "Tyler" wire screens having an aperture of about .55 mm.

The batteries have an inside "V" plate, an outside splash plate 8 inches wide, a "quadrant" plate with a radius of 9 inches and the usual 8 feet of table plate. The mercury traps are of the usual Homestake type and all the table tails run through a 4-ft. clean-up pan before passing to the concentrating tables.

It is not probable that the new mill will use stamps to comminute the ore, as it has been proved that this can be done more cheaply by other machines that are not so expensive to erect or build.

The main items that are desired from the test mill are: (*a*) the average value in free gold that is amenable to amalgamation; (*b*) the percentage of metallic sulphides in the ore and the gold values therein contained; (*c*) the gold values in the non-metallic tails. The necessity for (*b*) arises from the fact that the Arognaut sulphides are cupriferous, carrying from 3 to 12 per cent. of metallic copper, and putting their treatment quite outside the usual cyanide methods. A process is now being devised that promises to recover both copper and gold values at a favourable cost so that both metals will help the profits.

The results that have so far been obtained from working some 2,000 tons have been very satisfactory; the average amalgamation recovery being 68 per cent. of total assay value, and the values in the concentrates averaging but 17 to 18 per cent. of total gold values. The 15 per cent. in the final tails yields its gold to a dilute cyanide solution.

Argonaut Gold, Limited, will not decide on either the process or the equipment of the new mill until a sufficient number of tests have been made on the red porphyry ore that underlies the Keewatin basalts. A cross-cut, No. 203, is now driving to cut this porphyry ore, but is not expected to reach it before midsummer; it is possible that a different mineralization may demand additional niceties or equipment in the mill.

## Acknowledgments

Thanks are due to the management of the Argonaut gold mine for kindness in giving the party every assistance in the geological survey of the property. The management placed at our disposal a geological map showing the location of the

feldspar-porphyry dike, the veins, buildings, roads, diamond-drill holes, etc. The geological map, accompanying the present report, is based on this map.

The management of the property is now under the efficient direction of J. W. Morrison, whom the writer particularly desires to thank for his kindness. John E. Hardman has furnished the Bureau with an account of the milling operations, and also the photograph of the interior of the mill showing the stamps and plates. The writer wishes to express his thanks to Mr. Hardman for these and other courtesies.

Messrs. R. Elliott, D. E. Kerr-Lawson and R. Presgrave were members of the geological survey party and assisted in the mapping.

# GOWGANDA SILVER AREA

By

A. G. Burrows

## Introduction

The writer spent nearly two weeks in September and October, 1919, in making a brief examination of the recent developments in Gowganda, particularly in the vicinity of Miller lake. A geological map of six townships was published by the Bureau of Mines in 1910, accompanying the report that appeared in Volume XIX, Part 2. The Geological Survey of Canada published a map covering a wider area to accompany Memoir No. 33, "The Geology of Gowganda Mining Division," 1913, by W. H. Collins. The reader is referred to these reports and maps for a general description of the geology and the properties in operation at that time.

## Location

The village of Gowganda [1] is about twenty-seven miles by wagon road west of the town of Elk Lake, the terminus of the T. and N. O. railway branch line from Earlton.

Silver was discovered in 1908 in the vicinity of Miller, Leroy and Calcite lakes, and later in the fall of the same year to the west of Gowganda lake. The latter discoveries caused a wide-spread rush and the staking of most of the surrounding area.

## Development

From that time to the present there have been shipments of silver ore from Gowganda, derived from properties near Miller lake, west of Gowganda lake, and east of Calcite lake. The great preponderance of the ore shipped has come from northwest of Miller lake. Several shipments of high-grade silver ore have been made from the Mann ridge west of Gowganda lake. In 1910, 1911 and 1912 the Millerett mine was the chief producer, and since that time the Miller Lake O'Brien. The latter deposit has supplied most of the silver ore yet shipped from Gowganda. With the exception of an ore shoot in conglomerate in the Millerett mine, which produced about 500,000 ounces of silver, all the ore to the end of 1919 has come from the diabase sill. From 1909 to the end of 1919 the total production was approximately 5,430,152 ounces.

Gowganda Production.

| Year. | Ounces Silver. |
|---|---|
| 1910 | 481,523 |
| 1911 | 468,687 |
| 1912 | 549,976 |
| 1913 | 502,370 |
| 1914 | 399,300 |
| 1915 | 242,229 |
| 1916 | 360,670 |
| 1917 | 1,064,635 |
| 1918 | 638,198 |
| 1919 | 722,564 |
| Total | 5,430,152 |

[1] The location of Gowganda is indicated on the key map, page 28.

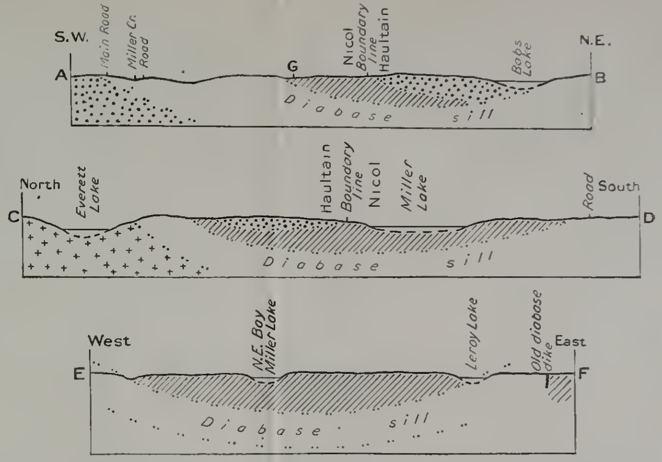
### Geology

The rocks at Gowganda are in general similar to those at Cobalt. The oldest are of Keewatin age, consisting chiefly of greenstones and basic tuffs, with minor volume of light-coloured porphyritic rocks and iron formation. Pillow structure in lava is rare, but was observed north of number one post of W. J. 1 (1702), east of Leroy lake. Tufaceous rocks are prominent around Leroy lake and south of Everett lake. These old rocks are frequently very schistose. Intruding them are granite and syenite, of Laurentian or Algoman age. On the eroded surface of the Keewatin rocks and the granite and syenite, sedimentary rocks of the Cobalt series were deposited, and these have been little disturbed. They usually dip at low angles, but occasionally reach dips of 45°, shown a mile east of Lost lake on the government road.

Later than all these rocks are diabase sills that are here and there exposed by erosion, in large volume. They not only intrude the Cobalt series, but in places cut below the contact of this series with the older rocks. This is illustrated in the vicinity of Miller lake, where an area of Keewatin, overlain in part by conglomerate, and about two miles in width, lies on the diabase sill. Erosion has removed large volumes of the sill, which is also concealed by overlying rocks, where it dips under them. There are several fresh-looking dikes of diabase throughout the area, particularly in the Keewatin and in the granite and syenite, which may be of similar age to the sill diabase. In addition, a number of dikes of quartz diabase and olivine diabase intrude the sill diabase, and are therefore the youngest rocks in the area.

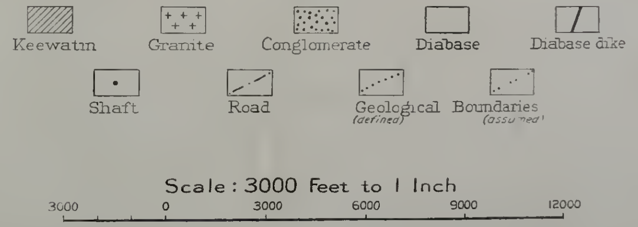
While the relationship of the sill diabase to the other rocks has not been studied closely, there are a number of contacts throughout the area showing its sill-like character. Northeast of Elkhorn lake the diabase dips under the sedimentaries at about 20° E. South of Shanty lake it overlies the slate almost horizontally. About seven hundred feet west of the Miller Lake O'Brien road there is an erosive remnant of sill diabase overlying sedimentaries. From this patch, only a few inches in thickness, the diabase can be followed northeasterly with increasing thickness to Miller lake, where it dips under the Keewatin. In the former place the lower or foot wall of the diabase is exposed, and in the latter, the upper or hanging wall. The westerly side of the diabase sill, exposed to the west of Miller lake, was followed from near Everett lake to the main wagon road, and only at the latter place was the actual contact observed. At another time the westerly edge of the sill to the east of Everett lake was observed to show the diabase above the sedimentary rocks, hence it is evident that this contact represents the lower or foot wall of the diabase. Directly west of the Miller Lake O'Brien mine there is a prominent conglomerate ridge, much higher than the diabase just east of it; consequently the contact in this vicinity must have been quite steep. This contact becomes gradually flatter toward the south, and at the main road it is nearly horizontal. The columnar jointing observed repeatedly in the diabase sill west of Miller lake suggests a sill rising to the west. That the westerly side of the diabase sill exposed to the west of Miller lake is the footwall, was recognized by G. M. Colvocoresses, at one time manager of the Millerett, who remarks:

To accompany report by A. G. Burrows in Volume XXIX, Part 3, Ontario Department of Mines, 1920.


Ideal Sections, A-G-B, C-D and E-F, showing relationship of the diabase sill to the older rocks. Horizontal scale same as plan; vertical distances not to scale, hence only general relationship is indicated

## LEGEND




Geological plan of part of the Gowganda Silver Area, scale 3,000 feet to the inch, showing Sections in the vicinity of Miller Lake.

The Huronian rocks underlying the particular sill on which the O'Brien and Millerett are located are very clearly exposed less than a mile west of these properties, and prospecting there has so far had no good results. It would seem, nevertheless, that the claims thus located would merit particularly thorough development if Professor Miller's theory as deduced at Cobalt is in any measure applicable to the Gowganda district. Professor Miller states that at Cobalt 85 to 90 per cent. of the production has come from the veins found in the foot wall of the diabase sill, and it is strange that up to the present time absolutely nothing has been found in the foot walls of the several diabase intrusions which carry silver in the Gowganda district.[1]

The hanging-wall side of the diabase is exposed in the underground workings of the Miller Lake O'Brien and the Castle (R.S.C. 106), showing an average dip of contact of about 20° northeasterly. To the south of Leroy lake, near the road, the contact of the underlying diabase and the Keewatin is well exposed, and is probably not greater than 30° to the northwest. One chain south of No. 1 post of H.R. 715 (495), the diabase sill shows a steep contact of 60° below the Keewatin, a small area of which is separated from the larger area west of Leroy lake. On the east side of claim W.J. 16 (279) the diabase sill has a steep contact with a fresh-looking diabase dike that intrudes the Keewatin. The diabase sill is later than the diabase dike, which in the early mapping was considered part of the sill.

Little geological work of a structural kind has been done on the diabase contacts on the "Mann" ridge, west of Gowganda lake. Geo. R. Rogers, who lately operated the Boyd-Gordon, Mann and Labrick properties, informed the writer that mining operations at the Boyd-Gordon showed the diabase to underlie the sedimentaries at its west contact and at the Labrick to underlie also the sedimentaries on the east contact. Both these contacts, therefore, represent upper contacts exposed by erosion, which suggests that the diabase arched up into the older rocks. The deposits of silver found in this vicinity were consequently in the upper part of the diabase sill, a part of which had been removed by erosion.

No definite information is as yet available regarding the actual thickness of the sill near Miller lake. A diamond-drill hole put down in the diabase on claim W.J. 15 (470), southeast of Miller lake, penetrated 485 feet of diabase before entering the Keewatin greenstone foot wall. This was about half a claim width south of the hanging-wall contact exposed on the surface, so that a certain thickness of diabase had been eroded at the drill location. The attitude of the sill below the Keewatin area between Miller and Leroy lakes has been explored on only a few claims to the northwest of Miller lake; consequently the sections showing the geological relationships are not to scale vertically, and the attitude of the sill can only be roughly indicated. Exploratory work by means of diamond-drilling is necessary to prove thickness of formation away from the surface contacts, and the geological conditions would warrant some work of this nature being performed.

## Silver Deposits

The study of the silver occurrences at Cobalt has shown the ore deposits in that locality to have a close relation to the intrusion of a diabase sill.[2] The ore-bearing veins occur in rocks that were originally, or are now, below the diabase sill, in the sill itself, or in rocks above the sill.

[1] Gowganda in 1911, Canadian Mining Journal, Apr. 15th, 1912.

[2] The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming. Bureau of Mines, Ont., Vol. XIX, Pt. II, p. 5.

By far the greatest production has come from the formations that were below the diabase sill, chiefly from the conglomerate and slate of the Cobalt series and also from Keewatin greenstone, which have been exposed by the erosion of part of the overlying sill in the vicinity of Cobalt and Kerr lakes, and to a certain extent in formations below the sill, where it is still in place.

The productive veins in the diabase have occurred in the upper or lower part of the sill, i.e., in proximity to the upper or lower contact, the greater part of the production coming from veins toward the lower part of the sill, as in No. 3 vein at the Kerr lake mine and veins at the O'Brien mine.

The production from veins in rocks above the sill has been chiefly from the southeast part of the Cobalt camp, where the sill dips under a thickness of Keewatin formations. For example, at the Temiskaming mine the top of the diabase sill is about 500 feet below the present surface and the bottom of the sill nearly 1,600 feet.

The production from Gowganda has been chiefly from veins in the diabase and, as far as can be judged at the present, mostly from the upper part of the sill, where it has been exposed by erosion of the overlying rocks, and also where it dips gently under the overlying rocks, as shown in workings at the Miller Lake O'Brien mine. A part of the production has been from an ore shoot in conglomerate, which is on the hanging-wall side of the diabase sill at the old Millerett mine near Miller lake.

Some silver ore is being mined and shipped from veins that occur in the lower part of the diabase sill at the Bonsall mine. The mine workings are about 700 feet east of the lower contact of the diabase sill with the Keewatin.

A silver-bearing vein, striking east and west, has been recently discovered in Keewatin on the Castle property, R.S.C. 101. The Keewatin overlies the diabase sill, which is exposed at the surface 100 feet west of the discovery. Shipments of high-grade silver ore have been made from this deposit.

No silver ore has yet been produced, as at Cobalt, from the formations that were once below the diabase sill and are now exposed by erosion. Under favourable conditions one would expect that silver ore would occur in some parts of this area, where the footwall is exposed in proximity to the diabase.

## Veins

There are several strong veins, carrying smaltite and niccolite, in the Keewatin greenstone and conglomerate of the Cobalt series, in the area north of Miller lake. These veins are in the rocks overlying the diabase sill. So far no silver ore has been found in them, except the ore shoot in the conglomerate at the Millerett mine, but for the most part these veins have not been prospected other than by shallow pits or shafts. The ore shoot in the Millerett conglomerate did not carry into the underlying Keewatin. However, the structure of these veins should warrant further operations to determine their relation to the underlying diabase, with the possibility of encountering silver ore on a change of formation. Some silver was obtained in a calcite vein carrying smaltite, niccolite and native bismuth in Keewatin, at the Dodds claim, northeast of Leroy lake. The attitude of the diabase southwest of this location suggests that it is dipping steeply below the Keewatin. Native silver has also been found in veins on the Collins claim, west of Leroy lake, which occur along the contact of a diabase dike and Keewatin tuffs. This occurrence is also in rocks overlying the diabase sill. Whether this dike of diabase is older than the underlying sill diabase or is an offshoot dike, is not known. Some cobaltite has been obtained in veins on claim W.D. 962 (1283), in Keewatin formation, to the northeast of Gowganda lake. The sill which rises to the west of Miller lake has been removed by erosion from an area East of Gowganda lake, the surface rocks being Keewatin, intruded by numerous dikes of diabase, and rocks of the Cobalt series.

## WORKING PROPERTIES

### Miller Lake O'Brien

The Miller Lake O'Brien mine comprises a group of claims to the northwest of Miller lake. They were formerly the Gates claims, on which discoveries of native silver and smaltite were made in 1908. Later the Millerett mine was pur-

Miller Lake O'Brien mine, Gowganda.

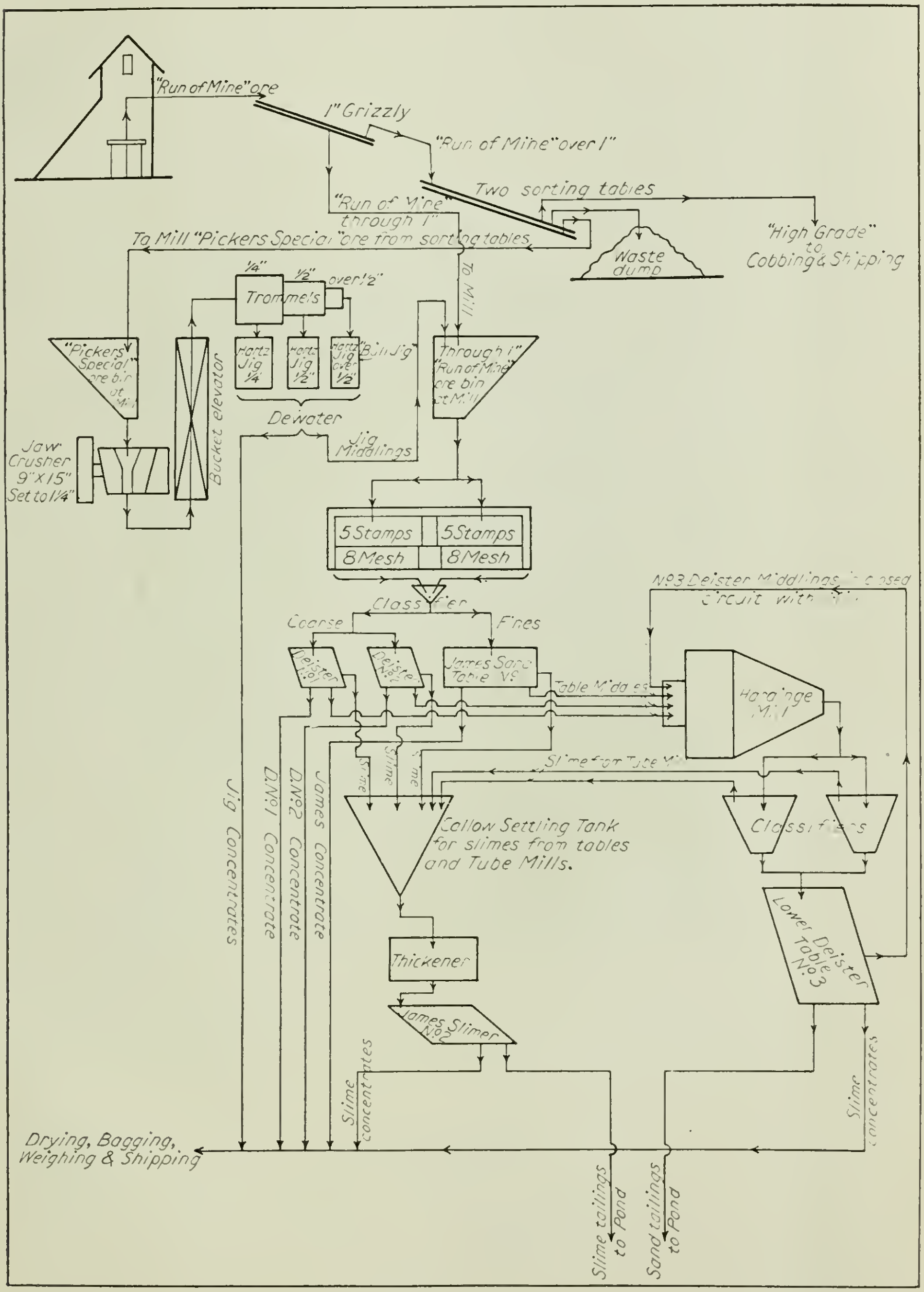
chased by the Miller Lake O'Brien Company. The first development was done on veins with a general north and south strike, lying near the line between claims R.S.C. 90 (654) and R.S.C. 91 (653). Of these the most important were known as No. 2 vein system, which produced most of the ore in the early years of the mine. Development showed the veins of this system to dip steeply to the west, with the pitch of the ore shoots to the south. Of this system, the foot-wall veins have been the most productive. The ore shoot in the hanging-wall veins did not extend to the 140-foot level, whereas the foot-wall ore body continued nearly to the 350-foot level. Each of these series carried two or more veins, which were sufficiently close together, where the ore shoots occurred, to allow mining in one stope. The veins were generally from two to five inches wide, and in the ore shoots individual veins were not always productive, but where one was barren, a parallel vein would carry the high grade ore. Very little ore was taken from this system above the 60-foot level. The greater proportion of the silver values was confined to the veins themselves, there being only a small impregnation of the wall rock. Strong east and west faults dipping 30° north were encountered in the workings on No. 2 system. In developing this vein system a series of cross-veins was encountered south of the shaft, on the 250-foot level, having an east and west strike. This series of veins is known as the cross-system and dips to the south at a high angle. An ore-shoot was found on the 250-foot level, and was stoped a short distance above the 140-foot level. It was followed down below the 400-foot level with decreasing length along the drifts.

The latest discovered ore system is known as the "Flynn." The first ore was encountered on the 350-foot level. A long east and west drift had crossed a very pronounced north and south fault, dipping 50° east, and a northerly cross-cut had intersected No. 6 vein, which was followed to a second fault, striking east and west and dipping 30° to 40° north. Ore was found in No. 6 vein above this fault. From this discovery the development was extended to a number of veins, the principal of which are No. 6, No. 7 N., No. 7 N.W., etc. On stoping No. 6 above the 350-foot level it was found to join No. 7 N., producing the greatest width of high-grade found in the mine, where one portion of the vein was three feet wide, of high-grade silver, smaltite and calcite. Later, in drifting on No. 7 vein on the 350-foot level, portions of it were of high-grade ore two feet wide. In this rich section of the " Flynn " system the stope was 14 feet in width, in places of high-grade veins and mill rock. Development in this part of the mine threw light on the ore relationships. The workings show that the high-grade values did not extend into the Keewatin, while the veins themselves became more indefinite, branching into stringers carrying galena, copper pyrites and other common minerals. The contact as determined at a few points in different parts of the mine dips from 30° to 20° (with the sill diabase below the Keewatin greenstone), gradually flattening.

Development has shown the aforementioned east and west fault to be generally the lower boundary of the ore. The veins carrying the ore are said to have been only slightly displaced by the fault. One vein, No. 7 N.W., was observed to have been faulted about three feet. In this vein the east and west fault is not the lower boundary of the ore, since ore was being stoped from it on the 400-foot level below the fault. The ore occurs in the diabase below the Keewatin greenstone, while the main ore-shoots pitch to the north, being controlled by the Keewatin-diabase contact and the east and west fault, the ore not necessarily coming close to the contact. In developing vein No. 7 N, which carries the principal ore body, an inclined winze (87° W) has been carried from the 350-foot level to the 525-foot level, and the ore from this and other veins is developed from the several levels.

Development at this mine on R.S.C. 90 and 91 has shown all the ore so far to be in the diabase. The early workings at No. 2 vein system were in the diabase, but outcropped at the surface, where only a small portion of the sill had been eroded. Later work being in the diabase below the Keewatin, it has been determined that silver ore occurs at greater depth from the present surface, depending roughly on the Keewatin-diabase contact. The silver ore occurs in the upper portion of the diabase sill in proximity to the contact.

The ore is partially dependent on faulting conditions, as shown in the workings of the Flynn system.




Flow sheet, Miller Lake O'Brien mine.

The treatment of the ore is shown by the flow sheet diagram, page 83. The ore, after passing through the high-grade and waste-sorting treatment at the main shaft, is hauled in trains of 2-ton cars to the incline at the mill by a gasoline motor. The cars are drawn up the incline singly by a hoist to the mill ore bin. About 35 tons of ore are treated daily in the mill. The mill was operated originally by the Millerett Mining Company, and is situated about a quarter of a mile north of the main shaft.

Power for the mine and mill is supplied by a hydro-electric development at the foot of Gowganda lake. The natural fall is 27 feet, but by a dam it is raised to 30 feet and the installation is capable of developing 500 horse power. The transmission line is 2¼ miles in length and the voltage 4,000. About 300 horse power is required for the mine and mill; in dry seasons, owing to the lack of storage, this requirement is not always met.

### Castle Mining Claims, R.S.C. 106 and R.S.C. 92 (632).

Considerable exploratory work has been done on these claims by the Trethewey Mining Company with a view to prospecting the diabase formation which occurs beneath the Keewatin. These claims are situated just northwest of Miller lake.

A shaft was started in Keewatin on claim R.S.C. 106 and sunk to the 300-foot level. The diabase was first encountered at 90 feet and from this depth to 130 feet the shaft was partly on both formations, showing a nearly vertical contact for this distance. Below this the shaft was entirely in the diabase, and a cross-cut 400 feet in length to the north of east was run to the contact, indicating a general dip of contact of 20° from 130 feet in the shaft. The contact was further determined, in a long drift extending 500 feet to the north of the cross-cut, to be 15° N.E. Consequently at this horizon the diabase dips gently under the Keewatin. A calcite vein striking north and south and dipping steeply to the west, was discovered 130 feet from the shaft, and drifting on the vein for about 230 feet has been done on the 300-foot level, and also on the 360-foot level, which is connected with the upper level by a steeply inclined winze on the vein. This vein carries in places some native silver together with smaltite, niccolite, native bismuth, copper pyrites and pyrite, and some quartz. Several strong faults dipping 30° N.E. were encountered in the workings. One of these displaced the vein 20 feet on the 300-foot level. Several other calcite veins were also discovered. One of these showed a width of six inches in a cross-cut west from the main vein, while another was encountered 400 feet from the shaft in the long cross-cut, near the Keewatin contact. This vein of calcite up to 4 inches wide carries some smaltite.

### Walsh (1250)

The Walsh property, on the west side of Miller lake, was under option for a time to the Crown Reserve Mining Company and was being worked during a part of 1918 and 1919. A shaft was sunk to the 200-foot level with drifts on veins on the 100- and 200-foot levels. Some small lenses of silver ore were encountered on the 100-foot level.

### Castle Mining Claim, R.S.C. 101 (1036)

This claim, which lies about one-quarter of a mile south of the west end of Everett lake, is operated by the Trethewey Mining Company. The discoveries being worked lie near the west side-line of the claim, the veins striking approximately north 30° west. A shaft has been sunk 150 feet on a series of narrow veins standing nearly vertical, and from this level drifting will be done on the vein. Two stopes have been opened on the ore-shoot above the 100-foot level. At a depth of 15 feet the southeast end of the shaft exposed for over eighteen inches a series of veins, from a fraction of an inch to over one inch in width, in several of which native silver could be readily seen. The vein filling is calcite with a great amount of quartz, carrying copper pyrites, specularite and smaltite in places. In the bottom some of the veins had united to form a strong silver-bearing vein.

Open cut on vein in Keewatin rock, Castle mine, R.S.C. 101. The vein carries high-grade silver ore with smaltite, and varies in width from an inch to six inches, its location being on north wall of cut or right side of the illustration.

The vein is in some places five inches wide of high-grade silver ore, while the wall-rock carries leaf silver. A plant has been placed on this property, consisting of two locomotive boilers, a three-drill compressor and hoist.

Several shipments of silver ore have been made.

### Mining Claim R.S.C. 102 (1055)

This claim, lying to the west of R.S.C. 101, was operated some years ago by the Everett Mining Company, and 8.35 tons of silver ore were shipped in 1910. The ore was taken from a long open cut on a series of silver-bearing veins striking north 35° west. The ore was hand-sorted, and there are a few tons of mill rock on the dump at present, where fragments of diabase frequently show scales of native silver. Fissuring is pronounced on claims R.S.C. 101 and 102 in the vicinity of the north and south centre line.

### Chapelle Claim, H.R. 715 (495)

This property lies to the east of Leroy lake, including part of the lake. The rock exposed on the surface is nearly all sill diabase, with a small amount of Keewatin near the northeast corner post. In October, 1919, C. L. Campbell and W. H. Fairburn, who had optioned the property, were continuing the sinking of a shaft that had been begun some years before. This shaft is on a strong aplite dike and calcite vein. Some high-grade silver ore was encountered by the former operators at 48 feet and again in the drift at the 85-foot level. Small amounts of silver had been found frequently while sinking the shaft and running the drift. Exploration showed that the vein, which strikes south 20° west when drifted on to the south, was faulted 55 feet to the southeast. This fault which dips 60° northeast contains drag vein material and also that of an aplite dike. In the face of the drift beyond the fault, there is a 4-inch vein of calcite and two mineralized aplite dikes of 1½ and 4 inches respectively. Specimens on the dump show calcite and aplite with copper pyrites, bornite, iron pyrites, and some smaltite and niccolite. A number of veins were located on the surface by means of trenching in previous years, but most of these are now concealed by sand filling in the trenches. These veins occur in the diabase, which rises as a sill from the northwest, having the same relation to the Keewatin area northwest of Leroy lake, as the diabase to the northwest of Miller lake, that is, it dips under the Keewatin. Owing to trouble over the option, work was discontinued on this claim in November.

### Dodds Claim, W.J.1 (1702)

Campbell and Fairbairn did some work on this claim, just north of the south line of the claim, near the outlet of the lake. The rock is of Keewatin age, schistose greenstone and tuffs. Some trenching was done on a calcite vein carrying native silver with massive smaltite and native bismuth, fragments of which were observed on the dump. It was reported that the vein or lens did not extend below the bottom of the trench, being either faulted or terminated; not sufficient work has been done to determine which.

### Symmes-Young Claim, H.S. 351

This claim is situated a quarter of a mile north of Miller lake, the surface outcrops showing Keewatin greenstones and conglomerate and greywacké of the Cobalt series. These formations overlie the diabase sill that outcrops nearly one-half mile west and dips gently under the Keewatin and conglomerate. Two hundred feet west of No. 1 post there is a strong smaltite-niccolite vein on the property, striking approximately north and south. It crosses the north line of the claim to claim H.S. 350, being traceable on both properties for about 700 feet. A shallow shaft has been sunk on H.S. 350, 15 feet north of the line. Here the vein is about a foot wide, decreasing in width in both directions. Toward the south the vein splits into several stringers, which have been exposed at several points by shallow pits. The ore is massive smaltite and niccolite, and so far no silver ore has been exposed along the outcrop of the vein. The depth of the diabase sill below the surface where the vein outcrops is not known, but this will probably be determined by diamond-drilling to prospect the diabase immediately below the upper contact with the Keewatin.

View on Symmes-Young claim, H.S. 351, containing massive smaltite and niccolite (7 inches in width at hammer). The rock is quartzite-conglomerate, Cobalt series.

### Collins Claim, T.C. 220 (2947)

This claim, on the west side of Leroy lake, shows surface exposures of Keewatin tuffs and greenstone, intruded by dikes of diabase. The Keewatin rocks, where banded, strike north 60° east. A vertical shaft has been sunk 200 feet on the east contact of a diabase dike with the banded tuff, where there is a vein of calcite with quartz, copper pyrites, iron pyrites and some smaltite and niccolite. A station has been cut at the 180-foot level, from which cross-cuts will be run to veins that outcrop at the shaft and to the west of the shaft. The vein is somewhat lens-like and is four inches in width 100 feet south of the shaft, running in places along the contact with the diabase dike. It was found to dip from the shaft at 50 feet, and below 80 feet the shaft is entirely in the diabase dike, which also dips to the east. At 165 feet a second vein was encountered, averaging 4 inches in width and dipping from the shaft at 180 feet. Some native silver is reported to occur in this vein. Distant 375 feet north of the main shaft there is another shaft 20 feet in depth on the west contact of the diabase dike, where a vein about three inches wide contains minerals similar to those previously mentioned. Native silver is reported to have been found occasionally in the vein.

This area of Keewatin overlies the diabase sill that outcrops on the east side of the lake and to the south along the road. Mr. Collins, the manager of the property, may continue the shaft through the Keewatin to the underlying diabase. No definite information is available as to the dip of the contact of the sill below the Keewatin in this vicinity, but where observed along the road south of the lake, it is probably less than 30°.

### Reeve-Dobie Mine

The Reeve-Dobie is situated three-quarters of a mile from the southwest shore of Gowganda lake. Work has been carried on intermittently since the discovery of silver and smaltite in 1908. Several shipments of high-grade silver and smaltite and some concentrates have been made from the property. The early work at the mine was confined to prospecting for high-grade ore, which was found to occur in a number of short shoots along a mineralized zone about 700 feet in length. Most of the high-grade was taken from a number of open cuts. Later a mill was erected, which ran for a short time treating diabase carrying minute veinlets of native silver. This mill was reopened in 1919, and ore from an open cut or glory hole to the south of the shaft was being treated. The open cut is now 70 feet long and 16 feet wide, the ore being dropped to the 50-foot level and trammed to the shaft. The ore is said to carry 30 to 35 ounces of silver. A flotation plant has been added to the mill, which with the addition of a ball mill will treat 45 tons per day. The underground workings have been carried to the 200-foot level, where prospecting by drifting and cross-cutting has been done. A number of strong faults have been encountered in these workings. Further exploration underground is to be carried on to examine the area to the west of the shaft, which is concealed at the surface by a drift-filled ravine.

### Crews-McFarlan Mine

The Crews-McFarlan, formerly the Bartlett, situated to the southwest of Gowganda lake, was in operation and producing a small amount of silver ore from veins in diabase in the southeast part of the property. The veins are in the foot-wall part of the sill.

### Other Properties

Several properties have been re-opened since the visit to the camp. These include the Bonsall, northwest of Miller lake, the Silver Bullion, near Leroy lake, the Silverado in Leith township, and the Walsh and Hart properties at Miller lake.

Further examination of the Gowganda area will be made during the field season of 1920.

### South Bay Power Company

A hydro-electric power plant is being installed by the South Bay Power Company at the outlet of Hanging Stone lake, where it discharges into Gowganda lake. The natural head is 58 feet, but by means of a dam this has been raised to 69 feet 4 inches. The flume is 450 feet in length, but most of the fall is near Gowganda lake. The drainage area of Hanging Stone lake is approximately 39 square miles, and the present installation consists of a 250-h.p. plant.

# INDEX VOL. XXIX, PART III

TWENTY-NINTH ANNUAL REPORT

OF THE

# ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXIX, PART IV,

1920

# Kirkland Lake Gold Area

By

A. G. BURROWS AND P. E. HOPKINS

(Second Report)

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## PREFACE

The following report on the Kirkland Lake Gold Area will be found to be one of the most interesting and important descriptions of a Canadian mining area that have been published for some years, at least. The authors, A. G. Burrows and P. E. Hopkins, of the Geological Staff of the Ontario Department of Mines, have had wide experience in the pre-Cambrian gold and silver areas of the Province.

The Kirkland Lake Area can be classed as Ontario's fourth most important metal-producing area, being preceded, in order of seniority, by Sudbury, Cobalt and Porcupine. The development of the area was retarded during the period of the war, systematic work having been begun only about a year previous to the outbreak of the great conflict. To the end of the year 1919 the output of gold, with some silver, had a value of nearly $3,000,000.

Exploration in the Kirkland Lake Area has shown that there are three principal zones of mineralization. or, to use a more definite term, of metallization. The main or central zone extends in a northeast-southwest direction along the southern expansion of Kirkland lake for a distance of over two and a quarter miles. The southern zone is distant about three-quarters of a mile from the main zone and the northern about two miles. The gold production up to the present has come from the central zone.

According to the authors. the central zone shows a major fracturing along which are situated the principal mines. This fracturing crosses all the rocks in the zone, including feldspar-porphyry, syenite, lamprophyre and conglomerate. In addition to the major fracture there are branch or minor fractures now represented by branch veins or lodes.

The fracture zone. where examined, usually contains several fault planes which often form the boundaries of ore bodies. The fault planes along which the ore deposits have been formed dip to the south, generally at angles of 80° to 85°. At several mines development has been carried on with regard to two prominent fault planes. called footwall and hanging-wall planes. These planes are from a few feet to 40 feet or more apart, ore occurring sometimes over the whole width, or, as is more common, near one wall or the other, depending on subsidiary slip or fault planes. Ore has also been found beyond the recognizable fault planes or so-called vein boundaries. Mineral-bearing solutions with accompanying vapours have filled fissures and more or less replaced the rock in the fracture zone. The quantity of vein quartz in the ore deposits is relatively small as compared with the mineralized porphyry or other rocks that make up the ore bodies.

The minerals in the ore bodies. other than the primary constituents of the rocks, are quartz, of two or more ages, calcite, ankerite, sericite, chlorite. iron pyrites, copper pyrites. small quantities of galena and zinc blende, molybdenite, graphite and barite. The ore minerals are native gold with the tellurides, calaverite. kalgoorlite and hessite. Other tellurides are altaite, coloradoite and tetradymite.

The authors say that the gold deposits at Kirkland lake in their mineral constituents resemble those of the Sierra Nevada. Cal., and that it is probable that they were not formed at as high temperatures as those of Porcupine, Ont. Granite, syenite and porphyry in the Kirkland Lake Area are believed to represent different facies of one magna. While the gold-bearing deposits were formed subsequent to the intrusion of the porphyry. they are believed to be genetically connected with this rock.—W.G.M.


Key plan showing location of the Kirkland Lake Gold Area. Roads are indicated by broken lines.

Polished Sample (Natural Size) of high-grade Gold Ore in Red Porphyry and Syenite, typical of the Kirkland Lake Area. From Kirkland Lake mine.

# KIRKLAND LAKE GOLD AREA

By

A. G. Burrows and P. E. Hopkins

(Second Report)

## Introduction

The first report on the Kirkland Lake Gold Area was published as Part II of the Twenty-Third Report of the Ontario Bureau of Mines, 1914. The area covered by that report and the accompanying map embraced the townships of Teck. Lebel, Gauthier, Otto, Boston and McElroy, an area of about 210 square miles, and dealt principally with the Tough-Oakes mine, the chief property at that time.

Owing to the important developments that have since taken place, a detailed examination was made of the geology and ore deposits in the vicinity of Kirkland lake during a part of the summer, 1919. The report is accompanied by a geologically coloured map, number 29g, scale 600 feet to the inch, embracing 12 square miles in the vicinity of the productive area. and 29h (insert) showing the geology and veins of the central ore zone.

The topographical mapping, chiefly with plane table and telescopic alidade, was done by W. R. Rogers and P. A. Jackson, assisted by G. A. L. Gibson, E. Howell, J. Kirkconnell and Geo. Tyrrell. Contours at vertical intervals of ten feet are shown on those parts of the map-area which have been cleared of trees. Sea-level datum was adopted, using bench marks of the Timiskaming and Northern Ontario railway.

The areal and economic geology was examined during a part of 1919 by the writers, ably assisted by A. W. Carlyle and K. B. Heisey. The chief difficulties in mapping consisted in outlining the extremely small outcrops caused by the frequent changes in rock types. As some of the mines were filled with water at the time of their visit in 1919. the writers returned in the spring of 1920 and continued the underground examination. It is hoped that the maps and report will be of assistance in further development of the area.

The writers are indebted to the mining men of the camp for their assistance and hospitality.

Assays and analyses were made by W. K. McNeill and T. E. Rothwell, Provincial Assay Office.

## Location

Kirkland lake, latitude 48° 9′ north and longitude 80° 3′ west. through which pass the ore bodies to be described in this report. is situated in Teck township. Larder Lake mining division. District of Timiskaming, Kirkland Lake lies four miles northeast of Swastika, a village on the Timiskaming and Northern Ontario railway, 63 miles north of Cobalt and 392 miles north of Toronto by railway. An excellent macadam road has been constructed from Swastika to the various mines. The camp has local and long distance telephone connection. and there is a good stage service between Kirkland Lake and Swastika.

## History

At the time of the gold rush into Larder Lake in 1906 and during the boom days of Cobalt, many claims were staked for gold around Swastika and northeasterly to the lake now known as Kirkland lake.

Some assessment work was done on many of the claims, but most of them were allowed to revert to the Crown. The Swastika property continued to be worked and by 1911 had produced some gold. In the same year gold was discovered in several veins on adjoining claims, which were developed by the Lucky Cross Mining Company. The encouragement received by these two mining companies, together with the success being obtained at Porcupine, led to renewed interest in the older area. The first gold discovery in the vicinity of Kirkland lake was made in the autumn of 1911 by W. H. Wright on claim No. T.C. 709 (L. 1830), now a portion of the Wright-Hargreaves mine. The gold occurred in quartz veinlets traversing reddish feldspar-porphyry. By the end of the year most of the ground had been restaked. In January, 1912, gold-bearing veins were found in the porphyry and conglomerate on the Tough-Oakes claims, three-quarters of a mile northeast of Kirkland lake. Little interest was taken in the area during that year. However, the development of the No. 2 vein of the Tough-Oakes and shipments of high-grade gold ore from that property created great interest during 1913. Much surface trenching was done, which resulted in the finding of a number of promising veins on the following properties: Burnside, Robbins (Sylvanite), Wright-Hargreaves, Oakes (Lake Shore), Teck-Hughes, Wettlaufer (Orr), Wood-McKane (Kirkland Lake), and Hunton.

By midsummer, 1914, hydro-electric power from Charlton was available for the Tough-Oakes. Underground work was carried on at the Oakes (Lake Shore) and Teck-Hughes.

In 1915 the Tough-Oakes operated a cyanide mill with a capacity of 125 tons per day. The Oakes, now incorporated as the Lake Shore, continued to develop ore in the No. 1 vein. Considerable prospecting was also done during the year on two or three properties at Goodfish lake, two and a half miles northeast of Kirkland lake.

During 1916 the Tough-Oakes worked continuously, employing some 300 men and producing $700,000.00 in gold. A mill was also built on the Teck-Hughes. The Lake Shore continued to develop ore, and work was commenced on the Wright-Hargreaves and Wood-McKane (Kirkland Lake).

In March, 1917, ample hydro-electric power reached the camp from Cobalt, 65 miles distant, and active mining was begun on numerous properties. Toward the close of the year mills were in course of erection on the Lake Shore and Kirkland Lake, and at the latter the shaft had reached a depth of 700 feet.

The Lake Shore mill commenced operating in March, 1919, and up to the strike in June, 1919, produced bullion valued at $648.134.51, the recovery being $26.05 per ton. The finding of the main No. 2 deposit under the lake early in 1918 was of great importance. The Tough-Oakes closed in the midsummer of 1918, the developed ore having been exhausted. Other properties also closed temporarily on account of the high cost of supplies and labour.

In 1919 three mills operated, namely: Kirkland Lake, Lake Shore and Teck-Hughes; and others were being constructed on the Burnside and Wright-Hargreaves.


View looking west from hill on road from Tough-Oakes mine to Kirkland Lake.

Work was also resumed on the Ontario-Kirkland and on the Tough-Oakes, the latter having amalgamated with the Burnside. Owing to the miners' strike, which caused all mining operations to cease from June 12th to October 22nd, 1919, the year's production was low, namely, $489,207.30. Up to the end of 1919 the camp had produced bullion valued at $2,987,994.42.

During the early part of 1920 the mines were running smoothly. The production for 1920 will probably be in the neighbourhood of one million dollars. The yield is small compared with the ten million dollars annual yield of Porcupine, the most important gold-mining camp in Canada; nevertheless, Kirkland Lake is second in importance among Ontario's gold camps and is rapidly developing. It is characterized by the richness of its ore.

## Topography

The Kirkland Lake area is situated a few miles south of the divide between the Hudson bay and river St. Lawrence waters. A contoured topographical map has been made of the cleared portions of the map-area, the contours being shown at vertical intervals of ten feet. Kirkland lake has an elevation of 1,038 feet above sea-level and no hill apparently rises more than 100 feet above that level. Rock outcrops over most of the area. The small proportion of drift is usually sand, thinly distributed. The mineral deposits are frequently found in the lower parts of the area, since the fractured zones and adjoining altered rocks are more easily eroded than are those that are less fractured and less altered. The porphyry apparently weathers down more easily than the other rocks.

## Previous Work

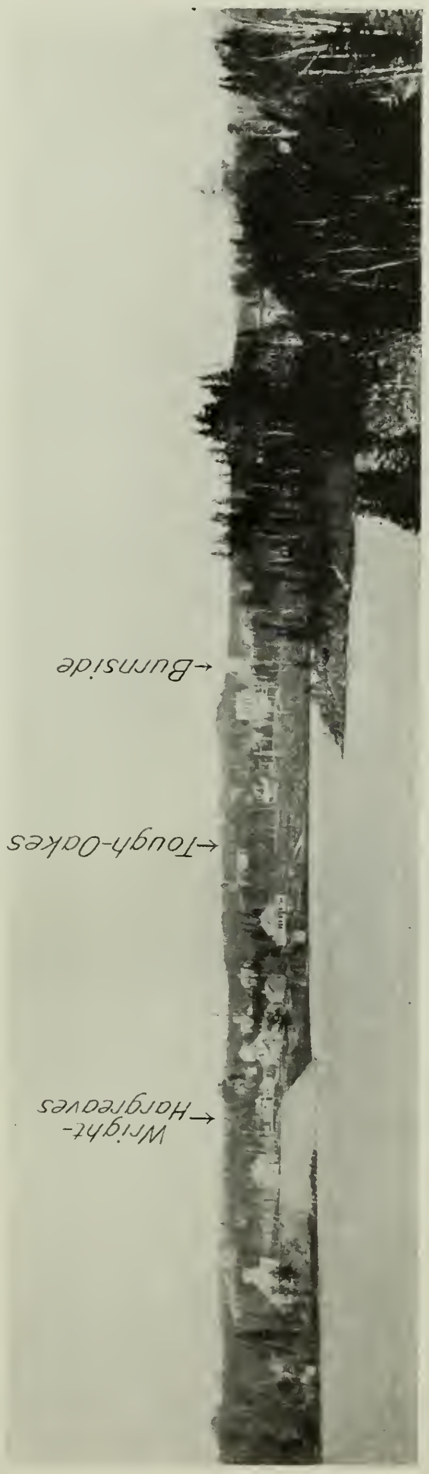
The east boundary line of Teck township was surveyed in 1907 by J. J. Newman, O.L.S. This line passed near Kirkland lake, which was named after Miss W. Kirkland, of the Surveys Branch, Department of Lands and Forests. In 1911, E. L. Bruce,[1] while examining the gold deposits at Swastika, mapped to within one mile of Kirkland lake. During parts of 1913 and 1914 the writers made their first report[2] on the area. Descriptions and articles have from time to time appeared in mining journals and transactions of mining societies. The writers are R. E. Hore. Charles Spearman, J. B. Tyrrell, G. C. Bateman and others.

The map accompanying this report represents only a limited part of the area ordinarily known as the Kirkland Lake Gold Area, which was geologically mapped in a general way a few years ago and shown on map No. 23a, 1913, Ontario Bureau of Mines. The present map is on a larger scale and shows in greater detail the geology in the vicinity of Kirkland lake, where a number of properties have been developed into producing mines. It will serve as a guide for further exploration in a larger area, for similar associations of rock extend for several miles to the southwest in Teck township and northeast and east of Kirkland lake through Lebel and Gauthier townships, where with but little prospecting gold has already been found in a number of veins.

The Kirkland Lake area is part of a large mineralized region that extends

[1] "The Swastika Gold Area." E. L. Bruce, Ont. Bur. Min., Vol. XXI, 1912, pp. 256-265.
[2] "The Kirkland Lake and Swastika Gold Areas." A. G. Burrows and P. E. Hopkins, Ont. Bur. Min., Vol. XXIII, Part II, 1912, pp. 1-39.


View showing location of mines at the southwest end of Kirkland lake.




East end of Kirkland lake showing location of mines.

roughly from Matachewan in the southwest to Larder lake and beyond into Quebec province to the east. In places the older gold-bearing rocks are covered by deposits of newer formations, conglomerate, greywacké and slate of the Cobalt series that have not been removed by erosion and consequently cover possible gold deposits.

The character of the gold deposits varies greatly in different parts of the larger area, but all occurrences are believed to be associated with the acid intrusive rocks of a granite, syenite and porphyry character that frequently outcrop in various parts of the area.

### Hydro-Electric Power

In April, 1914, in the early stage of development of the area, the Tough-Oakes mine received a small quantity of power from the Charlton hydro-electric plant, 26 miles to the south. The power is transmitted on a three-phase transmission line at 33,000 voltage and stepped down at the mine sub-station to 2,200.

Following upon further development, the Northern Ontario Light and Power Company bought the Charlton plant and extended their transmission line from the sub-station at Cobalt, a distance of 65 miles. When the power from Cobalt was turned on in March, 1917, sufficient was available for the whole Kirkland camp.

A large sub-station was built on the Sylvanite property at the terminus of the transmission line. The voltage is stepped down from 4,400 volts to 2,200, and the power lines run from this station to the several mines.

The larger motors are operated on 2,200 volts, and transformer stations are located at the different mines where the voltage is again stepped down to 550 volts for motors and 110 volts for lighting.

## GENERAL GEOLOGY

The compact rocks are pre-Cambrian, classified according to the following table, the oldest being placed at the bottom and the others in the order of their relative ages.

### Table of Rocks in Kirkland Lake Gold Area

| | |
|---|---|
| **PLEISTOCENE** | |
| Glacial and Recent | Sand, gravel and swamp. |
| **PRE-CAMBRIAN.** | |
| Keweenawan (?) | Quartz diabase and olivine diabase. |
| Post-Timiskaming Intrusives (Algoman?) | Red and grey feldspar-porphyry with subordinate amounts of hornblende-syenite and felsite occurring as dikes and stocks. Red hornblende-syenite. Black mica lampophyre grading into or cut by red, hornblende-syenite, the latter being felsitic or porphyritic in places.[1] Serpentine. Hornblende and biotite granite and gneiss, syenite, granite-porphyry, feldspar-porphyry, felsite, pegmatite and hornblendite. |
| Timiskamian | Schistose conglomerate greywacké and quartzite containing some carbonate schist. Rusty carbonate. |
| Keewatin | Pillow lava, altered diabase, green schists, rusty carbonate and iron formation. |

[1] These three groups of rocks are differentiation facies from the same magma.

## Historical Geology

The Keewatin, which is the dominant rock in the region, occupies only a small portion along the north and southeast sides of the map-area. These rocks are chiefly basalt and diabase, volcanic rocks which have flowed out under the sea, with subordinate amounts of iron formation, rusty carbonate and other rocks. Lying unconformably on these rocks and interfolded with them, is a band of Timiskamian sediments which occupies most of the accompanying map-sheet. These fragmental rocks are two miles in width and extend to the southwest and to the northeast for several miles. After the deposition of the sediments extensive folding and metamorphism took place. Later the sediments were cut by a number of intrusives, namely: granite, syenite, serpentine and related lamprophyre, syenite and feldspar-porphyry. The gold deposits are genetically connected with the porphyry. All the rocks including the ore bodies have been intruded by diabase dikes of Keweenawan age. These pre-Cambrian rocks may have been covered by Paleozoic rocks, but no erosion remnants are to be seen at present. The glaciers which passed over the whole region have scraped away any decomposed rock from the surface and carried it southward, leaving the rocks and mineral deposits exposed as we find them. In places the rocks are still covered by a thin mantle of glacial sand and gravel.

## Keewatin

The Keewatin rocks have the widest distribution in the area, but only portions of them occur in the north and southeast parts of the map-area. They consist largely of ellipsoidal, amygdaloidal and spherulitic lavas with alternating flows and dike-like masses of diabase, together with some rusty carbonate and narrow bands of iron formation. The greenstone type is usually massive and green in colour, but a schistose area occurs in the northeastern part of the map-sheet along the Keewatin-Timiskamian contact. These rocks are so altered that it is difficult to classify them distinctly.

In the fresher samples of fine-grained greenstone a basaltic texture can be observed showing rods of plagioclase set in a groundmass of pyroxene or hornblende, which is generally altered to chlorite. The chemical composition of typical Keewatin rocks from the northern part of the township is shown below:

| | 1. Per cent. | 2. Per cent. |
|---|---|---|
| Silica | 48.70 | 53.90 |
| Alumina | 15.21 | 19.67 |
| Ferrous oxide | 8.35 | 10.21 |
| Ferric oxide | 4.28 | 0.71 |
| Lime | 11.11 | 8.30 |
| Magnesia | 3.76 | 0.72 |
| Soda | 3.23 | 2.78 |
| Potash | 0.59 | 0.58 |
| Carbon dioxide | 2.25 | 0.86 |
| Water | 0.65 | 1.80 |
| Manganous oxide | .... | 0.32 |

1.—Ellipsoidal greenstone (basalt) 15 chains west of III mile post, north line of Teck township.

2.—Amygdaloidal greenstone (basalt), Amikougami lake, 15 chains north of III mile post, north line of Teck township. This rock also shows an ellipsoidal structure.

Ellipsoidal greenstone, Amikougami lake, which lies to the northwest of the map sheet.

Unconformity between conglomerate of the Timiskaming series and Keewatin diabase. Claim L. 1824, Kirkland lake.

Diabase, occurring as dikes and broad masses, intrudes the fine-grained greenstone at many places. This rock is generally less fresh-looking than the Nipissing diabase of Cobalt, but occasionally is mistaken for this much younger basic rock. It is often light green in colour and coarse in grain like gabbro, while the original constituents are usually altered to secondary minerals. There is a large volume of this rock around Amikougami lake and throughout the Keewatin areas in the north part of Teck and Lebel.

The rock is pre-Timiskaming in age, since an unconformity was observed on mining claim L. 1824 on the south shore of the northwest bay of Kirkland lake. Fragments of the diabase were found as pebbles in the Timiskaming conglomerate that rests on the diabase.

Numerous narrow rusty carbonate bands occur throughout various parts of the Keewatin.

A pronounced band of ferruginous carbonate cut by numerous quartz stringers extends for a few miles in length across the southern part of the area. These rocks may be equivalent to the Grenville series, but they are closely associated with the Timiskaming series and so classed.

A few narrow iron formation bands consisting of black slate, chert and magnetite occur with the Keewatin in the southeast part of the area.

### Timiskaming Series

In the central part of the area there is a broad series of sedimentary rocks extending in a general northeast and southwest direction with an average width of about two miles. These rocks are bounded on the north side by highly altered Keewatin greenstone and related rocks and on the south side by intrusive rocks, syenite, granite, etc., in the area shown on the accompanying map. Farther southwest the boundary rocks along the south side are Keewatin lavas, as seen near Swastika. In this series of rocks there are recognized various bands of conglomerate, slate, greywacké and quartzite, all in a highly inclined attitude, usually dipping to the south. These have been greatly altered to schist with a cleavable structure developed across the bedding planes of the sediment. Some of the bedding and schist strikes and dips are marked on the map. The marginal bands of sedimentary material are more highly altered than those nearer the centre of the series.

To the north of the northeast bay of Kirkland lake, on claim L. 2322, to the west of the wagon road, the northerly edge of the sedimentary rocks can be observed. Here both the greenstone (pillow lava) and the fine-grained sedimentary rock are extremely schistose, and the contact is obscure. There are some included fragments in the fine-grained material near the contact. A few feet farther south are bands of extremely fine-grained glossy schists of varied colour, yellowish to blackish, while a few hundred feet farther south along the road there is a striking conglomerate carrying numerous rounded fragments of older rocks and numbers of conspicuous jasper pebbles from an old jasper iron formation. The contact previously described dips steeply to the south, but the evidence here is not sufficient to indicate an erosional unconformity. On mining claim L. 1824 (H.S. 1199) on the south shore of the northwest bay of Kirkland lake there are fragments of diabase included in a conglomerate that lies on an old diabase of the Keewatin, and in an isolated outcrop of conglomerate on claim L. 2796, in the northwest part of Lebel township, fragments of basalt are numerous. The basalt is the principal Keewatin rock on which the conglomerate was deposited. No contacts with the Keewatin have been observed along the south boundary of the sedimentary series. In the first report on " The Kirkland Lake and Swastika Gold Areas " it was suggested that the sedimentary series may occur as a syncline in the Keewatin, in which the rocks were folded into their present highly inclined attitude, the edges of the strata now being exposed at

Conglomerate of the Timiskaming series, one half mile north of Gull lake, Lebel township.

the surface. Owing to the numerous intrusions of porphyry, syenite and lamprophyre throughout the sediments, it would be difficult to work out a sequence of the bands of conglomerate and other rocks in cross-section.

These rocks appear to have suffered more alteration than the Keewatin greenstone, but owing to the more open structure of the sedimentary rocks and the chance for replacement with carbonate, the alteration could easily be greater in the younger rock.

The sediments are mainly conglomerate in which pebbles of various kinds are generally numerous, while in section the conglomerate alternates with narrow bands of greywacké and other fine-grained sediments. As previously stated, the marginal sediments have been entirely altered, and much of this rock is simply fine-grained glossy schists. Some of the conglomerate bands have been compressed into schists as shown to the northeast of O'Connell lake. At other places where the pebbles are of hard porphyry, chert and other material, the matrix has been rendered schistose and the pebbles are readily separated from it. A conglomerate of this character occurs to the north of Gull lake on L. 2452.

There is a great variety of pebbles in the conglomerate, including various greenstones, diabase, porphyries, felsite, an occasional granite and numerous frag-

Conglomerate of the Timiskaming series which has been rendered highly schistose. North of O'Connell lake, Lebel township.

ments of iron formation. Some of the fragments of iron formation are of a bright-red jasper, which gives the rock a very striking appearance. There are also pebbles of quartz with pyrite from a series of veins older than the Kirkland Lake gold-bearing veins. One of these mineralized quartz pebbles was assayed and found to contain no gold. A microscopical examination was made of greywacké from the vicinity of the Tough-Oakes mine, south of No. 3 vein, near the Teck-Lebel line. The greywacké is composed of angular fragments of quartz, orthoclase, plagioclase, chlorite, and other minerals, with considerable carbonate scattered through it. The rock is quite readily recognized as of sedimentary origin. The impregnation of the rocks by much carbonate or sericite aids in distinguishing them from greywacké of the Cobalt series.

Like the Keewatin, the Timiskaming series has been impregnated with carbonate solutions. A rock which has been altered to ferruginous carbonate outcrops about nine chains north of O'Connell lake. Because of the high percentage of carbonate in these rocks, they are generally rusty-weathering, owing to the oxidation of the iron in the carbonate to ferric oxide. Generally, the sediments in fresh specimens are grey, but where the material has been exposed for a few years on dumps, it becomes oxidized and rusty in appearance.

In the southerly part of the sediments there is a band of carbonate rock traceable at intervals for several miles, which has been differentiated on the map. It is not definitely known whether the rock belongs to the Keewatin or Timiskaming. The rock is cut by numerous irregular veinlets of white quartz, and resembles the carbonate or ankerite bands frequently observed in the Porcupine and Larder Lake areas. Some of the material mineralized with iron pyrites and copper pyrites was found to yield traces and up to $2.00 of gold to the ton.

### Post-Timiskaming Intrusives (Algoman?)

There are several igneous rocks, namely: granite, syenite, hornblendite, feldspar-porphyry and serpentine, which are found in the southerly part of the accompanying detailed map-sheet, but whose relationship to the Timiskaming series is not definitely known, since they were not observed in contact with the sedimentary rocks. Since most of them are fresh and massive and the sediments are greatly altered, it is considered that the igneous rocks are the younger.

A number of intrusives also, including lamprophyre, syenite and feldspar-porphyry occur throughout the conglomerate and associated rocks of the Timiskaming series, and their relationship is therefore clearly recognized. These intrusives occur in the central part of the area, either as broad stock-like masses or narrow dikes in the sedimentary rocks. The surface outcrops usually have their longer axes in a northeast-southwest direction.

It is quite likely that all these igneous rocks belong to the same era, being different facies of a plutonic rock which underlies the whole area. The syenite and granite are exposed by deep erosion.

#### Granite, Serpentine, etc., South of Kirkland Lake

These rocks consist of aplite, felsite, syenite, feldspar-porphyry, granite-porphyry, granite and gneiss, pegmatite, hornblendite, lamprophyre and serpentine. all of which are closely intermingled and grouped together, since they are difficult to separate. These rocks occur in the southern part of the area separating the Keewatin on the south from the Timiskaming on the north. They clearly intrude the Keewatin, and apparently cut the rusty carbonate, which may be of Timiskaming or Keewatin age. The acid rocks are pink, grey or light green in colour, while the basic ones are dark green. The rocks vary in texture from quite fine-grained aplite to coarse-grained hornblendite with crystals two inches across.

*Granites.*—These are usually of the mica type, although hornblende granites were seen. Occasionally large feldspar phenocrysts are present. The dark-coloured types may be due to the assimilation of some of the adjacent rocks.

*Feldspar-Porphyry.*—A grey feldspar-porphyry, to the east of Murdock creek, from claim T 15,752 has been described by E. L. Bruce as follows:

The feldspar phenocrysts show distinctly on the surface. Under the microscope the rock is distinctly porphyritic. The phenocrysts are plagioclase feldspar near the albite end, set in a groundmass of quartz, feldspar and hornblende. Considerable alteration has taken place, producing chlorite, sericite, kaolin, carbonates and epidote. Magnetite and chalcopyrite are present. The phenocrysts make up a large part of the rock, the areas of groundmass being narrow.

An analysis of this rock gave: silica, 60.71; alumina, 14.87; ferric oxide, 3.26; ferrous oxide, 3.60; magnesia, 3.52; lime, 3.29; potash, 2.52; soda, 4.40; carbon dioxide, 1.68; water, 2.35.

This calculates to a norm consisting of: quartz, 17.34; orthoclase, 11.10; albite, 37.16; anorthite, 1.67; magnetite, 1.20; chlorite, 12.93; kaolin, 4.82; sericite, 3.14; hornblende, 7.70.

This shows the acidic nature of the feldspar. The large quantity of chlorite present explains the rather high percentage of water in the analysis.

*Hornblendite.*—The large massive hornblendite outcrop near the second milepost on the east boundary of Teck township probably represents a basic segregation from the granite rocks. In places the hornblende crystals are two inches across. Other minerals present are biotite, magnetite, apatite, titanite and epidote.

*Serpentine.*—Narrow dikes of serpentine were found cutting the above rocks. Three of these typical fine-grained dikes have been indicated on the map.

## Intrusive Rocks Near Kirkland Lake

There is a close association of lamprophyre, syenite and feldspar-porphyry in different outcrops in the vicinity of Kirkland lake and extending southwesterly and northeasterly from this locality. This relationship does not appear to be fortuitous, but is evidently the result of a number of intrusions from the same parent magma. In many parts of the area it is possible to trace a dark-coloured lamprophyric rock into a red syenitic type with intermediate hybrid varieties, suggesting magmatic differentiation. Again it is possible to see the red syenite distinctly cutting the lamprophyre, either in broad masses or in narrow dikes, only a few inches in width. Both these rocks are intruded by a reddish or greyish rock showing distinct phenocrysts of feldspar, to which the name feldspar-porphyry has been applied. In underground examination it is frequently difficult to distinguish the red feldspar-porphyry from the red syenite. From observation in the field it is possible to state that the basic lamprophyre type is the oldest and the feldspar-porphyry the youngest of the intrusions, i.e., the rocks have been intruded in the order of decreasing basicity from one general magma. These various types are all well exposed on the northwest part of the Orr claim (L. 16,626), to the southwest of Kirkland lake. They are of great economic importance, since the gold deposits of Kirkland lake are believed to be genetically connected with these intrusions and to have been formed subsequently to the intrusion of the more acid variety, the feldspar-porphyry.

*Lamprophyre.*—This is normally a black to dark grey rock frequently showing phenocrysts of ferromagnesian mineral which may be augite, hornblende or mica; occasionally two of these minerals show in the same specimen. The common lamprophyre is of the "vogesite" type, while "minette" has been recognized at the Lake Shore mine and elsewhere. The rock usually has a rough surface in weathered outcrops, due to unequal weathering of its constituents. Occasionally it has a pitted surface, due to the leaching of the ferromagnesian phenocrysts. Again it is often traversed by numerous dikelets of red syenite, only an inch to a few inches in width. These dikelets resist weathering better than the basic lamprophyre and stand out as ribs, usually in a direction parallel to the long axes of the outcrop. These small dikes have resulted from a filling of cracks by the more acid material of the residual magma.

Analyses of augite lamprophyres are given in the following table:

| | 1. Per cent. | 2. Per cent. | 3. Per cent. | 4. Per cent.. |
|---|---|---|---|---|
| Silica | 48.50 | 52.29 | 47.44 | 47.20 |
| Alumina | 22.43 | 19.38 | .... | .... |
| Ferric oxide | 2.85 | 4.40 | .... | .... |
| Ferrous oxide | 4.78 | 6.00 | .... | .... |
| Lime | 7.62 | 7.79 | .... | .... |
| Magnesia | 1.16 | 3.54 | .... | .... |
| Potash | 3.56 | 4.12 | 4.34 | 4.46 |
| Soda | 3.38 | 2.12 | 3.10 | 3.17 |
| Carbon dioxide | 3.72 | .... | .... | .... |
| Water | 2.26 | .95 | .... | .... |

1. Lamprophyre from Day claim, L. 6526, N.E. Kirkland lake.
2. Lamprophyre north of Blanche river, Eby township.
3. Lamprophyre, 500 feet south of Southwest bay, Kirkland lake.
4. Lamprophyre, north of road, near south shaft, Orr claim.

A specimen of lamprophyre from southeast of A. shaft at the Tough-Oakes mine shows prominent phenocrysts of augite, now altered to fibrous hornblende, secondary feldspar, chlorite and calcite. The feldspar is principally orthoclase with subordinate plagioclase. Crystals of apatite are abundant and have mostly crystallized with the ferromagnesian mineral. Small grains of magnetite are scattered throughout the rock.

The analyses of the lamprophyric types of rock indicate that the orthoclase feldspar is in excess of the plagioclase even in the basic phases. As the rock becomes lighter in colour with an increase of red feldspar, the proportion of orthoclase also increases and the rock approaches a red syenite.

The normal dark-coloured lamprophyres, occurring in large volume on the northeast shores of Kirkland lake and easterly, are accompanied by an unusual porphyritic rock to the south of the northeast bay of Kirkland lake. On the surface it contains conspicuous bleached feldspar crystals and is older-looking than the normal feldspar-porphyry of the Kirkland Lake area. It is intruded by a dike of feldspar-porphyry in this locality and is therefore an older rock. The older porphyritic rock is syenite porphyry, containing, under the microscope, phenocrysts of orthoclase with zonal structure and numerous hornblende crystals in a fine-grained feldspathic groundmass containing apatite and magnetite with secondary calcite. Minute blades of sericite are scattered through the rock.

A diabasic rock, apparently a facies of the lamprophyre, occurs on claim No. L. 2643.

*Syenite.*—As previously mentioned, there is a red rock associated with the basic lamprophyre either in broad masses or narrow dikes that occurs abundantly in the area southwest of Kirkland lake, especially around the southwest bay of the lake, and in Lebel township, north of Gull lake. The syenite is of a bright red colour, consisting largely of orthoclase feldspar, with scattered grains of ferromagnesian mineral, altered to chlorite, calcite and secondary feldspar, and apatite, pyrite and magnetite as accessory minerals.

Lamprophyre dike with narrow dikelets of red syenite, northwest of the Tough-Oakes mine.

An analysis of the red syenitic rocks shows the following composition:

| | Per cent. |
|---|---|
| Silica | 57.56 |
| Alumina | 18.53 |
| Ferrous oxide | 1.87 |
| Ferric oxide | 5.84 |
| Lime | 1.25 |
| Magnesia | 0.89 |
| Potash | 8.34 |
| Soda | 3.58 |
| Carbon dioxide | 0.69 |
| Water | 1.69 |

This analysis is very similar to that of a red porphyritic syenite at the Davidson property in the Matachewan area that has the following composition:

| | Per cent. |
|---|---|
| Silica | 61.80 |
| Alumina | 18.86 |
| Ferrous oxide | 0.32 |
| Ferric oxide | 2.95 |
| Lime | 0.63 |
| Magnesia | 0.34 |
| Potash | 8.86 |
| Soda | 3.19 |
| Carbon dioxide | 0.84 |
| Water | 0.54 |
| Pyrite | 1.45 |

The red syenite is the most acid syenite seen in the vicinity. It can be traced into an intermediate rock showing less silica and more lime and magnesia with increasing percentages of ferromagnesian minerals. At times it is difficult to state whether particular specimens are syenite or lamprophyre, particularly where they grade into each other as seen on the high ridge just south of the southwest bay of Kirkland lake. In fact, the darker intermediate varieties could be called basic syenite.

In consequence of the close association of the red and black rocks, which in places are differentiation products of the same magma, a separation on the map is extremely difficult. An attempt has been made to separate them in the vicinity of the southwest bay of Kirkland lake. In this locality the veins are partly in the syenite and less basic lamprophyre types, and commercial ore shoots occur in them.

*Feldspar-Porphyry*:—This is the latest intrusive of acid or intermediate composition occurring in the vicinity of Kirkland lake. It is present as narrow dikes, often only a few feet wide and broad stock-like masses that may be nearly the width of a claim. This rock is usually characterized by the presence of conspicuous phenocrysts of red feldspar, but in portions of it the phenocrysts may be inconspicuous, the rock resembling more the red syenite previously described. It is generally of a bright red or pink colour, but is sometimes grey or greenish.

The porphyry intrusions, like the lamprophyre, have their long axes in a general northeast and southwest direction.

Often a mass of porphyry will include narrow strips of conglomerate and greywacké, resembling the main mass of the sedimentary rocks which occur in great volume in the central part of the area. Such small masses of conglomerate can be observed on the surface at the Wright-Hargreaves mine to the east of the main shaft. Narrow masses of conglomerate are also encountered underground at the Lake Shore mine.

The feldspar-porphyry is often intimately associated with the lamprophyre in narrow bands. Where exposed on a point just north of the shaft at the Lake Shore mine there are repeated alternations of porphyry and lamprophyre, the bands being only a few feet in width. In a cross-cut 200 feet below these outcrops the rock is all porphyry, showing that the bands of lamprophyre at the outcrop do not extend to great depth.

The relationship of the porphyry to the conglomerate, greywacké and quartzite is well shown in many outcrops. There are a number of narrow dikes of porphyry intruding the conglomerate in the Kirkland Lake townsite, where outcrops show the porphyry masses cutting across the bedding of the sedimentary rock.

In additiont to the feldspar phenocrysts the rock occasionally shows 'eyes' of clear quartz and blades of biotite in hand specimens.

Microscopically the feldspar crystals often exhibit a beautiful zonal structure. Zones of sericite are frequently recognized in the phenocrysts, probably the result of alteration of some intergrown orthoclase. Multiple twinning is prominent in most of the feldspar crystals, which are therefore of the plagioclase variety, but orthoclase is intergrown with the plagioclase in some of the crystals, the intergrowth being referred to anorthoclase. There are a few scattered crystals of quartz, generally smaller than the feldspar phenocrysts, and laths of biotite, some of which show alteration to chlorite. The groundmass is fine-grained, consisting largely of feldspar and quartz. Chemical analyses show plagioclase feldspar to be more prominent than orthoclase, in which respect the porphyry is different from the red syenite.

Photomicrograph of reddish feldspar-porphyry, from north part of Burnside claim, L. 1823. (× 19 diameters)

Photomicrograph of greenish feldspar-porphyry from wall of gold-bearing vein on Burnside claim, L. 1823. The rock contains considerable sericite. (×19 diameters)

Analyses of feldspar-porphyry gave the following results:

| | 1. Per cent. | 2. Per cent. |
|---|---|---|
| Silica | 66.30 | 66.48 |
| Alumina | 15.37 | 15.42 |
| Ferrous oxide | 1.47 | 1.18 |
| Ferric oxide | 0.37 | 1.05 |
| Lime | 3.06 | 3.15 |
| Magnesia | 1.16 | 1.67 |
| Potash | 3.86 | 2.56 |
| Soda | 4.78 | 5.97 |
| Carbon dioxide | 3.34 | 2.65 |
| Water | 0.60 | 0.30 |

1. Tough-Oakes near No. 1 vein.
2. Teck-Hughes near vein east of No. 1 shaft.

Where the red feldspar-porphyry is lacking in distinct phenocrysts of feldspar, the difficulty in distinguishing it from the red syenite is increased. Analysis has shown that the syenite has a higher percentage of orthoclase than plagioclase feldspar, whereas in the feldspar-porphyry the preponderance of feldspar is plagioclase. In hand specimens it is often impossible to distinguish the red intrusive rocks, and since both the porphyry and syenite are favourable to ore deposition the distinction is not important.

### Later Dikes

Diabase that is later than the post-Timiskaming intrusives is rare in the area. Two dikes occur in the vicinity of Kirkland lake. The easterly dike that can be seen to the southwest bay of Kirkland lake is an olivine diabase and in places is partly altered to serpentine. About one-quarter of a mile west is a dike of quartz diabase that has been encountered in the workings of the Teck-Hughes and Orr properties. It can be traced south and southwesterly to the Canadian Kirkland claims. Since no rocks of the Cobalt series are present in the area the relation of these dikes to this series is not known. They may, however, be of Keweenawan age, similar to many other dikes in the pre-Cambrian.

### Glacial and Recent

Drift areas, outlined on map No. 29*g*, consist of thin sheets of glacial sand and gravel. A part of the area is overlain by swamp. Where the soil has been removed recently the glacial grooves and striations are quite distinct. The ice came from the north over the height of land, the movement being in a southerly direction varying from S. 20° to S. 35° E.

## ECONOMIC GEOLOGY

An economic map-sheet, No. 29*h*, including a longitudinal section showing the known ore shoots along the main fracture on a scale of 600 feet to the inch, accompanies the report.

### Origin and Age of Gold Deposits

All the gold deposits of northern Ontario are in the pre-Cambrian, in rocks which, with few exceptions, are older than the Cobalt series. After the folding of the Timiskaming series and before the deposition of the Cobalt series, there was a period of igneous activity during which basic and acid rocks, including lamprophyre, porphyry, syenite and granite, were intruded into the older rocks. The probable genetic relationship of the gold deposits of Porcupine to granite intrusions has been noted in a report on that area. There are a number of gold-bearing veins at Kirkland lake associated with feldspar-porphyry and syenite, suggestive of a relationship between the intrusives and the veins. There are areas of granite and syenite within a short distance of the gold deposits. An examination of a number of specimens from these plutonic areas shows that these rocks contain albite, usually as phenocrysts, similar to the feldspar-porphyry. It is quite likely that the granite, syenite and feldspar-porphyry belong to the same period of intrusion and are different facies of a magma which underlay or underlies a large part of the area. The syenite and granite have been exposed by deep erosion.

While the gold-bearing veins were formed subsequent to the intrusion of the porphyry, it is likely that they are genetically connected with the intrusive rock which occurs as dikes and boss-like masses. The cooling of the intrusive was apparently accompanied by shrinkage, faulting and displacement in the porphyry itself and in the adjacent rocks. The gold-bearing, silicious solutions that deposited their burdens in the fissures and other fractures in all probability represented the end product of the intrusion of the acid rocks that have been mentioned.

Lindgren[1] in his classification of mineral deposits places the gold-quartz veins of Ontario in the division of "veins and replacement deposits formed at high temperature and pressure and in genetic connection with intrusive rocks." He says: "These veins are clearly related to those of the southern Appalachian states, but, on the other hand, they present some remarkable analogies with those of California." These veins were formed at considerable depth and have been exposed by extensive erosion, but it is probable that they were not formed at as high temperatures as the veins at Porcupine, in which tourmaline and pyrrhotite frequently occur. The minerals tourmaline, pyroxene, garnet, amphibole and biotite, characteristic of deposits formed at high temperatures, have not been recognized by the writers in the Kirkland Lake area. Albite, chlorite, sericite and carbonates are present in the deposits as alteration products. The veins at Kirkland lake in their mineral constituents greatly resemble those of the Sierra Nevada, California, which are described by Lindgren.[2] In these latter veins tellurides like altaite, hessite, calaverite, petzite and melonite are frequently associated with native gold.

In a comparison of the Cripple Creek and Kalgoorlie gold deposits, Lindgren has shown that telluride of gold may be deposited in large quantities both near the surface (as at Cripple creek), and at a depth of many thousands of feet below it (as at Kalgoorlie).[3] Telluride of gold is not so abundant in the Kirkland lake deposits as telluride of lead, but probably occurs in greater quantity than has been suspected owing to the difficulty of identifying the telluride in fine grains when accompanied by native gold. As stated above, the mineral associations at Kirkland lake are not typically those of high temperature deposits. Magnetite has been found in gold-bearing veins at the Argonaut[4] mine, a few miles east of Kirkland lake, and specularite has been reported in veins from the Tough-Oakes mine. The Kirkland Lake deposits have probably been formed at considerable depth, like the Kalgoorlie deposits, but not at such high temperatures, while the mineral association is somewhat similar in that native gold accompanies the tellurides.

### Distribution of Ore Deposits

Exploration in the Kirkland Lake area has indicated three principal zones of mineralization. The main or central zone is that which runs northeasterly and southwesterly along the southern expansion of Kirkland lake and along which a group of mines is being developed over a distance of two and a quarter miles. The principal mines of the area, Tough-Oakes, Burnside, Sylvanite, Wright-Hargreaves,

[1] Mineral Deposits, 2nd edit., W. Lindgren, p. 676.

[2] Ibid., p. 565.

[3] Economic Geology, 1905-6, Vol. I, 542, "Metasomatic Processes in the Gold Deposits of Western Australia."

[4] Formerly La Mine d'or Huronia, Gauthier township.

Lake Shore, Teck-Hughes, Orr, Kirkland Lake, and also several prospects are situated along this zone.

A southerly zone lies about three-quarters of a mile to the south with a similar strike, and along it are located the Ontario-Kirkland, Hunton, Honer and Canadian-Kirkland and on which considerable work has already been done.

A northerly zone known as the Goodfish Lake Gold Area,[1] lies about two miles north of the central zone where a number of properties, including the Costello, La Belle Kirkland and Fidelity, are located. This zone is not shown on the accompanying geological map.

### Kirkland Lake Mineral Zone

The greatest amount of work has been done on the central zone, where a number of gold-bearing veins have been discovered extending over two and a quarter miles in length and a width of one-half a mile. In this zone operations have shown a major fracturing along which the principal properties are located. It is believed that after the intrusion of the porphyry and syenite faulting took place in lines roughly parallel with the long axis of the intrusions, accompanied by fracturing and crushing of the porphyry and other rocks with the formation of the veins or lodes along these fracture planes. The principal or major fracturing can be traced across a number of properties where ore shoots are being developed at widely separated points, but evidently along one system of fracturing. This fracturing has crossed all the different rocks in this zone, including feldspar-porphyry, syenite, lamprophyre and conglomerate. No. 1 vein at the Kirkland Lake mine, No. 2 vein of the Orr, No. 3 vein of the Teck-Hughes, No. 2 vein at the Lake Shore and No. 2 vein at the Wright-Hargreaves are being developed along the major fracturing. In addition there are branch veins and other fractures roughly parallel, on which development has been done on a number of properties; examples are No. 1 vein at the Lake Shore, Nos. 1 and 5 veins at the Teck-Hughes, and No. 1 vein at the Wright-Hargreaves, etc.

The fault planes along which the ore deposits have been formed dip to the south, usually at a high inclination, 80° to 85°, although locally there are rolls in the fault planes that are steeper or flatter than the average dip. A fracture zone will contain several fault planes, which often form the boundaries of ore, and at several mines development has been carried on with regard to two prominent fault planes called footwall and hanging-wall planes. These planes are from a few feet to 40 feet or more apart, the ore sometimes occurring over this whole width, or, as is more frequent, near one or the other wall, depending on subsidiary slip or fault planes. The ore will also at times extend beyond the recognizable fault planes or so-called vein boundaries.

The faulting and fracturing of the rock has permitted the circulation of mineral-bearing solutions with accompanying vapours, which have partly filled any open fissures and partly replaced the country rock in the fracture zone. The amount of vein quartz in the ore deposits is relatively small as compared with the mineralized porphyry or other rock through which the fractures have extended. In addition to irregular masses of quartz several feet in width that occur along the veins, there are numbers of narrow irregular quartz veins a few inches in width penetrating the

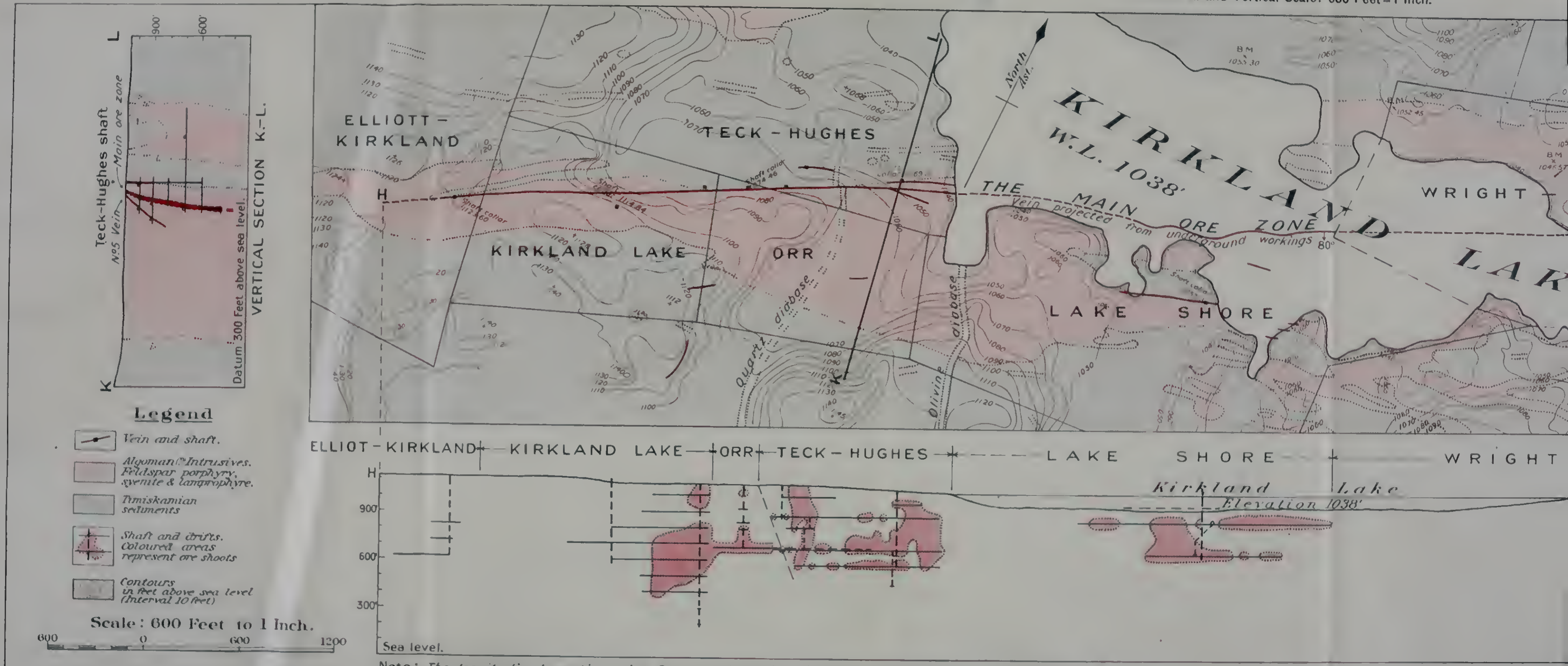
[1] Ont. Bur. Min., Vol. XXV, 1916.

Map No. 29h.

# PLAN SHOWING GEOLOGY AND VEINS OF THE CENTRAL ORE ZONE, KIRKLA

TOGETHER WITH A LONGITUDINAL, NEARLY VERTICAL SECTION, H-J, ALONG THE PLANE OF THE MAIN FRACTURING, AND A VER

Horizontal and Vertical Scale: 600 Feet = 1 inch.




Note: *The longitudinal section dips 80° south which is the approximate dip of the ore zone.*

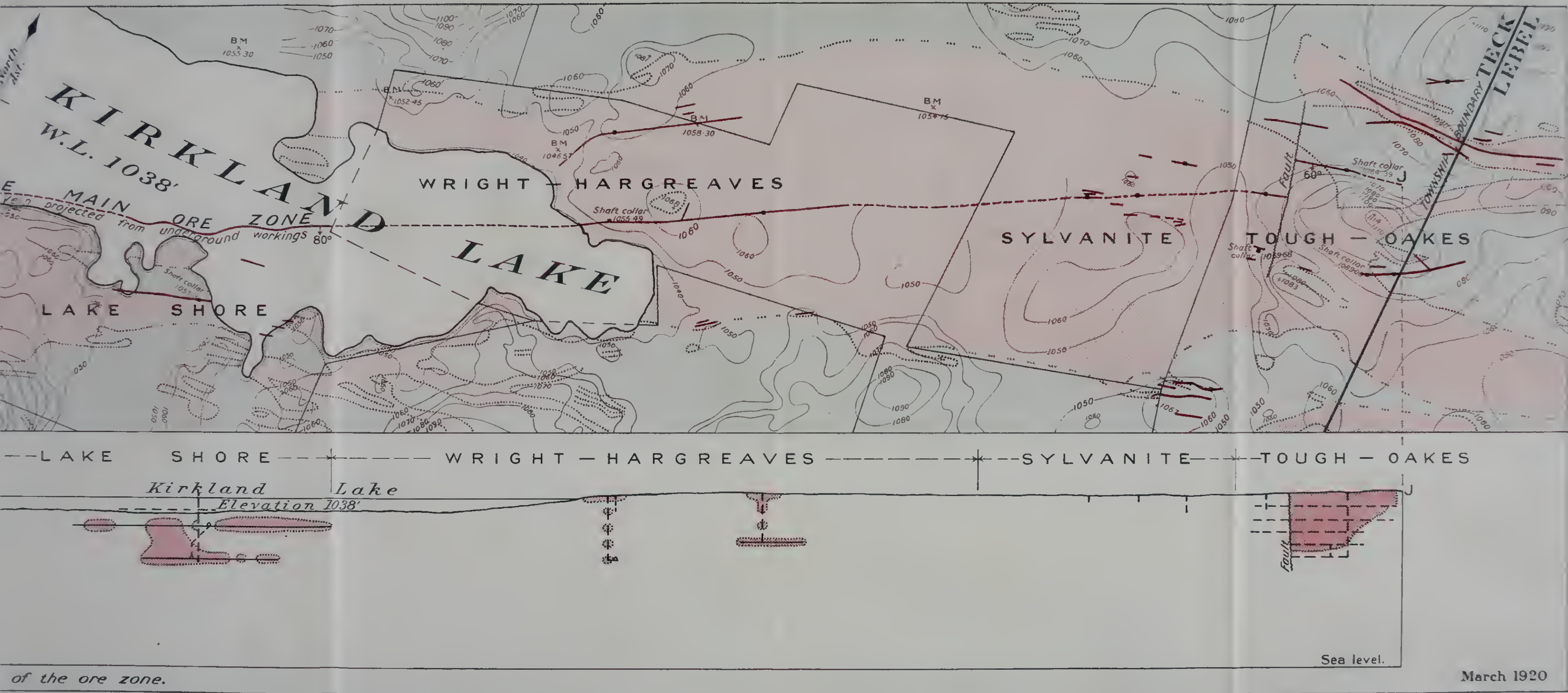
*To accompany report by A. G. Burrows and P. E. Hopkins on Kirkland Lake Gold Area, Volume XXIX, Part IV, Report of Ontario Depa*

Map No. 29h.

# ...OGY AND VEINS OF THE CENTRAL ORE ZONE, KIRKLAND LAKE GOLD AREA

...SECTION, H-J, ALONG THE PLANE OF THE MAIN FRACTURING, AND A VERTICAL SECTION, K-L, ACROSS THE ORE ZONE.

Horizontal and Vertical Scale: 600 Feet = 1 inch.




...Burrows and P. E. Hopkins on Kirkland Lake Gold Area, Volume XXIX, Part IV, Report of Ontario Department of Mines, 1920.

porphyry or other rock, together with mineralized or replaced rock, which make up the ore body. In consequence of the irregular distribution of quartz in the veins the working faces along drifts on the veins vary greatly in appearance, sometimes showing considerable quartz and at other times almost entirely mineralized porphyry or other rock with minute veinlets of quartz intersecting it.

The mineralization of the veins has extended over a long period, since there has been repeated fracturing along the mineralized zone. The primary quartz is greatly brecciated and fragments of quartz and porphyry have been displaced along the fault planes. Movement along the walls in the ore bodies is evidenced by grooving and slickensided surfaces in the direction of movement. Information as to the extent of horizontal displacement may be obtained at the Teck-Hughes mines, where a north and south dike of diabase 60 feet in width has been faulted a distance of 150 feet along No. 3 vein, the part of the dike to the north of the fault planes being to the west. Several large blocks of diabase occur in the frac-

Mineralized porphyry with quartz veinlets, showing faulting-face in west drift, No. 1 vein, 300′ level, Lake Shore mine.

ture zone together with masses of crushed porphyry or syenite thrust along the fault planes. Mineralization even later than this extensive movement is indicated by the presence of gold values along slip planes in fragments of diabase in the fault zone. The unaltered diabase itself does not carry gold values.

### Mineralization of Porphyry and Syenite

There has been an extensive mineralization of porphyry and syenite in parts of the area that extend through the southerly part of Kirkland lake. This is apart from that mineralization that occurs with the commercial ore bodies. The long cross-cuts connecting Nos. 1 and 2 veins on the 200- and 400-foot levels at the Lake Shore mine are through these rocks. The assay plans show numerous assays of gold from traces up to 40 cents with occasional higher assays of rock in the cross-cuts. This rock when examined closely is seen to carry minute veinlets of quartz with disseminated iron pyrites, which would account for the frequent gold values. Similar low values are shown in cross-cuts at other properties away from the veins, indicating a general mineralization of much of these intrusives away from the recognized veins. This mineralization is probably dependent on the faulting and fracturing previously referred to along the central zone, and not, as might at first be supposed, due to a gold distribution at the time of the crystallization of the intrusive rock.

### Character of Gold Deposits

The early development of the Kirkland Lake area was chiefly at the Tough-Oakes mine where a number of narrow gold-bearing veins were discovered. The most important was No. 2, which, at the surface, carried extremely high-grade ore over a width of 2 to 6 inches in the conglomerate, the vein fissure being largely filled with quartz. Development proved that the vein ran from the conglomerate into the porphyry on the surface and at depth, and by far the greater part of the gold extraction has come from the ore shoot in the porphyry. While the high-grade quartz vein in the conglomerate carried most of the values with mill ore in the wall rock affording a narrow compact ore deposit, when it entered the porphyry the quartz occurred usually in narower veinlets spread across a greater width with much fracturing of the porphyry along the vein. Consequently most of the ore in the porphyry is fractured porphyry with numerous slip planes, along which quartz, calcite and ore-bearing minerals have been deposited, affording a greater width of ore than in the conglomerate. The stopes on the vein average about 5 feet in width. Development on other veins on the property also indicated that they contained narrow ore bodies either in the porphyry or greywacké and conglomerate.

The early exploration farther west along the mineralized zone did not meet with such satisfactory results, the veins in the conglomerate and porphyry along the surface not showing such high-grade ore as occurred at the Tough-Oakes, with the exception of the north vein at the Wright-Hargreaves, which produced a small amount of high-grade when it was operated for a short time in 1913.

The main fracture zone, or main vein, which for most of its length is in low ground or under the bed of Kirkland lake, was difficult to prospect, and only after several years of work has it been proven to be the locus of the principal ore deposition. Much of the previous work was done on parallel or subsidiary and narrower veins. In the main fracture the ore deposits have been found to be wider than had been expected, reaching in places forty feet in width, but as a general rule running from about five to fifteen feet in width.

Strictly speaking the ore-bearing deposits should be called lodes or composite veins formed under strong compressive forces, with the solutions following openings along fracture planes in an irregular manner and partly replacing the country rock adjacent to the fractured planes. The stringers and masses of quartz intermingled with the fractured porphyry or other rock generally lie in the direction of the vein or lode, but are often connected by transverse stringers. The replacement character of the ore is frequently recognized by masses of quartz spotted with remnants of red porphyry; this ore has a faint reddish colour due to the included porphyry. In other cases masses of ore are bright red porphyry or syenite with very thin seams of quartz that are hardly recognizable. The lenses of quartz are sometimes several feet wide in portions of an ore deposit and contain much visible gold together with tellurides, pyrite, copper pyrites, molybdenite, etc. Some of the ore shows very little vein quartz, and specimens of altered red syenite from the Lake Shore mine have been found to contain grains of gold in the secondary minerals, calcite and sericite intermingled with the original feldspars of the rock.

Mining operations at the Kirkland Lake mine, October, 1920, have indicated promising ore at a depth of 900 feet where the same general mineralization has been encountered.

### Minerals in Kirkland Lake Veins

The oldest mineral in the veins, apart from the rock-forming minerals, is a coarsely crystalline quartz. Usually this quartz has been broken up and other minerals deposited in the fracture planes. Of these there is quartz, often of a somewhat darker colour than that first deposited. Carbonates of various composition are present in the veins. A pink carbonate proved on analysis to be calcite with 5.34 per cent. of magnesium carbonate; a grey variety is ankerite. There have been different periods of fracturing. Some of the quartz is later than the carbonates. Where there have been inclusions of country rock in the vein and replacement, some sericite has been developed. Chlorite also occurs as a vein material. Iron pyrites is the most abundant of the sulphides, being found both in the wall rock and in the veins, usually in well crystallized forms. Some of the pyrite in the vein is in fine grains. Copper pyrites occurs to some extent, generally where the vein is gold-bearing. Galena and zinc blende occur in very small quantity. The latter material has been observed in small incrustation veinlets, which are later than the ore. Molybdenite has been deposited abundantly in fractures, usually as a thin film. Graphite has been recognized in some of the ore. This mineral, when in thin films, is difficult to distinguish from molybdenite. Crushed iron pyrites along slip planes has also produced a bright blackish deposit that resembles molybdenite or graphite.

Gold-bearing solutions have circulated along these planes, and the veins have been enriched by the deposition of gold in these later fractures. Later movements have often occurred along these planes and the gold, altaite and other tellurides, pyrite, copper pyrites, molybdenite and graphite deposited along the planes have been crushed and polished or slickensided. In some cases the gold has been deposited after the slickensides have been formed, since veinlets of the metal have been observed on the 200-foot level of the Tough-Oakes mine cutting across the smooth planes of the molybdenite.

One of the latest minerals with white calcite along fault planes is barite of a deep red colour, observed at the Teck-Hughes and Lake Shore mines.

### Tellurides

Several tellurides have been recognized in ore from the Kirkland Lake area. The most abundant telluride is altaite (PbTe), telluride of lead, which has been recognized in ore from all the mines in the central zone. This mineral is readily recognized by the well developed cubical cleavage and brilliant cleavage planes. It has a very faint greenish tinge, which aids in recognizing it in fine grains. This mineral is usually accompanied by visible gold and its presence often indicates high-grade portions of the vein.

Telluride of gold, calaverite, ($AuTe_2$) has only been recognized in ore from No. 3 vein at the Tough-Oakes mine. Specimens from this vein show calaverite in quite coarse grains and readily recognizable. The mineral is of a pale brassy almost white colour, brittle and quite soft. It resembles pale-coloured iron pyrites, but is much softer. The mineral on assay yielded 40.6 per cent. gold. This mineral is probably sparsely distributed in the ore, but if in very fine grains would be difficult to recognize in hand specimens.

Black tellurides carrying mercury have been recognized recently in specimens from the Tough-Oakes mine. One of these corresponds to kalgoorlite, a telluride of gold, silver and mercury. An analysis of selected material by W. K. McNeill gave the following composition; Au. 20.40 per cent.; Ag. 31.1 per cent.; Hg. 10.2 per cent. Another telluride contains mercury and tellurium with no gold or silver and is coloradoite. These mercury-bearing tellurides were definitely recognized in polished surfaces by means of the microscope and by chemical and blowpipe tests. A mercury telluride, probably coloradoite, also occurs in specimens of ore from No. 2 vein at the Lake Shore mine. The mineral is here associated with native gold, altaite, pyrite and copper pyrites.

The tellurides, tetradymite (telluride of bismuth) and hessite (telluride of silver), have been reported from No. 2 vein of the Tough-Oakes mine but have not been recognized by the writers.

### Ores in Thin Section

Examination of a number of thin sections of ore from the Kirkland Lake area shows that the vein material has been much brecciated. Fragments of porphyry, syenite, conglomerate, or greywacké, depending on the character of the wall rock. are enclosed in vein materials, which are chiefly quartz with calcite and dolomite. Replacement of the various rocks by quartz is also in evidence. The coarsely crystallized quartz of the first generation is fractured, and the fracture filled with later quartz, calcite and dolomite. The principal sulphide and telluride minerals occur chiefly with the finer-grained material in the minute fracture planes in the quartz and altered rock. An interlacing meshwork of metallic sulphides and tellurides with native gold is frequently observed. Wherever the tellurides occur, native gold is usually recognized in grains close to the telluride grains. Grains of gold are seen in the tellurides, and again minute veinlets of gold sometimes traverse coarse masses of telluride. The crystallized calcite frequently contains gold that has been deposited along the rhombic cleavage planes. The contact of fragments of porphyry or other rocks with quartz is usually a place for concentration of the sulphides, tellurides and gold. Replacement of the rock is recognized by a gradual transition to quartz and other later minerals. Native gold has been observed in contact with telluride, molybdenite, pyrite and copper pyrites.

A section of high-grade ore from the Kirkland Lake mine shows quartz in contact with altered syenite. There is a concentration of pyrite and tellurides with gold along the contact of quartz and rock and also in the quartz, which is fractured and carries fine-grained quartz and calcite in the fracture planes. There is abundant sericite and carbonate in the altered rock. A blackish mineral in very thin films is believed to be molybdenite. A sample of high-grade ore from Kirkland Lake mine containing 21.42 oz. of gold per ton, has the following partial composition: Fe 1.65 per cent.; $MoS_2$ 0.34 per cent.; S 0.65 per cent.; C 0.09 per cent.; Te 0.10 per cent. This analysis shows the presence of both molybdenite and graphite in the ore.

TOTAL PRODUCTION OF GOLD AND SILVER FROM THE KIRKLAND LAKE AREA.

| Year | Mine | Tons Ore Milled | Gold Ounces | Gold Value $ | Silver Ounces | Silver Value $ | Total Value, Gold and Silver $ | Extraction per ton $ |
|---|---|---|---|---|---|---|---|---|
| 1913 | Tough-Oakes | 2,220 | 3,164.05 | 64,376.30 | 3,890.4 | 2,255.92 | 66,632.22 | 30.01 |
| | Wright-Hargreaves | 3.4 | 42.77 | 884.04 | 404.2 | 242.55 | 1,126.59 | .......... |
| | Total | 2,223.4 | 3,206.82 | 65,260.34 | 4,294.6 | 2,498.47 | 67,758.81 | 30.47 |
| 1914 | Tough-Oakes | 3,734 | 5,523.62 | 114,153.46 | 6,634.3 | 3,490.21 | 117,643.67 | 31.24 |
| 1915 | Tough-Oakes | 26,196 | 26,658.23 | 551,069.07 | 8,922.0 | 4,470.07 | 555,539.14 | 21.21 |
| 1916 | Tough-Oakes | 39,865 | 33,991.32 | 702,760.70 | 13,051.1 | 8,864.76 | 711,625.46 | 17.85 |
| 1917 | Teck-Hughes | 11,257 | 3,181.46 | 65,752.96 | 1,154.6 | 969.12 | 66,722.08 | 5.44 |
| | Tough-Oakes | 38,695 | 16,383.60 | 338,593.30 | 5,256.9 | 4,237.34 | 342,830.64 | 8.86 |
| | Total | 49,952 | 19,565.06 | 404,346.26 | 6,411.5 | 5,206.46 | 409,552.72 | 8.20 |
| 1918 | Lake Shore | 16,749 | 20,031.01 | 415,229.75 | 1,188.62 | 1,184.06 | 416,413.81 | 24.86 |
| | Teck-Hughes | 14,774 | 3,869.29 | 79,949.48 | 669.52 | 620.73 | 80,570.21 | 5.45 |
| | Tough-Oakes | 22,000 | 6,619.52 | 136,827.63 | 3,006.68 | 2,855.67 | 139,683.30 | 6.35 |
| | Total | 53,523 | 30,519.82 | 632,006.86 | 4,864.82 | 4,660.46 | 636,667.32 | 11.81 |
| 1919 | Kirkland Lake | 11,324 | 2,675.05 | 55,780.38 | 378.9 | 482.21 | 56,262.59 | 4.97 |
| | Lake Shore | 11.081 | 12,695.72 | 262,421.80 | 932.5 | 932.50 | 263,354.30 | 23.77 |
| | Teck-Hughes | 18,387 | 8,156.37 | 168,607.15 | 930.1 | 983.26 | 169,590.41 | 9.22 |
| | Total | 40,792 | 23,527.14 | 486,809.33 | 2,241.5 | 2,397.97 | 489,207.30 | 11.99 |
| | GRAND TOTAL | 216,285.4 | 142,992.01 | 2,956,406.02 | 46,419.8 | 31,588.40 | 2,987,994.42 | .......... |

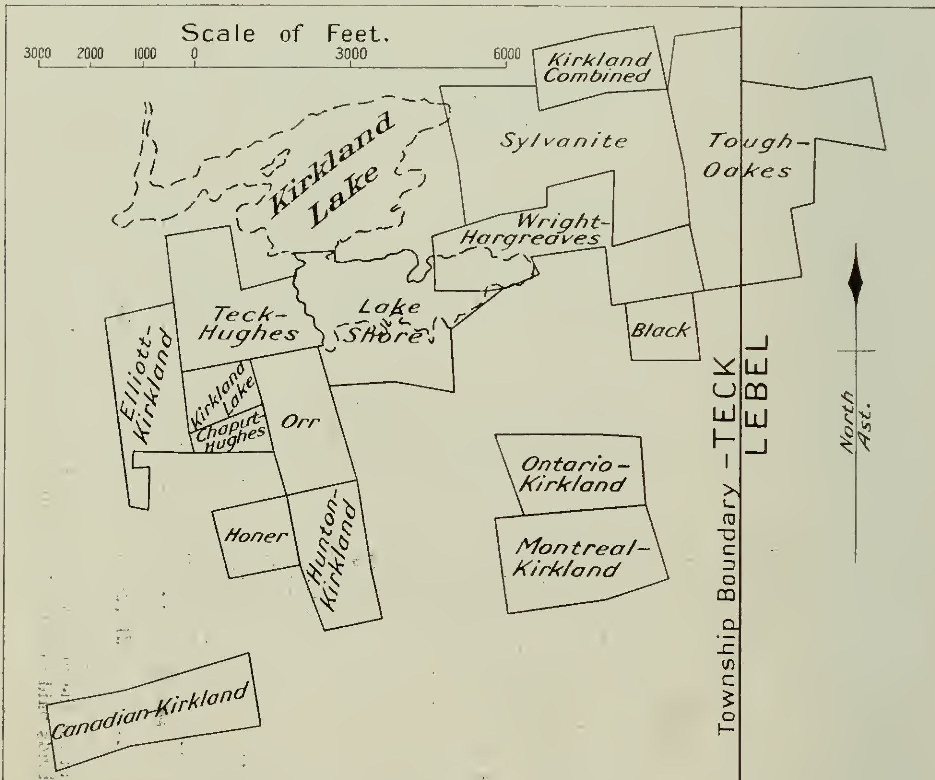
NOTE.—The output of gold for the first half of 1920 totalled $506,790, made up as follows: Lake Shore $243,977, Kirkland Lake $137,676, and Teck-Hughes $125,137. Dividends paid to the end of 1919 were $398,625 by the Tough-Oakes, and $200,000 by the Lake Shore.

## WORKING PROPERTIES

### Kirkland Lake Area

#### Elliott Kirkland

The Elliott Kirkland property lies to the west of the Kirkland Lake mine. It includes three claims, the principal of which is L. 1617 on which the shaft and mine buildings are located. The main fracture zone has been traced westerly through low land from the Kirkland Lake mine. A vertical shaft has been sunk 537 feet, with cross-cuts on five levels and drifts on the third, fourth and fifth levels along fault planes. The rocks encountered are porphyry, lamprophyre, syenite, and reddish feldspathic quartzite. During the time of the strike at Kirkland lake the workings were allowed to fill with water and no further exploratory work has since been done.




Plan showing location and boundaries of the several mining properties mentioned in the report.

#### Kirkland Lake

The Kirkland Lake Gold Mining Company is operating claim L. 1236, formerly known as the McKane, situated one-quarter of a mile southwest of Kirkland lake. Native gold had been discovered in the main vein by the early operators, who also sank No. 1 shaft to a moderate depth. The original discovery was made through about 20 feet of overburden, the strike of the vein having been determined from workings on the Teck-Hughes and other properties.

There are two vertical shafts on the property. No. 1 is located in the north-east part of the claim near the Orr line and has been sunk to a depth [1] of 700 feet (April 1, 1920). The mineralization was followed to 104 feet, where the vein left the shaft on the south side. From the different levels cross-cuts were run to the south to intersect the vein. Since the vein dips approximately 85° S., the cross-cuts are slightly longer at each succeeding level. Drifts have been run on seven levels, but those on the first and second are short, the values obtained not having been as good as those from the 300-foot to the 700-foot levels.

A main hoisting shaft is located 600 feet southwest from No. 1 shaft and to the south of the main vein as exposed on the surface. This contains two hoisting compartments and a manway compartment and is connected on the third, fourth and fifth levels with the main workings along No. 1 vein. With depth the connecting cross-cuts become shorter owing to the dip of the vein to the south.

The main vein is recognized by the presence of fault planes, which dip to the south. These are called the footwall and hanging-wall planes, and they vary considerably in distance apart in different sections of the mine. At the cross-cuts from No. 1 shaft on the 400-, 500-, 600- and 700-foot levels they are respectively 19, 33, 40 and 40 feet apart.

The area between the principal faults is very much disturbed, since minor fault planes and cross-slips have in part controlled the ore deposition. Exploration has shown that there is consequently great irregularity in the mineralization in the fractured zone and values change quite rapidly in drifting along the vein. The development has been carried on with regard to the two principal planes or vein boundaries. On the 400- and 500-foot levels drifts have been run on the foot- and hanging-wall sides of the vein for some distance and up to the present time the greatest amount of development has been done on these levels, where large stopes have been opened up, that on the 400-foot level being about 300 feet in length and 23 feet wide at one point. The assay plans of the stopes have shown the greatest values to be in the footwall section of the vein. Development has also shown that the ore sometimes extends beyond the recognized vein boundary planes. The best grade of ore has been obtained where the fault planes or vein boundaries are moderate distances apart, roughly 15 to 25 feet. Where they are within a few feet of each other the values are not so good, and where very widely apart the values have a tendency to become more scattered. The ground between the fault planes is so broken and contains so many slip planes that it has been found advisable to leave solid backs above the drifts to protect them from the weight of broken ore in the stopes.

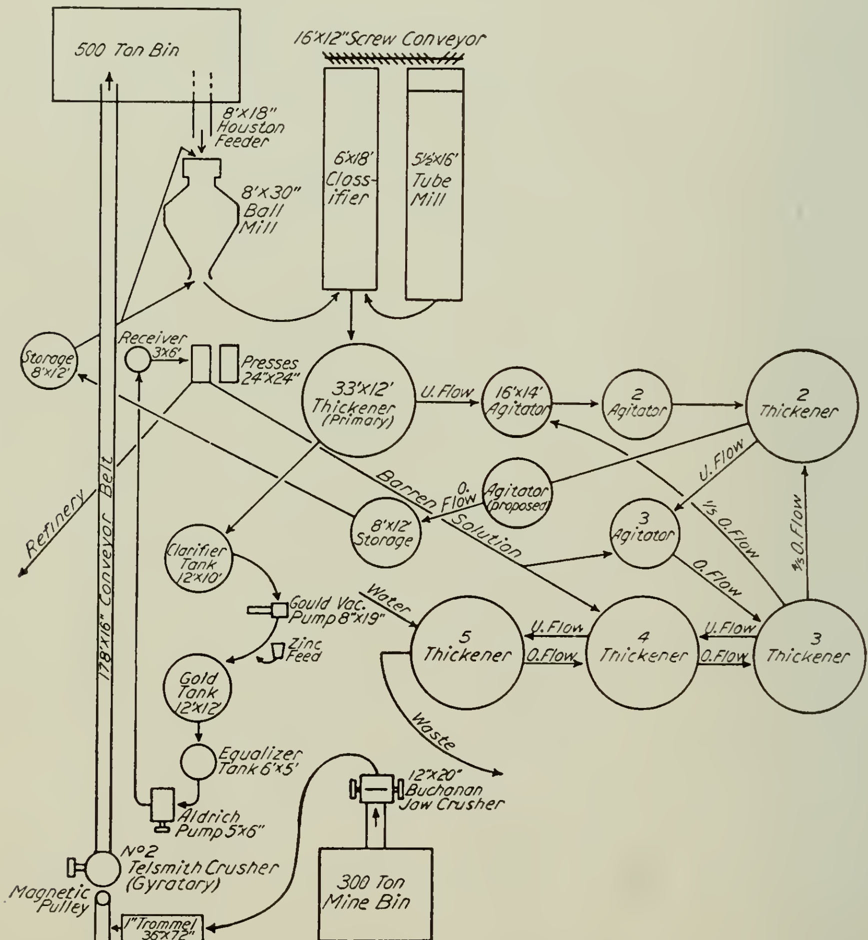
The development has so far indicated that the principal ore shoot extends from above the 300-foot level to below the 700-foot level, the deepest workings up to this time. The ore shoot pitches somewhat to the west, but sufficient development has not been accomplished to delimit its actual outline. On the third, fourth and fifth levels the ore shoot extends easterly to the Orr west boundary.

Some gold values are generally obtained along the main vein fracture, but these are not always of commercial importance. However, this mineralization indicates the possibility of exploration developing other ore shoots. A heavy fault

[1] In July, 1920, the shaft had reached a depth of 900 feet, and in October ore was encountered in drifting on this level.

plane is often in evidence in the workings, the gouge being frequently several inches thick. Considerable brecciation of ore has occurred, indicating faulting subsequent to ore deposition.

The best ore is a bright red porphyry or syenite through which there are ribbons of quartz carrying tellurides, copper pyrites, iron pyrites, molybdenite, graphite, calcite and native gold. The vein is principally in the porphyry and syenite that lies adjacent to a band of conglomerate, greywacké and quartzite, in




Flow sheet of mill, Kirkland Lake Gold Mining Co., Ltd.

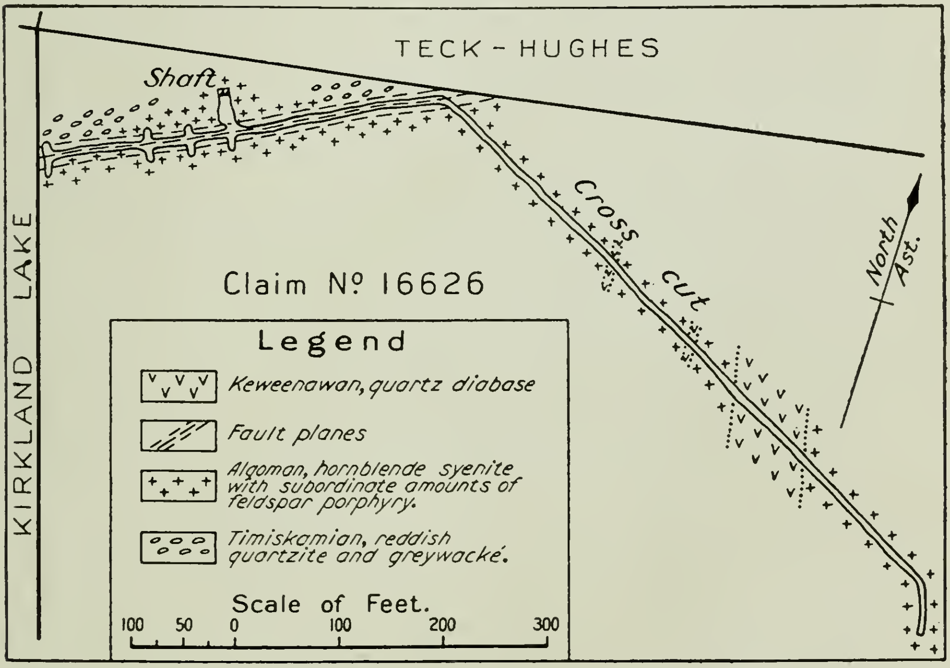
which the shaft has been sunk entirely from above the 300-foot level to the 700-foot level. The dip of the contact is approximately the same as that of the vein, about 85° S. The north fault plane or footwall of the vein is sometimes in the sedimentary formation. High-grade ore with visible gold was observed on the 400- and 500-foot level stopes, which, together with a lower grade, is expected to average approximately $10 a ton.

The ore is hoisted in the main shaft, passed through a crusher and carried to the mill bin on a conveyer belt. The mill treats 140 tons per day and the recovery is 92 to 95 per cent.

F. L. Culver is general manager, and W. Sixt, superintendent.

### Orr

The main fracture of the area passes from the Kirkland Lake mine across the northwest corner of the Orr claim, T. 16,626, otherwise known as the Orr-Wettlaufer, and extends to the Teck-Hughes and Lake Shore on the northeast.




Plan of Orr property, 400-ft. level. Ore occurs along this drift and is noted on the plan in the short cross-cuts north and south of the drift. The vein system, which dips 85° to the south, continues north-easterly to the Teck-Hughes and south-westerly to the Kirkland Lake mine.

The vein on the Orr property was discovered in 1913 and some work done. In 1917 the property was optioned to the Kirkland Porphyry, and considerable underground work was done under the supervision of Joe Houston. Ore was developed on the 280- and 400-foot levels during 1918. In 1919 a long cross-cut, 700 feet in length, was driven on the 400-foot level to the southeast to reach a parallel vein that outcrops 575 feet to the south. The cross-cut was thought to be within a few feet of the objective in June, 1919, when the miners went on strike and all work was suspended.

The main No. 1 vein, on which some ore has been developed, is approximately 300 feet in length on the surface and 400 feet on the fourth level, the gain in length being due to the vein dipping approximately 83° to the south. A vertical shaft has been sunk to a depth of 420 feet. On the 150-, 240-, 280-, and 400-foot levels the vein has been cross-cut at 12, 18, 23 and 50 feet respectively, to the south of the shaft. The vein is similar in character and structure to the main vein on the adjoining properties. For a depth of about 300 feet the vein is on or near the contact between the sediments and a red hornblende syenite. The shaft at a depth of 310 feet passed from conglomerate into syenite. On the 400-foot level the vein in places is entirely in the syenite while in the west workings it is in the contact between quartzite and syenite, as can be seen on the accompanying plan. There are two main faults from 12 to 25 feet apart, along and between which the ore occurs. A central fault is also quite pronounced, and there are numerous minor slips. A narrow drift 400 feet in length has been driven along the central fault in ore. Several cross-cuts on this level show that there is high-grade across narrow widths on both the hanging and foot walls. The high-grade is comprised of silicified porphyry with numerous molybdenite streaks and much iron pyrites, chalcopyrite, altaite and gold.

### Teck-Hughes

The main ore-bearing zone of the Kirkland Lake area passes through a southern portion of the Teck-Hughes property (L. 1238), where it is known as vein No. 3. The bulk of the gold produced at the mine, namely $316,882.70 up to the end of 1919, has come from this vein. It occurs largely in the porphyry and syenite, but passes for several hundred feet along the contact between the intrusives and the conglomerate. Practically all the early development work in 1913 was done on vein No. 1, which lies about 100 feet north of the main zone. The main, vertical No. 1 shaft at the east side of the property was commenced on vein No. 1, which dips 80° to the south. The vein is composed of brecciated porphyry and quartz from 2 to 6 feet wide and carries low contents of gold. Shafts numbers 2 and 4 are to the west on a narrow vein in the conglomerate which may be a continuation of the No. 1 vein. This vein resembles the vein in the conglomerate on the Ontario-Kirkland. No. 3 shaft near the south boundary of the claim has been sunk 200 feet on the main ore deposit with winzes down on ore to the fourth level. Cross-cuts from the No. 1 shaft have cut the main No. 3 ore zone at distances ranging from 100 to 170 feet to the south. Drifts, each approximately 1,000 feet long, extend along the main zone on the second, fourth and fifth levels. A cross-cut to the vein has been made on the sixth level. Over 10,000 feet of underground work has been accomplished to date above the 600-foot level. The section H.-J. on the accompanying map, No. 29h, shows the workings and ore shoots on the main vein, as recognized up to March, 1920.

Vein No. 5 is a branch from the hanging-wall side of the main vein and dips about 60° to the south.

The ore in the main No. 3 vein, which is typical of the ore described on other properties, occurs in shoots usually between two prominent, nearly parallel mud seams or faults, from 6 to 40 feet apart, and dips 85° to the south. The faults or slips are often filled with gouge from an inch to six inches in thickness, narrowing down in places to mere cracks. In many places secondary minerals such as quartz, calcite and reddish barite fill the faults. The ore, which is similar to that on the adjoining properties, is comprised of brecciated syenite, porphyry and quartz cut by veinlets of quartz, the whole containing numerous slip planes. The minerals present are pyrite, copper pyrites, molybdenite, altaite and gold.

The ore shoots are irregularly distributed throughout the faulted zone.

Usually the shoots lie on the inside and adjacent to one of the main fault walls. In places, however, the ore is continuous between the two fault walls, while in other places the ore extends out beyond a fault wall.

Two or three main faults are apparently subsequent to the ore deposition, but act as guides in following the ore. The shoots range in size from a few feet to over several hundred feet in length, being at times over 40 feet in width. The general superintendent, D. L. H. Forbes, has found that the best ore usually occurs where the faults are a considerable distance apart, or where there is a sharp roll in the dip along the main faults. The south or hanging-wall has produced more ore than the footwall.

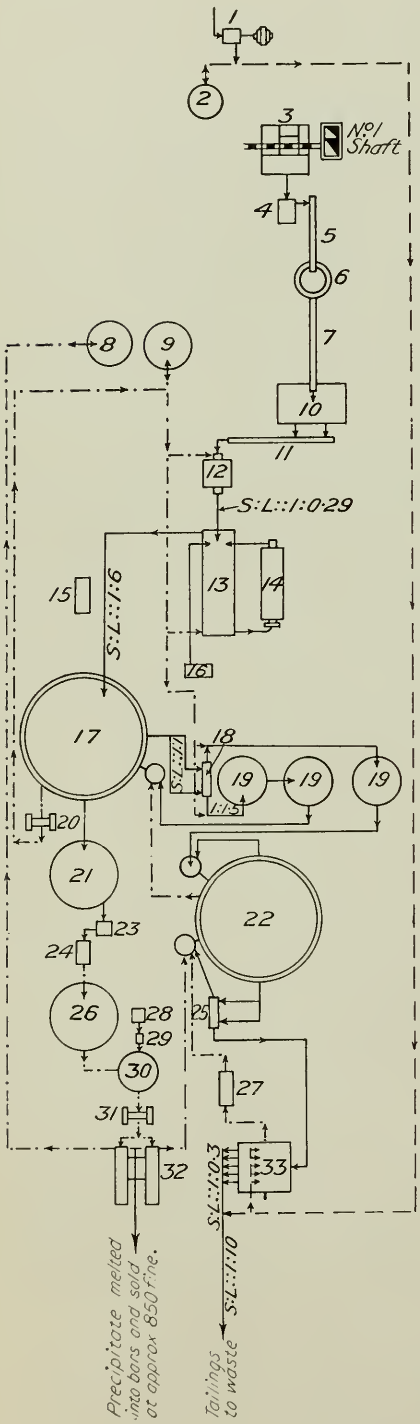
The values are so erratic that the careful sampling of every face or round is required to locate the ore shoots. Stoping, however, has shown that the values are not so uneven as lateral work would indicate.

In 1917-18 the ore averaged $7.87 per ton, which was a lower value than was indicated by the underground sampling. This was due to a dilution with waste rock caused by the easy breaking qualities along numerous slips in stoping. Ore, however, occasionally extends behind one of the fault planes or the supposed ore wall, hence horizontal drill holes are put in at regular intervals beyond the supposed ore wall for testing purposes. The west shoot was found to extend from the surface to the fifth level and to be still continuing as shown on the map section H-J. The values in the large stope above the 400-foot level near the eastern boundary of the property were more even than in the other ore shoots. The fractured zone between the ore shoots assays from 40 cents to $4.00 in gold, per ton; hence the grade of ore varies according to the amount of lower-grade material that is mined with the higher-grade.

The following notes are taken from D. L. H. Forbes', the general superintendent's, sixth annual report for the year ending August 31st, 1919.

> After a temporary shut-down during the summer of 1918, operation was resumed in October and continued without interruption until the workmen's strike on June 12th, 1919. During this period a total of 16,907 tons of ore was treated. This ore had an average gross value of $10.27 per ton, and from it gold bullion amounting to $149,874.77, or $8.86 per ton, was recovered. The silver in the bullion was 799.76 fine ounces, valued at $809.64. The average cost per ton for the seven months of uninterrupted operation was $8.58, which includes $2.72 spent in development and exploration work.
>
> Considerable new ore was found on the 2nd, 4th and 5th levels, and the result of development work in acquiring a better knowledge of the general character of the ore deposits and in obtaining more confidence in the persistence of ore shoots between levels and at depth was highly satisfactory.
>
> At the present stage of the mine's development the fully developed ore is estimated to be 26,600 tons with an average grade of about $10.00 per ton. Of this tonnage 7,800 tons are broken in the mine and 2,200 tons are at the surface in stockpiles. There is also a reserve of 12,600 tons of $5.00 average grade which is fully developed and of which 7,800 tons is broken in stockpiles or in low grade stopes in the mine. In addition to the above, the partly developed ore from the 5th level to surface is estimated to be 60,000 tons at an average grade of $9.70 per ton. It may be added that the reserves of fully developed ore at present are substantially greater than at the time when operation was resumed in October, 1918, consequently development work has more than replaced the ore treated during the year.

The flow sheet of the mill is shown in the accompanying plan. The capacity of the mill is as follows: crushing section 75 tons per 10 hours; grinding section 120 tons per 24 hours; cyaniding section 120 tons per 24 hours. The Crowe-Vacuum process of gold precipitation has considerably reduced the zinc consumption and gives a precipitate which is easily refined. The gold residue is melted into bullion and sold in bars around 850 fine.




Key to Numbers.

1. One Mather & Pratt turbine pump, direct connected to 15 h.p. motor.
2. One wood tank, capacity 37 tons.
3. One weighing platform for mine cars, ore bin, 60 tons.
4. One 16″ x 10″ Farrel-Bacon jaw crusher, capacity 75 tons per 8 hours.
5. One 20″ belt conveyor, 200 ft. per min., 20° incline, Ding magnetic head pulley.
6. One No. 2F. Telsmith gyratory crusher, set at ¾″ opening, capacity 75 tons in 8 hours.
7. One 14″ belt conveyor, 135′ centre to centre, speed 270 ft. per min., 12°-15° incline.
8. One 8′ x 10′ wood tank for barren solution.
9. One 10′ x 8′ wood tank for crushing solution, 20 tons capacity.
10. One 12′ x 16′ x 17′ deep wood ore bin, 45° bottom, capacity 110 tons.
11. One 20″ conveyor feeder, worm gear driven.
12. One 5′ x 5′ P. & M. Co. ball mill, belt-driven by 60 h.p. motor.
13. One 4½′ x 26′ Dorr duplex classifier.
14. One 5′ x 20′ P. & M. Co. tube mill, scoop feed, El Oro liners.
15. One 9½″ x 8″ Oliver F. Co., low pressure air compressor.
16. One 8″ bucket elevator, speed 275 ft. per min., returning spills.
17. One 30′ x 16′ Dorr duplex thickener, capacity 500 tons solution and 100 tons dry pulp per 24 hrs., S: L: :1: 5 underflow at 1: 1.
18. One No. 4 Sudbury Const. Co., 3-throw diaphragm pump.
19. Three 12′ x 16′ Dorr agitators, wood tanks, capacity of each 33 tons of dry pulp at 1: 1.5.
20. One 5″ x 5″ Aldrich V.T.B.D. solution pump, 80 gals. per min.
21. One 12′ x 10′ wood tank with 6 clarifying filter leaves, each 4′ x 8′
22. One 30′ x 16′ wood Dorr duplex thickener, capacity 100 tons, dry pulp per day S: L: :1: 4, underflow 1: 1.
23. One Roots rotary vacuum filter pump.
24. One 45° V-notch solution measuring weir.
25. One No. 4 Sudbury diaphragm slime pump, 20 strokes per min.
26. One 12′ x 10′ wood pregnant solution storage tank, capacity 40 tons.
27. One Blake-Knowles 6½″ x 6″ wet vacuum pump, 70 tons per day.
28. One Merrill zinc dust feeder.
29. One zinc dust emulsifier.
30. One wood agitation-precipitating tank, 4′ x 6′, capacity 2.3 tons.
31. One Aldrich 5″ x 5″ V.T.B.D. solution pump, run at 150-200 tons per day.
32. Two 2′ x 2′ x 2″ Perrin 23 frame filter presses, with Crowe vacuum and Merrill precipitation processes.
33. One 11′-6″ x 3′ Oliver slime filter.

Explanation of Flow Lines.

Ore and pulp ——————— Solution —. —. —. —. Water — — — —
Solid to liquid ratios and tons per 24 hours shown thus:—S: L: :1: 6.

FLOW SHEET (JULY, 1918) OF CYANIDE PLANT, TECK-HUGHES GOLD MINE.

### Lake Shore

The Lake Shore Mines is a consolidation of a number of claims, L. 2645, L. 2606, L. 2605, L. 1557 and 16635, along the main fracture zone that passes through Kirkland lake. It includes an area on the south side of the lake and also the southerly part of the lake bed itself. The principal mine buildings are on claim L. 1557.

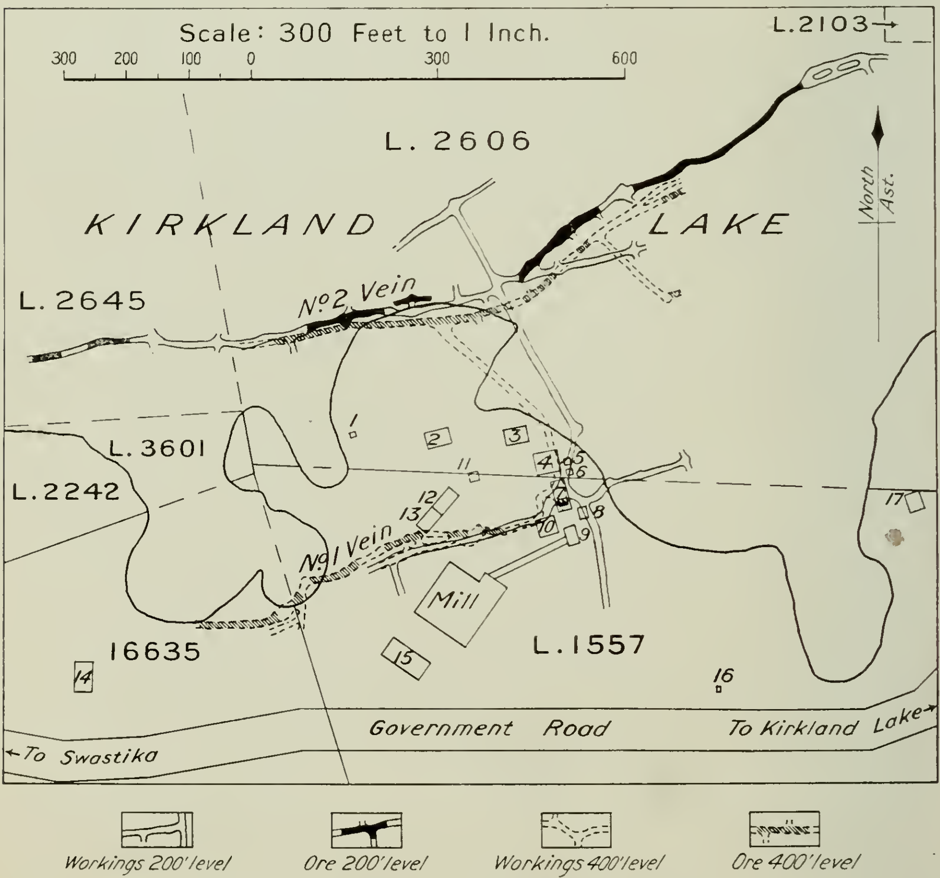
The first work was done on No. 1 vein on the south shore of the lake, where a vertical shaft has been sunk to a depth of 400 feet and drifts run on the 100-, 200-, 300- and 400-foot levels, the greatest amount of work having so far been done on the third and fourth levels. Development has shown that the vein dips slightly to the north above the 200-foot level. A strong fault was encountered just above the 200-foot level, dipping 25° to the south. The fault displaced the vein a distance of 28 feet. From the 200-foot level to the 400-foot level the vein is nearly vertical. The 400-foot level is also connected with the surface by raises. With the exception of a small amount of ore from back-stoping and raises, all the ore obtained from No. 1 vein has so far been taken from the drifts. The ore occurs chiefly in the reddish porphyry, but parts of the vein have conglomerate and lamprophyre as wall rocks. Owing to the small amount of cross-cutting the distribution of these bands of other rocks has not been worked out. On the 200-foot level, 100 feet west of the shaft, lamprophyre has been faulted over porphyry. A strong cross fault, 310 feet west of the shaft, on the 400-foot level, striking nearly north and south and dipping nearly vertically, has displaced the part of the vein lying to the west of the fault 20 feet to the south. This fault is also indicated in the workings in the west drifts on No. 2 vein. The work on the vein in the vicinity of this fault was rendered difficult by the occurrence of several subsidiary faults.

Cross-cuts have been run from the shaft northwesterly on the 200- and 400-foot levels to intersect No. 2 vein under the bed of Kirkland lake. This vein is on the main fracture that is being developed at a number of mines over a distance of 2¼ miles. It has been drifted on northeasterly and southwesterly from the cross-cut on each level, the greatest amount of drifting having been done on the 200-foot level. Here the vein is opened up for a distance of 1,500 feet, for the greater part in ore. With the exception of some back-stoping, preparatory to timbering for mining, the ore extracted has come from development. Red feldspar-porphyry and syenite occur with the vein over most of the distance so far developed, but in the west drift, 330 feet from the cross-cut, this rock is associated with bands of conglomerate and lamprophyre to the face of the west drift (April 15, 1920), about 800 feet from the cross-cut. The west face is entirely conglomerate and for a distance of about 150 feet the vein is in this rock and is of commercial grade. Ore also occurs where lamprophyre is the wall rock.

Development on the 400-foot level is similar to that on the 200-foot level, the vein where opened being principally in the red porphyry and syenite with conglomerate showing in the west drift. A long stope has been opened on this level and at the time of visit was almost through to the 200-foot level. Fracture planes occur along the vein, the ore body showing slickensided, nearly vertical walls with a slight dip to the south. The ore is largely of the red porphyry type, associated with which is quartz in lenticular masses and ribbon-like structures.

Brecciation of the ore is evident in the fractured character of the porphyry and the vein quartz. Minor slip planes occur along the ore body and commercial values sometimes cease at one of these slips and come in again on other slips in drifting along the vein. Constant assaying of faces is necessary, since the ore sometimes turns off, from where it has been following a well defined wall, diagonally along another wall.

In addition to the fracture planes with which the ore is associated there are heavy faults showing much clay gouge in places that in part have followed the ore bodies, and again are not near the ore body. One of these faults was drifted on for 210 feet easterly from the cross-cut on the 200-foot level, being mistaken for the




PLAN OF WORKINGS, ETC., LAKE SHORE MINE.

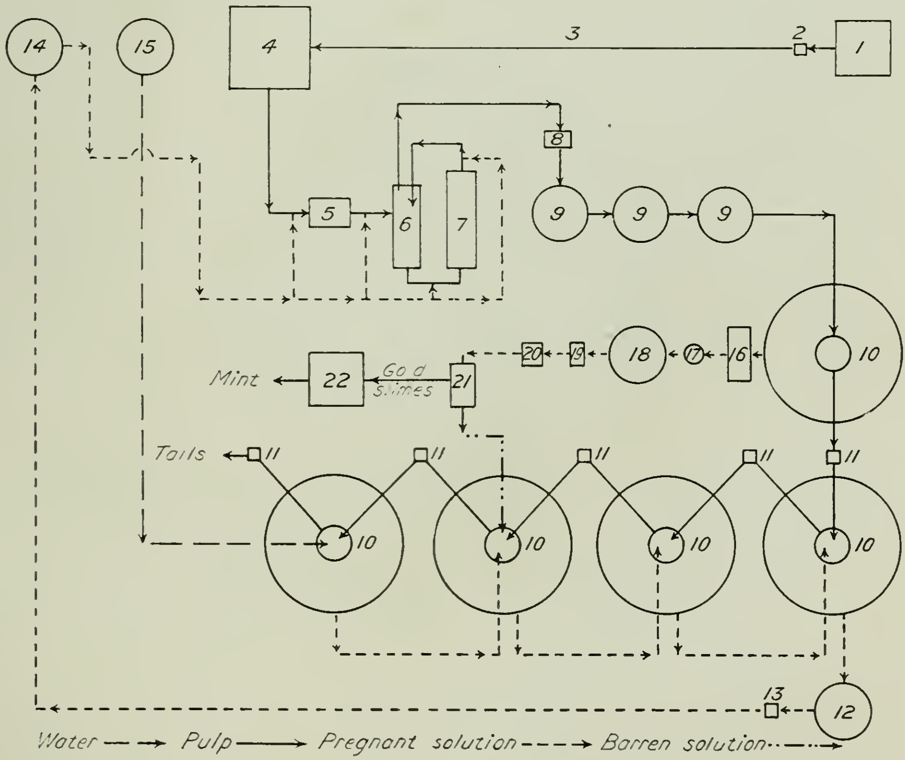
1. Thaw house.
2. Carpenter shop.
3. Boiler house.
4. Compressor and hoist house.
5. Transformer house.
6. Water tank.
7. Shaft house.
8. Dry.
9. Crusher house.
10. Blacksmith shop.
11. Lime house.
12. Assay office.
13. Refinery.
14. Manager's residence.
15. Office and store room.
16. Meter house.
17. Bungalow.

vein. Later it was discovered that the ore body had turned off from this heavy fault 40 feet from the cross-cut on the north side. Beyond this it was followed northeasterly for several hundred feet nearly to the Wright-Hargreaves boundary.

The ore bodies vary in width and it is difficult to determine the widths along the drifts, which are usually about five feet wide, and frequently all in ore. Much of the ore in the 400-foot stope on No. 2 vein will average eleven feet in width. In mining in the stopes the walls are tested by horizontal drill holes at regular intervals and the stoping continued to the boundary of the ore.

The following information has been taken from the fifth annual report of the Lake Shore Mines for the year ending November 3, 1919:

In the fiscal year 1918, 14,928 tons of ore were milled, producing $370,128.41, the average recovery being $24.76 per ton. During this period the mill operated slightly less than nine months. For the fiscal year 1919, 11,907 tons of ore were



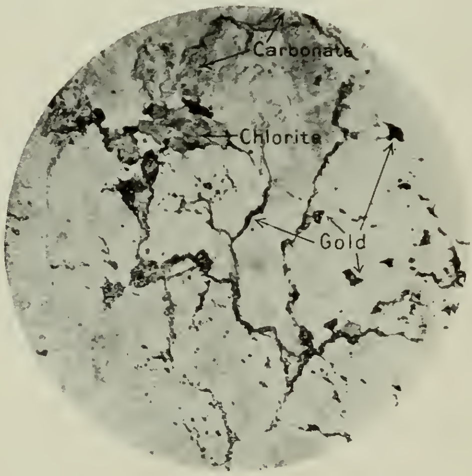

FLOW SHEET, LAKE SHORE MINE.

1. Mine Ore Bin.
2. Crusher.
3. Belt Conveyor.
4. Mill Ore Bin.
5. Ball Mill.
6. Classifier.
7. Tube Mill.
8. Bucket Elevator.
9. Agitators.
10. Thickeners.
11. Diaphragm Pumps.
12. Sump Tank.
13. Triplex Pump.
14. Storage Tank.
15. Water Tank.
16. Clarifier.
17. Vacuum Pump.
18. Pregnant Solution Tank.
19. Zinc Feeder.
20. Triplex Pump.
21. Precipitation Press.
22. Refinery.

milled, producing $293,818.18, with an average recovery of $24.67 per ton. During this period the mill was idle owing to a strike for over four months, the normal production being obtained for only the first six months of the fiscal year. Of the ore treated in the mill 43.67 per cent. was from stopes, 2.82 per cent. from raises, 3.33 per cent. from surface dump, and 50.17 per cent. from drifting; broken ore reserves—6,035 tons, average value $32.60, $185,914.00. During the year the development consisted of 1,864 feet of drifting, cross-cutting and raising on Nos. 1 and 2 veins. Regarding ore reserves R. C. Coffey, mine manager, states: "Although several ore chutes of commercial grade have been exposed, no ore has been actually blocked out, with the exception of broken ore as previously noted, and consequently no attempt has been made to figure ore reserves."

The authorized capital is $2,000,000 in shares of the par value of $1.00 each; up to November 30, 1919, four dividends of $50,000 each had been paid.

The mill treats approximately 60 tons per day and began operations on March 8, 1918.




Thin section of gold-bearing quartz from vein on Wright-Hargreaves, Carbonate, molybdenite, chlorite, telluride (altaite?), gold and other minerals occur in the fracture planes of the quartz. (× 19 diameters).

### Wright-Hargreaves

The Wright-Hargreaves mine is situated on the main ore-bearing fracture near the centre of the productive area, where the porphyry rocks have the greatest exposed width in the area. The mineralized zone has been traced intermittently for 2,400 feet on the surface, and it undoubtedly extends for 1,500 feet across the western part of the property, which is covered by a portion of Kirkland lake and passes to the Lake Shore mine on the west. The zone is roughly parallel to the longer boundaries of the property. It was in veinlets in this fracture that gold was first found in the area on L. 1830 (T.C. 709) in 1911 by W. H. Wright. During that autumn two core-drill holes were put down on the vein with a shot drill. The holes were driven only to shallow depths partly on account of the hardness of the porphyry. Dick Cartwright took an option on the property, and in 1913 discovered a small rich vein about 550 feet north of and parallel to the main vein. A 60-ft. shaft was sunk on this vein, which is five or six feet wide, and also in the porphyry, from which 3.4 tons of ore were shipped giving returns of $331.35 to the ton. The option was allowed to lapse, and the property lay idle for a long time before the present Wright-Hargreaves Company commenced operating. Two shafts about 950 feet apart have been sunk on the main fracture to the 300- and 400-foot levels respectively, and a drift on the 300-foot level to connect these shafts is about half completed. The vein and ore are very similar to those of the Lake Shore. The vein varies in width from a few feet to over twenty feet.

The north, or No. 2 vein, is similar in appearance to the main vein. The strike of the western portion of the vein suggests that it may be a branch from the main vein. This No. 2 vein where located at the 300-foot level by a long cross-cut from the main shaft was reported to contain high-grade ore over a stoping width. The vein at this point occurs slightly to the north of the vertical projection of the 60-foot shaft, which would indicate that the vein either dips to the north or has been faulted in that direction. The underground workings of this mine were filled with water at the time of inspection, but the owners state that ore of good grade occurs in a number of faces. Sufficient work has not been done to show the sizes and number of ore shoots. However, the property gives promise of becoming a substantial producer. A 175-ton mill was commenced in the spring of 1919, but owing to the miners' strike during that summer all work was suspended until May, 1920.

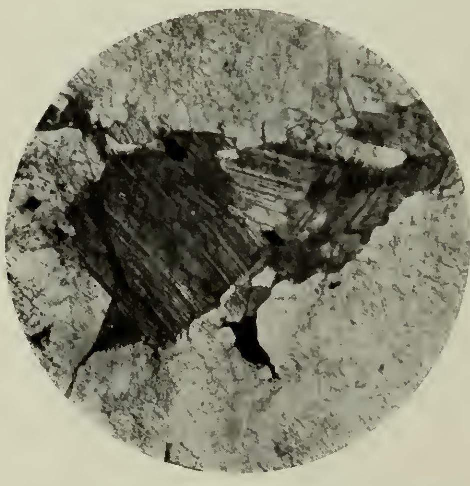
The Wright-Hargreaves Mines, Limited, has an authorized capital of 2,500,000 shares of a par value of $1.00. Albert Wende is managing director, and James Grant, resident engineer.

#### Tough=Oakes

The property was the first to be operated in the area following the discovery in January, 1912, of gold-bearing veins in the porphyry and conglomerate. It consists of five claims: L. 2372-L. 2376, situated along the boundary lines between Teck and Lebel townships, the major operations having been on L. 2375. Surface prospecting in the early years of the mine resulted in the finding of 11 veins in the porphyry, greywacké and conglomerate, some of the veins passing from one to the other formation. The veins are roughly parallel with the average strike, somewhat south of west. The principal development has been on veins Nos. 2, 3 and 6, the first two producing most of the ore already taken from the mine. The veins were traced on the surface by trenching. No 2 vein was traced for 370 feet; No. 3 for 830 feet: No. 6 for 1,460 feet, entirely in porphyry, with 740 feet of it showing an assay value of about $12.00 per ton for a width of 60 inches; No. 7 was trenched for 245 feet in the greywacké, the quartz rib of which averaged 18 inches with stringers in both walls.

In the first three years of operations high-grade ore was hand-sorted and shipped to smelters. The richness of the ore can be judged from shipments. In 1912 and 1913, 101.04 tons with a value of $46,221, or $457 per ton, were shipped to smelters. In 1914, 212.79 tons, with a value of $781,590.38, or $350.53 per ton were shipped. After being hand-sorted the remaining ore was treated in a 5-stamp mill by amalgamation, with a recovery of 55 per cent. The tailings from this treatment were impounded, and later treated in the new 100-ton cyanide plant in operation in March, 1915. The operations of the small stamp mill may be judged from the statement that during 1914 there were treated 3,493 tons of ore with a head value of $22.35 per ton for a recovery of $43,053.84. The ore raised from the mine in 1914 had an average value of $41.18 per ton.

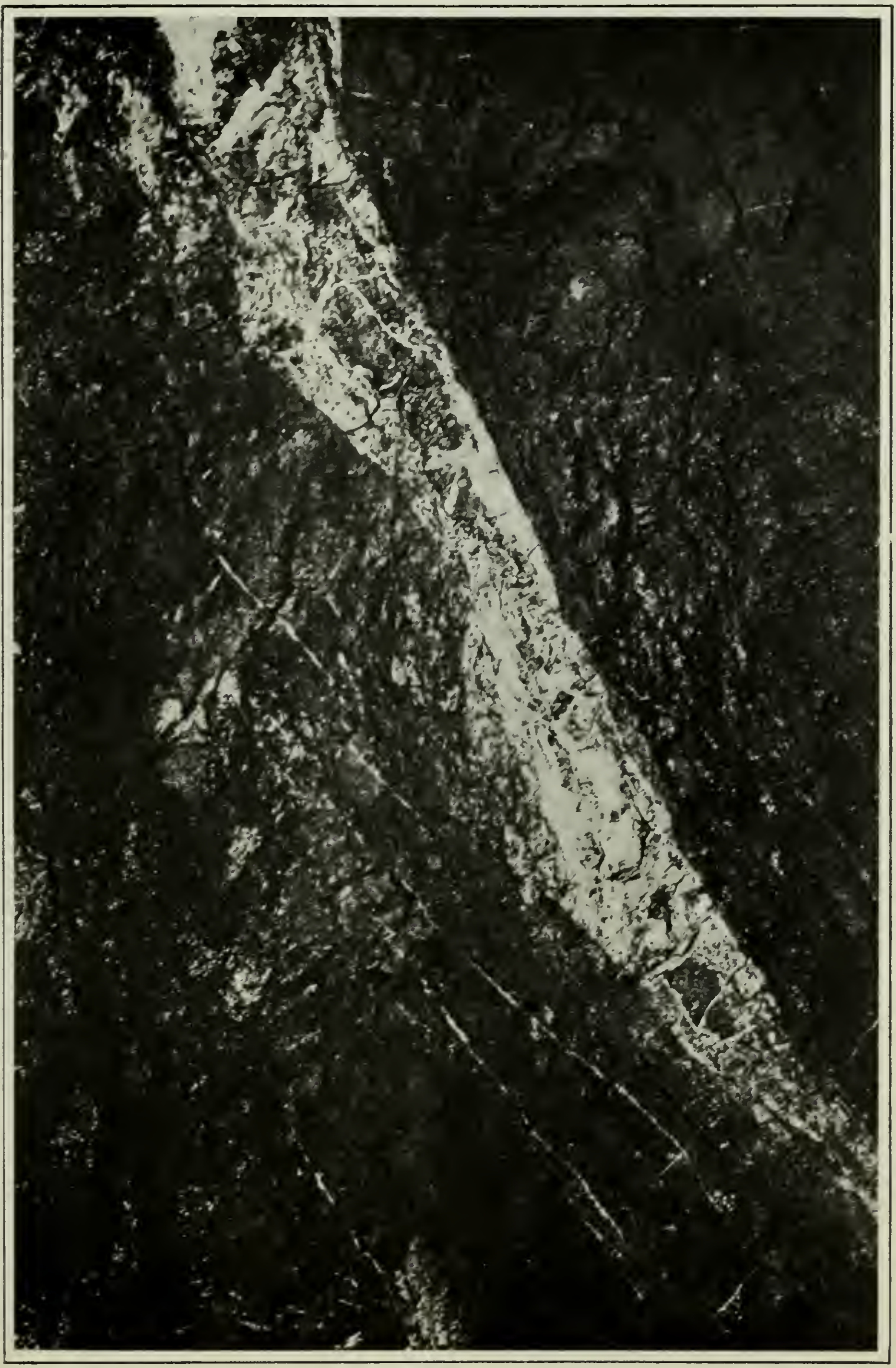
The veins that were developed were comparatively narrow, and the average stoping width was about 5 feet. An idea of the value of the ore along drifts is obtained from statements in annual reports of the company. For instance, in No. 2 vein one section of ore on the 200-foot level had an assay value of $78.00 for a length of 218 feet and width of 65 inches. A section on the same vein on the 300-



Thin section of gold-bearing quartz from No. 2 vein, Tough-Oakes mine. Quartz has been replaced by carbonate. Black spots are native gold. (X 19 diameters.)

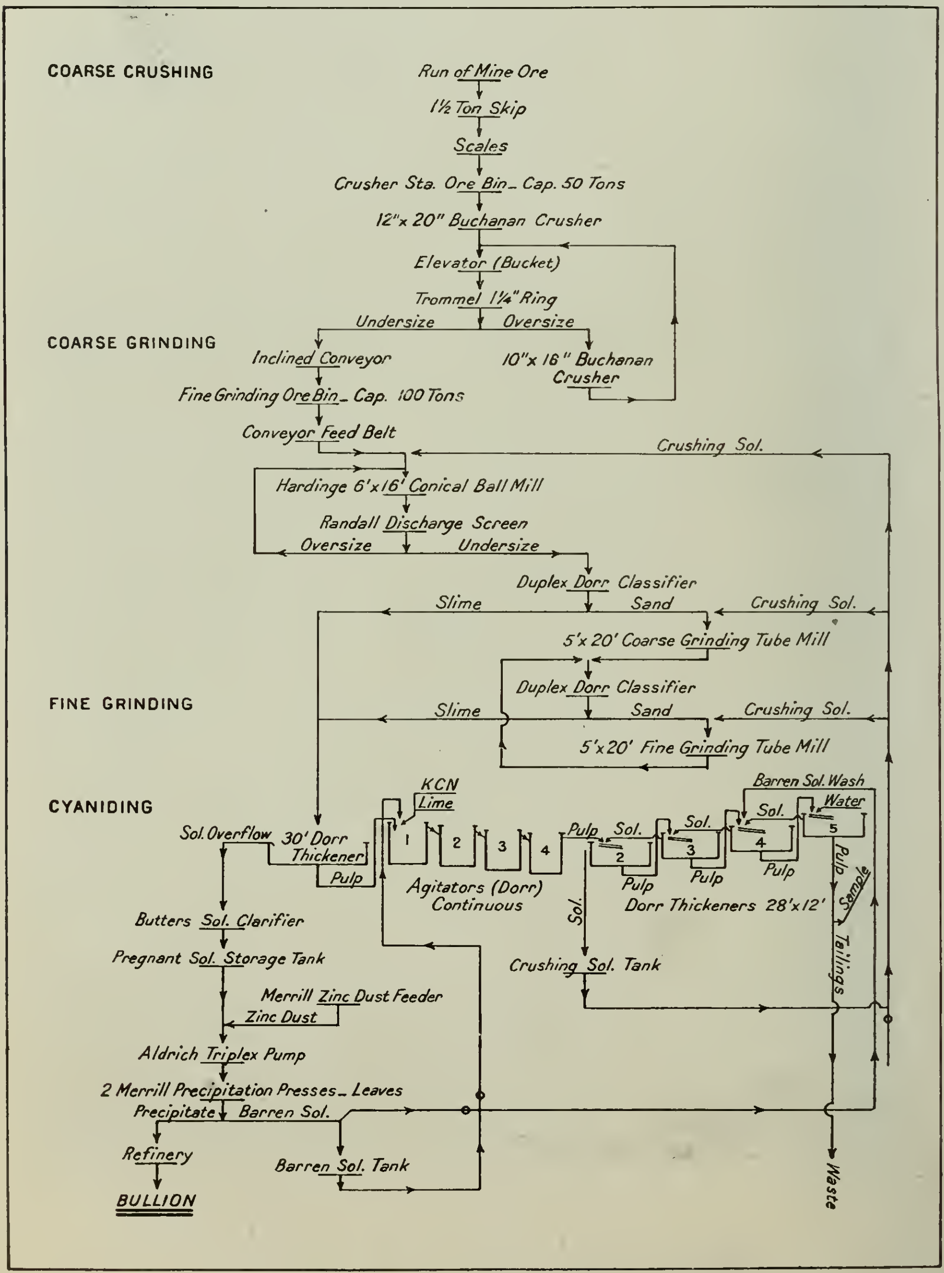
foot level showed an assay value of $32.00 over 65 inches; 180 feet of drifting on vein No. 3 on the 200-foot level had an assay value of $32.00 over a stoping width of 63 inches.

The early development was on No. 2 vein, the first work being an open cut, from which the first shipments of high-grade ore to smelters were made. An incline shaft (A) was then sunk on the vein, which has a dip of 55° south, and the main ore shoot developed on four levels. The workings that started in conglomerate passed into porphyry and the high-grade character of the ore was maintained. In drifting westward on different levels the vein was found to be faulted by a basic dike a few feet in width that strikes N. 20° W., and dips nearly vertically. Within the dike there are heavy fault planes. The dike was encountered 295 feet west of the shaft on the 200-foot level. The extension of the vein on the west side of the fault has not been determined definitely; one theory is that No. 1 vein, exposed on the surface 340 feet south of No. 2 vein, is the faulted portion of No. 2 vein.



Tough-Oakes mine, No. 3 vein, as exposed on the east side of the shaft between depths of 1 and 67 feet. The vein is in the porphyry, the fractured character of which is shown in the illustration.

High-grade ore in No. 2 vein was cut off abruptly against the dike, consequently the solving of the fault problem is of great importance to the mine. The dike is known to have displayed a strong east and west fault, dipping 87° S. on the Burnside to the south, a distance of only about 8 feet horizontally; while No. 11 vein, with a dip of 80° S. on the Tough-Oakes 180 feet north of No. 2, has been apparently

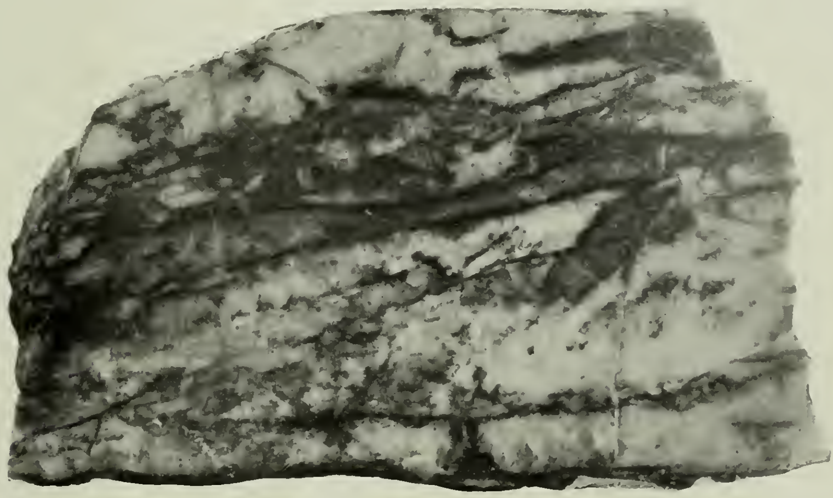



Flow sheet of mill at Tough-Oakes mine. The capacity is 100-125 tons of ore daily.

faulted only very slightly. In view of these facts it is probable that the displacement has been largely in a vertical direction. The main ore shoot on No. 2 vein has a stope length of about 250 feet on the 300-foot level. The easterly margin of the ore shoots indicates a pitch to the west. Ore shoots were also developed on subsidiary veins to No. 2.

Shaft B was sunk on No. 3 vein, which also dips to the south, and development continued below the 100-foot level by means of a number of winzes to the 400-foot level. The main ore shoot on No. 3 vein also pitches to the west. No. 6 vein and other parallel veins near No. 3 vein were also opened from the workings at B shaft.

The workings on No. 3 and parallel veins are connected with A shaft on No. 2 vein by a long cross-cut on the 200-foot level.



Gold-bearing ore from vein No. 2 in the conglomerate, Tough-Oakes mine. The specimen shows the repeated fracturing to which the vein has been subjected.

The ore from different parts of the mine is hoisted through the A shaft.

Since the amalgamation of the Burnside with the Tough-Oakes, No. 2 shaft (vertical) on the Burnside has been deepened and connected with A shaft on the 400-foot level by a long cross-cut. This shaft will be used for handling men and supplies. C shaft, sunk to the 100-foot level on vein No. 1, and shaft No. 3 on the Burnside are not as yet connected with the main workings of the Tough-Oakes.

Hugh Leggett is resident engineer.

### Sylvanite

This property lies between the Wright-Hargreaves and Tough-Oakes mines with workings in the feldspar-porphyry along fracture zones. The property was not in operation in 1919, but during 1917 a shaft was sunk to a depth of 120 feet and 169 feet of cross-cutting and drifting done on the 100-foot level. The mineralization as exposed where the vein is stripped on the surface is similar to other occurrences, where altered porphyry with quartz veinlets form the ore.

### Kirkland Combined

The Kirkland Combined Mines is operating the Day Claims L. 6526 and L. 6527 which adjoin the Sylvanite on the north, and corner the Tough-Oakes on the northwest. These two claims were formerly known as the Wishman claims, and considerable trenching and surface sampling were done in 1913 under the supervision of H. E. T. Haultain. The claims, which were allowed to revert to the Crown, were restaked and operated in the autumn of 1919 by the Kirkland Combined Mines under the direction of W. F. Greene and A. W. Greison. Air was delivered from the electrically driven compressor on the Sylvanite.

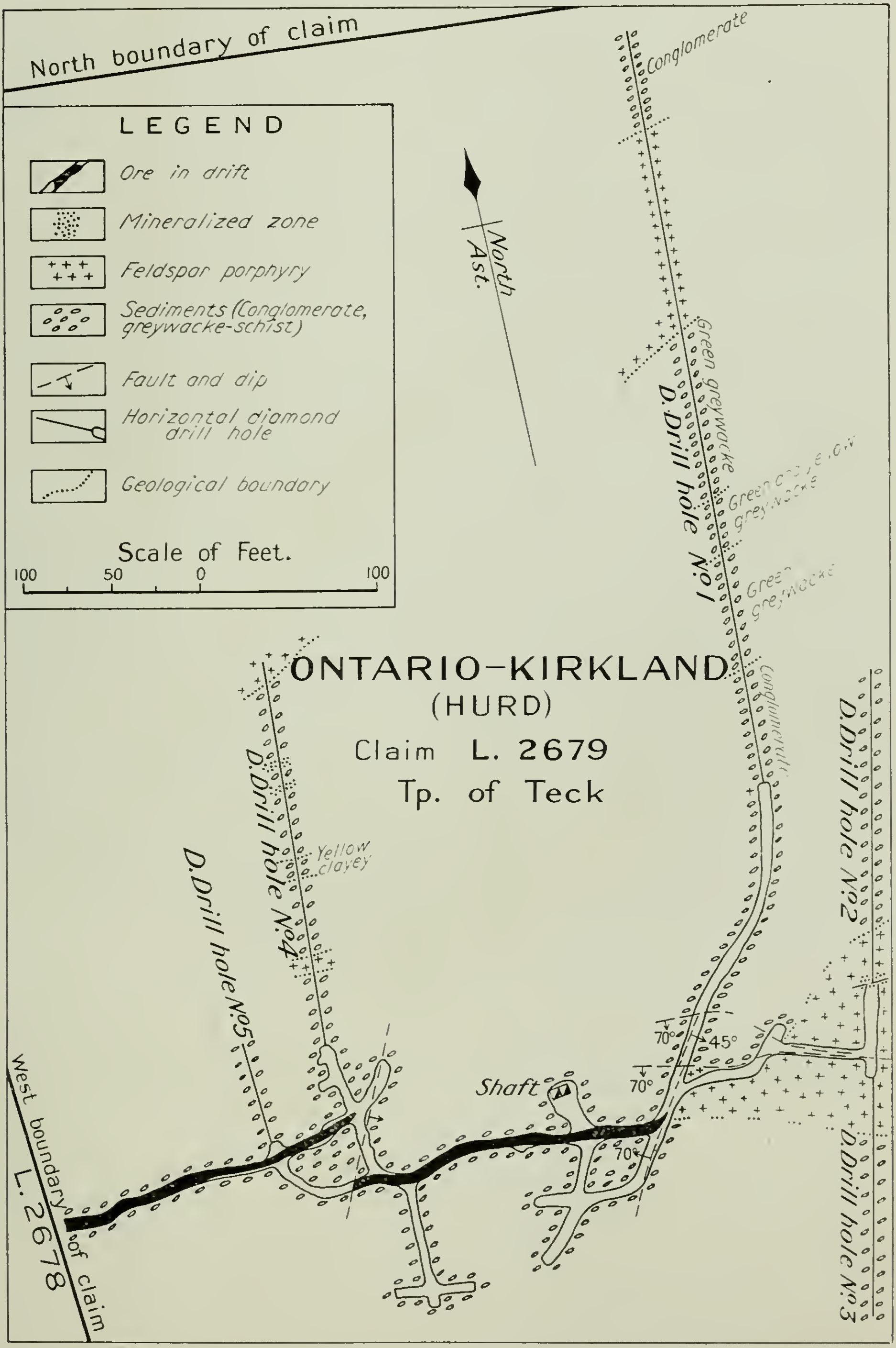
The west claim is practically all lamprophyre, while the east claim, L. 6527, on which most of the work has been done, has about equal proportions of conglomerate, lamprophyre, and porphyry. Extending along the porphyry-lamprophyre contact and passing into the lamprophyre to the west is a pronounced fracture zone, which is 5 feet wide and traceable on the surface for over 500 feet in an east-west direction. Veinlets of quartz and considerable iron pyrites and some molybdenite occur in the fault zone. Samples yielding low gold contents on assay have been obtained from a few places in the vein. By diamond-drilling it was found that the fracture zone was mineralized with pyrite to a depth of about 200 feet. At a point on the surface where the vein passes from the lamprophyre into the porphyry-lamprophyre contact a vertical shaft was sunk to a depth of 200 feet and a 106-foot cross-cut driven to the south. The vein passes out of the shaft on the south wall at a depth of 85 feet. In the cross-cut on the 200-foot level two nearly parallel mineralized fractures were encountered, 20 and 40 feet respectively south of the shaft upon which drifting is being done, the south fracture being on the porphyry-lamprophyre contact.

### Black

The Black claim, L. 2728, lies immediately south of the Wright-Hargreaves east claim. Near the north boundary is a vein striking northeast in the conglomerate, on which a shaft has been sunk to a depth of 155 feet. No mining was being done in the summer of 1919, but the vein, which is mineralized conglomerate with quartz stringers, is lenticular and narrow. It is said to contain in places high-grade ore over a width of 4 or 5 inches.

### Ontario-Kirkland

The Ontario-Kirkland Gold Mines owns two claims, L. 2678 and L. 2679, formerly known as the Hurd claim, which are situated about three-quarters of a mile south of the central ore zone of the Wright-Hargreaves. These claims were optioned during the early part of 1917 to the La Rose Mines who stripped and sampled a part of the surface and sank a 100-foot shaft on the main vein, after which the option was dropped. The present company continued the shaft to a depth of 300 feet, where 1,000 feet of drifting and cross-cutting and 930 feet of horizontal diamond-drilling have been done, resulting in the finding of some ore. Recently (May 23, 1920) the shaft reached the 450-foot level, where two gold-bearing veins were encountered at points 25 and 37 feet respectively south of the shaft, and upon which additional lateral work is being done.




Plan of the 300-ft. level, Ontario-Kirkland gold mine, showing drifts, cross-cuts, horizontal diamond drill holes, geology, ore bodies and faults.

The rocks consist of schistose conglomerate and greywacké, which have been intruded by typical reddish feldspar-porphyry. The largest porphyry mass in the area extends across the northern part of the property. It is 250 feet wide on the surface and one-half that width where it has been pierced by a diamond-drill hole on the 300-foot level. The porphyry in the southwest part of L. 2678 is unusually schistose.

Six veins have been found on the surface, all of which are practically vertical, with a nearly east-west strike. They occur largely in the sediments. Two extend from the conglomerate into the porphyry, while another is entirely in the porphyry. The main No. 1 vein, on which most work has been done, has been traced for 400 feet, the western part in a yellowish sediment resembling altered porphyry schist. At the shaft the vein passes into conglomerate, and farther east it has been faulted and probably extends into the porphyry as shown on map No. 29*g*. Two narrow short veins occur about 60 and 80 feet respectively to the south of the main vein. A fourth vein carrying high values in gold has been exposed by trenching in the south central part of L. 2678. It is a narrow, rusty band containing disseminated pyrite, chalcopyrite and a little quartz. Pits have also been sunk on two rusty pyritous porphyry bands in the northeast corner of the property.

The main No. 1 vein passed out of the shaft on a fault on the south side. On the 300-foot level the vein was located at a point 25 feet to the south of the shaft, and drifted on for 180 feet, over which length the values were reported by the manager to average $12 in gold per ton across 5 feet. The deposit consists of altered conglomerate and greywacké, quartz veinlets, iron pyrites, copper pyrites and some molybdenite. Little gold is visible. As the accompanying 300-foot-level plan shows, the ore has been cut off at both ends by faults. The portion of the vein to the east of the fault has not been definitely located, but a mineralized porphyry fault zone in the northeast cross-cut may be this extension. To the west of the west fault a somewhat similar ore deposit, but not necessarily the continuation of the No. 1 shoot, has been located 35 feet to the north. A drift on this deposit for a length of 150 feet was reported to average $17.00 per ton across 6 feet.

An electrically driven hoist and compressor are installed.

Ralph Hurd is manager, employing about 15 men.

### Montreal-Kirkland

These claims are situated south of the Ontario-Kirkland. A shaft has been sunk on claim number L. 6681, but was full of water at the time of inspection.

### Hunton

The Hunton property is situated nearly a mile south of the southwest end of Kirkland lake and consists of two claims, 16621 and 16620. A porphyry dike with strike N. 66° E. intrudes the schistose sedimentary rock near the line between the claims; most work has been done so far on the northerly claim, 16621. A mineralization occurs along the south contact, extending into both formations. An open cut was made along a series of narrow quartz veinlets 1 in. to 3 in. wide, which intersect the sediments and porphyry, the cut passing from the sediments to the porphyry to the northeast. A shaft was sunk to a depth of 40 feet in the sediment with the porphyry on the north wall. The mineralization is reported to extend to the bottom of the shaft, while visible gold was encountered down to about 30 feet. Diamond-drilling indicated gold in the core from a depth of 254 feet from the surface, vertically. By open cuts and pits the mineralization has been traced for 300 feet along the surface. Just northeast of the shaft three quartz stringers dipping south are exposed in the open cut; while 25 feet from the shaft there is a quartz vein 2 in. wide running diagonally across the trench, N. 30° E. in the porphyry, carrying extremely rich showings of gold with pyrite. The gold is very fine, almost like "mustard" gold. and shows as a yellow stain throughout the quartz. The porphyry and quartz along the rich streak carry abundant iron pyrites. This mineralization is adjacent to a fault plane that strikes in the same direction as the vein.

The management is installing power for compressor and hoist. and the shaft is to be sunk to the 300-foot level during 1920.

H. M. Porteous is in charge of the property.

### Chaput-Hughes

A power-plant has been installed on claim L. 2644 and a shaft has been commenced.

### Kirkland Kalgoorlie (Honer)

This property, claim L. 5433, is located just west of the Hunton. The rocks are sediments intruded by narrow dikes of red porphyry striking northeast and southwest. Several quartz veins have been found, the principal one of which is in the southwest part of the claim. It has been traced about 300 feet and prospected by means of several pits and a shallow prospect shaft. It occurs in schistose sediment on the northwest side of a porphyry dike. Where seen in one pit the structure shows a somewhat banded character of quartz veinlets in the sediment over a width of six feet, with the wider quartz bands toward the centre of the deposit. The quartz veins dip 70° to 80° S.E. and the best values are reported to occur in the footwall side in the narrow seams of quartz. The principal metallic sulphide is iron pyrites. A working shaft was being sunk near the northeast end of the exposure of the vein.

Good camp buildings have been erected and a power plant installed on the property.

### Canadian Kirkland

The property is situated a few hundred feet south of the Swastika-Kirkland lake road, one mile and a quarter southwest of Kirkland lake. The surface exposures are schistose sediments, conglomerate, greywacké and slate, intruded by narrow dikes of red feldspar-porphyry and a younger diabase dike that runs southwest through the property. There is a thin mantle of drift on much of the surface, requiring trenching to expose the rocks. Two vertical shafts and several pits have been sunk on mineralized zones. The main shaft on claim L. 6687, 50 feet from the north line, was sunk on a mineralized zone in the greywacké, consisting of quartz veinlets and greywacké impregnated with iron pyrites, copper pyrites, galena and calcite. The strike of the mineralized zone is E.N.E. and W.S.W. A section exposed in the shaft shows a series of quartz veinlets about one inch wide, dipping steeply to the south across the shaft to the 150-foot level. A short cross-cut was made southward at the 100-foot level, and on the 150-foot level a cross-cut was made to the north and south of the shaft. Promising assays were obtained for about 85 feet in the shaft, but no drifting was done to determine whether the mineralized zone pitched eastward or westward. The cross-cut at the 150-foot level is in greywacké with fine-grained slate-like rocks 85 feet south of the shaft.

The property is under option to the Crown Reserve Mining Company. H. J. Stewart states that on discontinuing underground operations a diamond-drill was set up 500 feet south of the shaft and a 45° hole started to intersect the main vein at a depth of approximately 400 feet from the surface.

## Goodfish Lake Area

### Fidelity

The Fidelity Mining and Development Co. is operating a group of claims in the northeast part of Teck township in the Goodfish lake section. These are located directly southwest of the La Belle Kirkland mines. The rock formations are Keewatin basalt and diabase with intrusions of grey quartz-feldspar-porphyry. The main work has been done on claim L. 2845, where there is a mineralized zone with strike N.W. and S.E. and dip 45° N.E. Work was done up to the time of the strike in June, 1919, in an inclined shaft on the lode to a depth of 140 feet. At the time of the visit, however, the workings were full of water. The dump material shows altered basalt with vein quartz and silicified rock carrying pyrite and some molybdenite. The hanging-wall side of the lode is grey porphyry. The deposit is exposed on the northeast side of a hill to the southeast of the shaft, where part of the hanging-wall portion of the vein has suffered erosion. The quartz occurs in an irregular manner in the altered rock and is frequently accompanied by feldspar. Calcite occurs in indefinite veinlets. The lode shows evidence of repeated fracturing. Native gold in fine grains was observed in specimens from the outcrop. C. E. Rodgers reports that the vein at the surface where the shaft was started showed a width of 20 inches, while at the 140-foot level the mineralized zone was over seven feet in width. A small plant consisting of a 50-h.p. boiler, a 3-drill Rand compressor and a 6- by 8-in. Jenckes hoist was installed in February, 1919. Work was resumed in February, 1920.

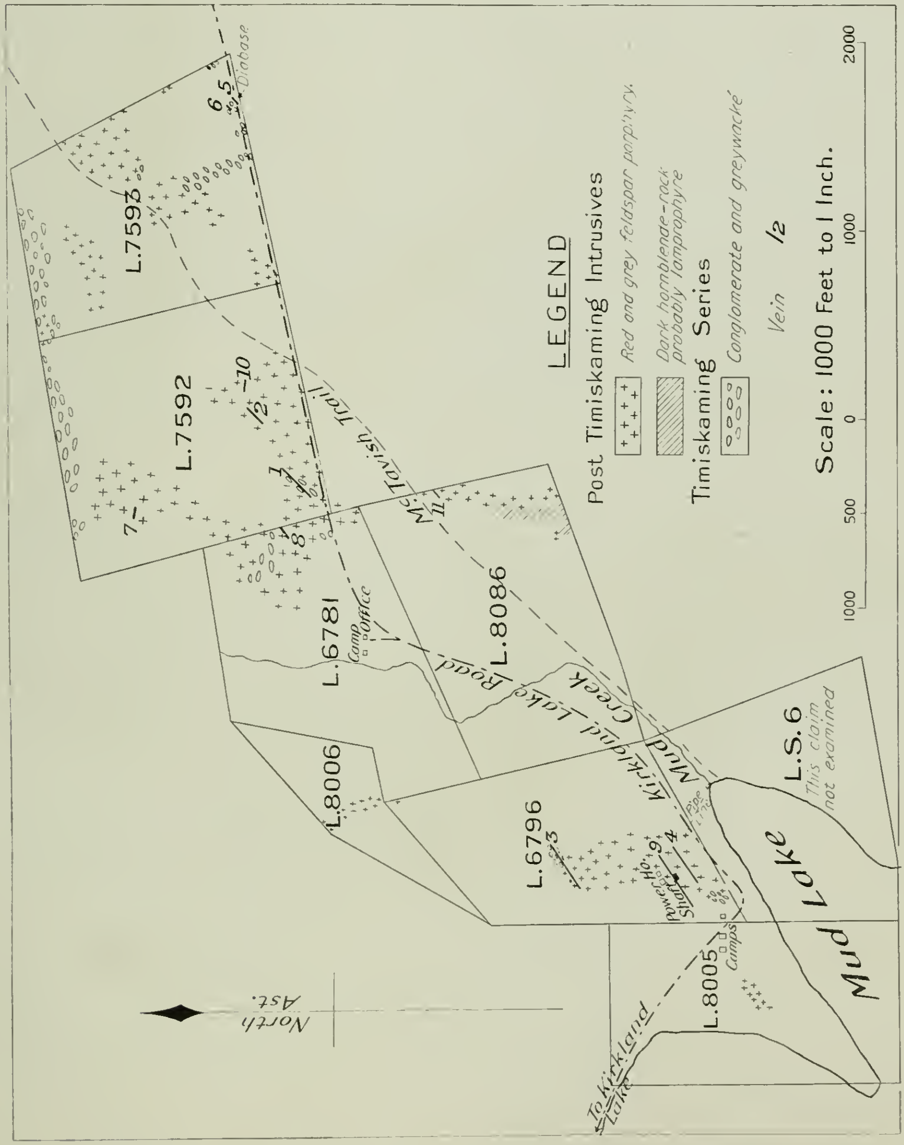
Other properties, including La Belle Kirkland and Costello, near Goodfish lake, were not in operation in 1919. These were described in the report on Goodfish Gold area in the Twenty-Fifth Report of the Ontario Bureau of Mines, 1916.

## Area East of Kirkland Lake

During the season of 1919 there was much activity in the easterly part of Lebel township and work was done on a number of claims in the vicinity of Mud lake. The same general assemblage of rocks that occurs around Kirkland lake is encountered in Lebel township. It consists of highly metamorphosed sediments of the Timiskaming series with intrusions of red and grey porphyry together with some lamprophyre. There was considerable work done on the Bidgood claims to the northeast of Mud lake and the Montgomery claims to the southwest of this lake.

### Bidgood

The Bidgood Gold Mines Limited, is prospecting a group of claims lying between Mud and McTavish lakes. A geological plan, showing the location of veins has been prepared by C. E. Rodgers and accompanies this report. About 3,000 feet of surface trenching was done by the end of 1919 and a number of veins




Geological plan, Bidgood Gold Mines, Limited, Township of Lebel.

uncovered. They occur in the porphyry or conglomerate near the porphyry. The early work was done on the northeast claims and several narrow quartz veins, from 4 in. to 12 in. wide, were prospected. Their average strike is N.E. and S.W. and the dip is steeply to the N.W. The quartz in places carries abundant iron and copper pyrites, with some pyrrhotite and also filmy seams of molybdenite. No visible gold was recognized in specimens from these veins, but some low values were obtained by assay of selected samples. Values from 80 cents to $12.00 in samples taken from Nos. 1 and 2 veins are reported by the company. Work is now being concentrated on veins Nos. 9 and 4 immediately northeast of Mud lake. These veins were not seen by the writers, but Mr. Rodgers states that vein No. 9 is 8 feet wide and traceable for 350 feet, while No. 4 vein, 75 feet to the south, is 25 feet wide and traceable for 250 feet. The strike of these veins is N. 55° E. and the dip vertical.

A shaft was started on No. 9 vein and continued to 17 feet, when work was temporarily discontinued. In the spring of 1920 a contract was let to sink the shaft to the 300-foot level.

The veins are fracture zones in the red porphyry, the vein material being porphyry impregnated with iron pyrites and copper pyrites together with veinlets of quartz. The quartz also replaces part of the porphyry and in specimens is often much brecciated. The sulphides occur in massive form as well as in fine grains. Values in gold have been obtained from the shaft of sufficient importance to warrant further sinking on the fracture.

A plant consisting of a 65-h.p. boiler, a 3-drill compressor and a 6- by 8-in. Jenckes hoist has been placed on the property.

### King Kirkland

The Montgomery group of five claims lying to the southwest of Mud lake has recently been incorporated as the King Kirkland Gold Mines. Considerable prospecting has been done on claims L. 4118 and L. 8002 and several narrow quartz veins discovered in the grey feldspar-porphyry. The rocks in the group are schistose sediments, lamprophyre and grey feldspar-porphyry. The principal vein on which much work has been done is on claim L. 4118. It strikes N. 48° E., dips 85° S., and has been traced for 250 feet. It varies from about an inch to a foot in width.

Visible gold can be observed in one section of 12 feet along the vein. The quartz carries scattered grains of iron pyrites, a little galena and some calcite. Quartz stringers run diagonally into the south wall. A shallow cut has been made along part of the vein. Two other quartz veins a few inches in width were found on L. 8002, with a similar northeasterly-southwesterly strike. The northerly vein, called the galena vein, carries small masses of galena, zinc blende, copper pyrites, iron pyrites and grey copper ore, tetrahedrite, together with some calcite. The south wall of this vein is altered and rusty in appearance for nearly a foot from the quartz vein. The southerly vein is similar to the galena vein, but carries fewer sulphides.

# INDEX VOL. XXIX, PART IV

TWENTY-NINTH ANNUAL REPORT

OF THE

# ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXIX, PART V

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E. S. ESTLIN, Commissioner of Natural Gas


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1920

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## ILLUSTRATIONS AND DIAGRAMS



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# NATURAL GAS INQUIRY, 1920

By

E. S. Estlin, Commissioner of Natural Gas

## THE COMMISSION

G. S.

L. H. CLARKE.

CANADA

PROVINCE OF ONTARIO

GEORGE THE FIFTH, by the Grace of God, of the United Kingdom of Great Britain and Ireland, and of the British Dominions beyond the Seas, KING, Defender of the Faith, Emperor of India,

To EUSTACE SENIOR ESTLIN, Commissioner of Natural Gas,

GREETING:

WHEREAS, in and by Chapter 18 of The Revised Statutes of Ontario, 1914, entitled "An Act respecting Inquiries concerning Public Matters" it is amongst other things enacted that whenever the Lieutenant-Governor in Council deems it expedient to cause inquiry to be made concerning any matter connected with or affecting the good government of Ontario or the conduct of any part of the public business thereof or the administration of Justice therein and such inquiry is not regulated by any special law, he may by commission appoint a person or persons to conduct such inquiry and may confer the power of summoning any person and requiring him to give evidence on oath and to produce such documents and things as the Commissioner or Commissioners deem requisite for the full investigation of the matters into which they are appointed to examine, and the Commissioner or Commissioners shall have the same power to enforce the attendance of witnesses and to compel them to give evidence and produce documents and things as is vested in any Court in civil cases;

AND WHEREAS Our Lieutenant-Governor in Council of Our said Province of Ontario deems it expedient to inquire into, obtain and report upon the matters hereinafter mentioned;

NOW KNOW YE that we, having and reposing full faith and confidence in you the said Eustace Senior Estlin, DO HEREBY APPOINT you to be OUR COMMISSIONER in this behalf, with all the powers authorized by the said Act, to make inquiry into the natural gas situation in the Province of Ontario, and to report thereon with all convenient speed; such inquiry to include all facts, circumstances and things in any way conducing to or bearing upon the said natural gas situation, in so far as the same may have any relation to the public interest or to the interest of those inhabitants of the Province in any way engaged in or connected with the production, transmission, distribution or consumption of natural gas, and without in any way limiting the generality of the foregoing directions in particular to include:—

(1) The extent of the failure of the supply of natural gas to meet the requirements of the consumers thereof, and the causes of such failure.

(2) The possibility of obtaining new sources of supply, and the best means for their development.

(3) The effect of existing contracts for the supply of gas and the possibility or advisability of removing, modifying or restricting contractual obligations relating to natural gas.

(4) The prices at which natural gas is supplied to the various classes of consumers, and the effect thereof upon the situation.

(5) As to the capital invested in the production, transmission and distribution of natural gas, and the financial position of any incorporated company, and the causes directly or indirectly contributing to the success or failure of the operations of any such company.

(6) As to the present methods of distribution of natural gas and any changes therein which may promote the conservation of the supply.

(7) As to the use of natural gas in manufacturing and other industries or for other purposes than heating, cooking or other domestic uses.

TO HAVE, HOLD AND ENJOY the said office and authority of Commissioner for and during the pleasure of Our said Lieutenant-Governor in Council.

IN TESTIMONY WHEREOF we have caused these OUR LETTERS to be made PATENT, and the GREAT SEAL OF OUR SAID PROVINCE to be hereunto affixed.

WITNESS:—HIS HONOUR LIONEL HERBERT CLARKE, LIEUTENANT-GOVERNOR OF OUR PROVINCE OF ONTARIO AT OUR GOVERNMENT HOUSE, in Our City of Toronto, in Our said Province, this twelfth day of February, in the Year of Our Lord one thousand nine hundred and twenty and in the tenth year of Our reign.

BY COMMAND:

H. C. NIXON,
*Provincial Secretary.*

## LETTER OF TRANSMISSION

The Hon. Henry Mills,

*Minister of Mines,*

Toronto, Ont.

Sir,—Pursuant to authority contained in a Commission issued by His Honour the Lieutenant-Governor of the Province of Ontario on the twelfth day of February, 1920, I proceeded to hold inquiry into the natural gas situation in the Province.

These inquiries were held under the Public Inquiries Act and the evidence was taken under oath.

Hearings were held at Sarnia on February 25th and 26th, at Windsor on March 2nd and 3rd, Chatham on March 8th and 9th, Hamilton on March 15th and 16th, Woodstock on March 18th, Chatham (enlargement) on March 29th and 30th.

During the course of these hearings one hundred and two witnesses were examined and a large amount of valuable evidence procured.

The several interests were represented by twenty-six counsel.

I beg respectfully to submit a series of extracts from the evidence taken at the Inquiry, given as nearly as may be, in the words of the witnesses.

I have the honour to be, Sir,

Your obedient servant,

E. S. Estlin,

*Commissioner.*

Chatham, Ont., April 19, 1920.

## PREFATORY NOTE

The natural gas situation as it stands to-day is brought out in the following summary of the evidence taken at recent hearings, the general trend of which indicates that:

(1) There are two recognized areas of production commonly known as the eastern and western gas fields, the former having been drawn upon for about thirty years and the latter for about fourteen. Some of the conditions affecting the life of the two fields differ, and they are separately mentioned, where possible, in the evidence.

(2) There is a shortage of natural gas for home use in cold weather, at a time when it is most required.

(3) The shortage is caused primarily by a field depletion common in the history of all gas areas, but this depletion was accelerated by excessive consumption during the war period.

(4) This depletion is not being offset by development work because of prohibitive costs, and for this reason will become more acute each year.

(5) Gas enterprises no longer hold out hope of financial gain under present conditions, and do not attract further capital, which is necessary for the development of new gas-bearing territory.

(6) If a general readjustment in the whole situation does not take place immediately the business will pass into decline, and this valuable fuel supply will be lost to about fifteen per cent. of the population of the Province.

(7) The need of seeking for new sources of natural gas at greater depth is apparent: this not only brings greatly increased costs, but also multiplies the risks, and the production end of the natural gas business is a miner's risk not lightly undertaken.

(8) The commercial end of the enterprise is hedged in with contractual obligations assumed when the fields were young and the wells flush, and the whole situation under prevailing conditions holds out no promise of improvement.

# EXTRACTS FROM EVIDENCE TAKEN AT INQUIRY

## Shortage

That a serious and general shortage of natural gas exists throughout the gas area of Ontario is fully borne out by the testimony of many witnesses who gave evidence at the several localities where hearings were held. This shortage occurs during the winter months only, and is most acute when the weather is severe.

The residents of cities have been deprived of gas in about an equal degree throughout the various sections of the city. Here and there a very few urban consumers appear to have suffered less inconvenience owing to their proximity to the point of intake at the city limits.

Some suffering and considerable inconvenience have resulted from the lack of gas during the past winter; the general shortage was first felt in the winter of 1917-18.

The classification provided for in the Natural Gas Act, 1919, and Regulations thereunder, was put into effect at Sarnia, Windsor and Chatham during the past winter. This classification cut off certain large users in the given order of preference in favour of the homes, but in spite of these precautions the shortage continued on very cold days.

During the winter of 1918-1919 the gas supply was fairly adequate to meet the demand, with the exception of a few days of low temperature, because the winter was unusually mild.

The shortage through the winter of 1919-1920 just passed, was fairly uniform throughout the districts supplied by the Kent county gas fields. Gas was not obtainable in the cities even for cooking purposes in many instances on severely cold days.

Some of the evidence shows that rural consumers taking their supply from lines tapping the high pressure pipe-lines have never experienced a shortage except in cases of breakage, etc.; this also applies to smaller towns located near the source of supply.

The supply in Petrolia was not so seriously affected as in Sarnia. Sarnia is on the extreme end of the Sarnia pipe-line, and the main feeding Petrolia is taken off the high pressure Sarnia line, some distance from the city, the gas passing through a feeder line ten miles long to Petrolia. At Petrolia the distributing pressure dropped to one ounce during the past winter for twenty-nine successive days, and the lowest pressure at the intake end where junction is made with the Petrolia line, was eight ounces.

In the township of Rochester, which is supplied from the Windsor pipe line, no shortage was experienced. In the city of Hamilton natural gas shortage has been felt for five years. At times the diminished flow of gas coming through the burners would not light.

The general tone of the evidence on gas shortage goes to show that the situation is a serious one. People have used gas for many years, and the shortage has come practically within the last two years. The homes are equipped with gas-burning appliances which do not admit of successful change to coal burning, and the chimneys require in many cases remodelling and rebuilding.

There can be no question that the evidence brings out very clearly the fact that the present available supply of gas is not adequate, under the present conditions of market and consumption, to supply the wants of the people in large centres.

It has been demonstrated that the period of greatest shortage occurs during the meal hours. During a cold wave the pressure at the city limits might be ample in the early hours of the morning, but when all the consumers lighted their cooking fires about the same time, the pressure would very soon drop to a point which made equal distribution impossible. This low pressure would be maintained during the day, but at night when the pull became steadier and more normal the lines would "pack up" and pressure rise again.

Several witnesses point out that the nocturnal rise in pressure is a source of great danger, as it is impossible sometimes to regulate the heaters so that the fire will neither go out nor increase to such an extent as to cause serious damage. No shortage occurs in the summer or during mild days through the winter except where there may be physical reasons such as small or choked service lines.

### Causes of Shortage

The chief reason given for the shortage is the decline of the gas fields and the small area of new producing territory explored. It has been shown that the shortage and high price of coal increases the demand for gas. Weather conditions affect the consumption of gas to such an extent that there is four times as great demand on cold as on mild days. The output of the gas fields does not provide for the domestic "peak load," which occurs at a time when the weather is most severe. The decline of the Kent gas field was increased by the heavy output during the war, when industries were using immense quantities.

### Supply

Distributing companies have no power to increase the supply of gas. They take the volume as indicated by the available pressure at the point where the distributing system connects with the high pressure supply line, and transmit to their customers what they can get. Distributing companies do, however, make every effort to relieve the situation during a sudden drop in temperature by cutting down the less important consumption. Only small amounts of gas are used in winter for industrial purposes, where gas is an essential part of the manufacturing process.

The number of domestic services is always increasing slightly, so that the domestic load does not become lighter. The supply is adequate at night even in cold weather. It is shown that, while gas is being consumed under present conditions in the homes, as high as thirty to thirty-five pounds "high" pressure at city limits is required to maintain a full distribution service.

In Sarnia the available supply this winter (1919-1920) would not permit increased consumption over last year. The amount of gas consumed in the city of Sarnia in 1916 was 86,330,000 cubic feet, and in 1919, 83,617,000 cubic feet. Sarnia city pressures varied during the winter from four ounces at night to one ounce in the day. The customers near the regulators get the best service and the highest pressure occurs about 1 a.m. The service pressure should be maintained at four and one-half ounces. Pressures recover at night because of reduction in consumption farther back on the pipe-line.

The Union Natural Gas Company issued a notice of expected shortage to their consumers in 1917. The general supply will decline more rapidly in the future because adequate development work is not being carried on to offset the decline of the wells. There is a natural depletion of all gas fields which ultimately results in shortage and rearrangement of consumption. The rate of delivery of gas from the field depends upon the pressure behind it, and when this field pressure decreases the supply from the wells diminishes.

Under a general adjustment of consumers' appliances a constant pressure of two ounces would prove satisfactory. There would be sufficient gas in the Kent field for a reasonably good service if suitable changes in burning and handling were made. There should be enough gas for heating with eight to ten pounds at city limits. It can be expected that eight to ten pounds pressure will be the limit if no new wells are drilled and no further supplies of gas located. The service is good for nine months in the year and bad for three.

All distributing and other regulators are seriously affected by the corrosive elements in the Tilbury gas: this is the reason why varying pressures are difficult to regulate. Witnesses claim that the use of coal nearly doubles the cost of heating, and that natural gas should be restricted entirely to household use. If furnaces were taken off in severe weather during part of the winter, there would be ample gas for other purposes.

### Consumption Data

If the pressure drops from four ounces to one ounce the reduction in gas volume is 1.3 per cent. As temperature rises and falls, gas expands and contracts; every five degrees drop in temperature causes one per cent. contraction. If gas temperature drops from fifty degrees in summer to thirty degrees in winter, causing a reduction of twenty degrees, the volume of gas is reduced four per cent., and this gives the consumer four per cent. more heat, so that contraction by temperature more than compensates for loss in volume due to low pressure.

On a gas bill of $10.00 there would be an advance of thirteen cents if pressure dropped from four ounces to one ounce. The correct proportion of air for proper combustion is 9½ parts to one of gas. If varying gas pressures prevent the use of proper proportions of air and gas, improper combustion results and the consumer complains of absence of heat. Great waste is also caused in this way. Domestic gas burners are connected with mixers which are set to draw in 9½ parts of air, but when the pressure drops to one ounce the right mixture of air and gas will not result.

Air cannot be introduced into the mains or pipe lines by gas companies because it forms a highly explosive mixture when mixed with gas under pressure. A case is cited where fifteen miles of new pipe-line was blown up by turning in gas to test the line before air had been allowed to escape; the result was that there were not a dozen lengths of pipe left worth picking up.

The best results can be obtained from the use of low pressure gas, but the present equipment in the homes is not suitable. The case of gas engines is cited, where low pressure gas gives the best combustion mixture. The same principle applies to gas used for cooking and other purposes. Satisfactory service was rendered in one home in Petrolia at one ounce pressure. Witnesses complain that at times the flame is yellow and at other times blue. When the pressure is low the efficiency of the flame is impaired and the heat units are not utilized. There is no difference in the quality of the gas; it is the same as it was ten years ago; the difference noticed by consumers lies in there not being enough air introduced at the burner on account of low pressure.

Meters are set to register correctly at two ounces when manufactured and tested, but will record accurately at four ounces with the difference that there will be a better flow of gas at four ounces. If pressure drops to one-quarter ounce the meter will still register the actual amount going through. If gas were flowing through a meter at one pound the customer would gain, because of the increased density of the gas. When pressures are low, the consumer is burning raw gas instead of gas and air in right proportions.

Many complaints were made by witnesses giving evidence at Woodstock, where Tilbury gas is supplied, that the odour given off goes through the homes and is injurious to health and destructive to furnishings. It was brought out that if leaks and unsuitable equipment were given more attention, and more care exercised, the discomfort and annoyance would not be felt. The same gas is used elsewhere without similar complaint.

Witnesses complained at all hearings of the increase of gas bills when gas supply was lowest. This was shown to be due largely to improper adjustment of air mixer and larger amount of gas required during cold weather.

### Consumption Figures

| | |
|---|---|
| Gas supplied to Windsor, 1916 | 2,929,000,000 cu. ft. |
| Gas supplied to Windsor, 1919 | 1,754,000,000 cu. ft. |
| 62 per cent. used by Industries in 1916. | |
| 54 per cent. used by Industries in 1917. | |
| Gas supplied to Windsor homes in 1917 | 1,500,000,000 cu. ft. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Domestic sales in | 1916 | (6 summer months), | 8% | of total of 12 months. |
| " " | 1917 | " " " | 11% | " " " |
| " " | 1919 | " " " | 16% | " " " |

| | | | | |
|---|---|---|---|---|
| Total consumption (all purposes) | 1916 | (6 summer mos.) | 30% | of total of 12 mos. |
| " " " " | 1917 | " " " | 37% | " " " |
| " " " " | 1919 | " " " | 16% | " " " |

The Glenwood Natural Gas Company's field in Kent County supplied to the Southern Ontario Pipe Line Company in 1917 14,000,000 cu. ft. per day; in 1918 7,000,000 cu. ft. per day; in 1919, 5,500,000 cu. ft. per day.

The Northern Pipe Line Company supplied during 1917 85% of its total output to industries.

Before restrictions were put upon the supplying of industrial gas, the Northern Pipe Line sold 5,000,000 cu. ft. per day and are now selling 1,000,000 cu. ft. per day.

## Transmission

The towns on the Southern Ontario Pipe Line receive their gas supply according to their relative distances from the gas field. Those nearest the fields get the better supply when shortage occurs. The transmission of large volumes of gas under reduced pressures through long pipe-lines is greatly retarded owing to the friction created. This is a serious factor when the field is supplying to its limit and a sudden increase in consumption takes place, reducing the pressure in the lines, so that the gas has to flow faster through the line. Duplicate delivery pipe-lines for conveying the products of different gas fields to market are a great and useless expense.

It was brought out that it is clearly in the interest of the consuming public that independent exploration work be encouraged and that where small fields are opened (at considerable distance from market but within reach of existing pipe-lines), some method should be found so that present pipe-lines become the carriers of such gas under circumstances encouraging to the smaller operators.

## Field Conditions

The decline of the Tilbury gas field was first indicated when gas compressor stations were first erected in 1913 and 1914. In the case of the Tilbury field the presence of salt water underlying the gas is found to be a great menace to the life of the field because, as the field pressures decline, the water invades and seals up the porous rock containing the gas. There was a general decline in rock pressures in the Union Natural Gas Company's field from 540 pounds in 1912 to 318 pounds at the present time. In 1915 the open-flow measurement of the Union wells was 90,000,000 cubic feet. In 1919 it was 33,000,000 cubic feet. Pumping outfits have to be maintained on the Tilbury wells for keeping the water down. These outfits consist of a separate gas engine unit for each well. The Union Natural Gas Company has 171 producing wells and 11 non-producers.

A former field with conditions somewhat similar to those of the Tilbury field was known as the Essex gas field. This field supplied the city of Windsor and large quantities of gas were exported to Detroit and Toledo. The field was drawn on for about ten years and ceased suddenly, causing great inconvenience. Every gas field begins to decline as soon as it is tapped.

In the drilling of wells in the Tilbury field the gas is encountered just above the big water, consequently pockets cannot be drilled down so as to form a gathering basin for the water at the foot of the well; this is a serious inconvenience because it makes constant and frequent pumping necessary. Wells are tested daily and weekly for shut-in pressures. This is a necessary part of the field work to determine what gas the well is making. Only three wells were frozen during the past winter in the Union Natural Gas Company's field. No producing wells were shut in during the winter.

The evidence goes to show that the Union Company's wells and those of the Glenwood and Beaver Companies, situated in the same field, were given the very best attention.

The open-flow measurements of all the wells in the Tilbury gas field show a decline of about one-third according to measurements taken in 1919. There is a strong possibility of the Tilbury field being drowned out if the output is not materially reduced; water is gaining in the field as pressures are lowered. The gas is being withdrawn at about one-third of the open-flow, which is much too fast for the safety of the field.

Water conditions in the eastern field are not nearly so serious and wells will produce down to a very low pressure. Tilbury field is a "tank" field: one part of the field communicates with another through the porous rock. In the Welland-Haldimand field there are wells where the rock pressures have declined from 500 pounds to 300.

The open-flow measurement of a well is not the amount of gas which the well will deliver into the lines; the actual delivery of the well is about one-third of the open-flow.

Large companies look after the field conditions more systematically than small companies or individuals, therefore the larger companies obtain the better results.

Recent drilling shows smaller results than formerly; this is true of all the Ontario established gas fields. Early drilling in the eastern field brought wells of from 200,000 cubic feet to 500,000 cubic feet open-flow per day. The Port Colborne-Welland Gas Company drilled five wells last year and kept three of them. Deep drilling has been tried in the eastern field and twelve wells failed. One witness claims that he could double his capacity by drilling on his reserve territory in the eastern field. In Rainham and Canboro townships the rock pressure has declined from 200 pounds to 120. The Chippewa Oil and Gas Company drilled eighteen wells in the eastern field at a cost of $21,600.00 and had five dry holes. It does not take the full output of all the wells to supply the summer demand.

The wet wells in the Tilbury field vary as to the time required to operate pumps. In some wells the water can be removed in a few hours; in others a whole day is required. All wells are operated to full capacity in all the fields to supply the winter demand. Some wells in the Tilbury field are being pumped at considerable expense although not producing gas, as it is found that this method keeps the water off the adjacent producing wells.

In Dover township the six deep producing wells which were drilled within the last two years by the Union Natural Gas Company, and which were connected to the Sarnia pipe line, have declined in production over one-half since they were drilled in. This is a far more rapid decline than that shown by the Tilbury wells. It is estimated that the gas field in Tilbury controlled by the Union Natural Gas Company will yield 58,859,510,000 cubic feet of gas when pressures drop to fifty pounds.

Total gas from the Dover wells drilled by the Union Natural Gas Company was in December, 1919, 5,961,524 cu. ft. per day, and in February, 1920, 3,439,858 cu. ft. per day, a reduction of about two and one-half million cubic feet.

Producing companies endeavour to maintain a reserve acreage in order to drill for increased supply and to protect their producing wells.

In the Glenwood Company's Tilbury wells the pressure is kept back to about 100 pounds to retard the flow of water into the wells. If the compressor plants were operated, the back pressure against the water would be lowered and there would be no gas. The Glenwood Company drilled nine wells in 1919, and the Beaver Company three, in the Tilbury field. More wells drilled in the Tilbury field would deliver the gas more quickly but would not increase the supply. The pressures would decline so much faster. The Glenwood Company would not keep a new well unless it measured over 20,000 cubic feet when brought in.

Twice as many pump-men are required to tend the wells in winter as in summer in the Tilbury field. The Union Company has sixty-five pumps out of one hundred and sixty-six wells; siphons are being replaced with power pumps as quickly as equipment can be obtained and installed. The expense in handling the water in Tilbury field is increasing. Water is being pumped from wells drilled as recently as 1918 in Tilbury field, but the greatest amount of water is found in the older wells.

The Glenwood Natural Gas Company has spent seven years in constructing a plant for removing the sulphur content from the Tilbury field. This plant is the only one of its kind in existence and is located in the heart of the Tilbury gas field. Crude ammonia in 17 per cent. solution is reduced to 2 per cent. and the gas passed through the liquid. The ammonia absorbs $H_2S$ out of the gas and ammonium sulphide is the product. The difficulty is in freeing the ammonia from the sulphur. This purifier cannot be operated continuously because of constant corrosion, which necessitates repairs. The only practical purifying plant is the oxide system, but this system develops water vapour which condenses and gives trouble. The life of a gas pipe varies, depending upon the kind of soil in which it is laid, the attack from electrolysis, and the corrosive elements in the gas. Some pipes last forty years and others only one year.

The Dominion Natural Gas Company operating in the eastern fields carries 55,000 acres of operated leases and 64,000 acres of unoperated leases. Some companies hold ten times as much unoperated as operated acreage. The largest area held by the Dominion Company is where the limits are not yet developed; the smaller area is where the district is tested out as in the older fields.

The Dominion Company at the beginning of the year 1919 had 773 wells, and at the end of 1919 had 796 wells (having drilled 38 producing and abandoned 22 wells). Seven dry holes were drilled in 1919. More wells were drilled by them in 1916 than in 1919, but more money was spent on the drilling in 1919. The open-flow of the Dominion Company's wells showed a decline between 1906 and 1919 of about 90 per cent., between 1907 and 1919 of about 95 per cent., between 1908 and 1919 of about 50 per cent.

Average Open-Flow and Rock Pressure of New Wells—Dominion Company.

| | Average Open-flow (cu. ft.). | Average Rock Pressure (lbs.) |
|---|---|---|
| 1905 | 703,000 | .... |
| 1907 | ...... | 478 |
| 1908 | 581,000 | .... |
| 1916 | 100,000 | .... |
| 1919 | 51,000 | 188 |

Table Showing Decrease in Production—Dominion Company.

| | | 1916 | 1919 |
|---|---|---|---|
| Area, unoperated | Acres | 94,887.5 | 64,231.5 |
| Area, operated | " | 47,518 | 55,670 |
| Average per well | " | 69.38 | 70.21 |
| Total production | M. cu. ft. | 2,397,787 | 2,035,759 |
| Production per well | cu. ft. | 4,524,100 | 2,593,300 |
| Production per acre | " " | 65,100 | 36,936 |
| Open-flow per acre | " " | 51,000 | 34,000 |
| Average rock pressure | lbs. | 188 | 166 |

## Financial

The gross revenue derived from the operations of the gas fields is not sufficient to meet ordinary expenses and make reasonable returns to investors. The production and sale of natural gas could continue if companies were permitted to sell to industries in the summer when the domestic sale is at a minimum. The increased cost of drilling new wells is prohibitive.

There is a fixed relation between the price at which gas is sold to the public and the average consumption. The average domestic consumption of gas at

| | | | | | |
|---|---|---|---|---|---|
| 25 cents is | | | 161,000 cu.ft. | per | annum. |
| 30 | " | " | 143,000 " | " | " |
| 35 | " | " | 128,000 " | " | " |
| 40 | " | " | 114,000 " | " | " |
| 45 | " | " | 102,000 " | " | " |
| 50 | " | " | 92,000 " | " | " |
| 60 | " | " | 75,000 " | " | " |
| 75 | " | " | 57,000 " | " | " |
| $1.00 | " | " | 39,000 " | " | " |

Higher prices have a tendency to level down the peak loads, which the producer with a declining supply cannot meet. The price at which gas is sold does not affect the consumption in direct ratio; there are contingencies which have a bearing upon consumption—doubling the price would not necessarily cut the consumption exactly in half. If the price were higher, the consumption would be decreased very considerably.

In the eastern fields there were good returns made thirteen years ago.

One company showed that its average profits for fourteen years were three and a half per cent. One operator in the eastern field who employs no labour is just paying expenses. Another operator in the same field has been operating his wells for five years and has paid no dividends.

Gas sold now at 25 cents per thousand would have had a value in 1909 of 10½ to 12 cents. Rate cases are coming up continually all over the vast gas areas of the United States and have been for five years. Some stock in the Union Natural Gas Company is offered at fifty cents on the dollar. The large compressor stations owned by the Glenwood Natural Gas Company and the Union Natural Gas Company and located in the Tilbury field, not at present in operation, could be scrapped and sold at a profit over cost.

*The Petrolia Utilities Co.*, the distributor in the town of Petrolia, shows a surplus from June 1, 1919, to January 31, 1920, of $256.42, and has no profits to spend in maintenance.

*The Windsor Gas Co.*, the distributor in the City of Windsor, is operating at a loss with an investment of $1,650,392.00.

*The Chippewa Oil and Gas Co.* made a profit from 1913 to 1919 out of their eastern gas field of from three to four per cent.

*The Chatham Gas Co.*, the distributor in the city of Chatham, sold *commercial gas* in 1918 to July 1st, $124,314.40; their share (one-third) was $41,438.13; sold *domestic gas* in 1918 to July 1st, $145,684.22; their share (one-third) was $48,561.40. If present conditions continue this company will lose $8,000.00 per annum.

*The Glenwood Natural Gas Co.* expended approximately $175,000.00 up to 1914 on their purifier plant in the Tilbury field.

*The National Gas Co.* at the end of 1919 had a deficit of $16,000.00 and is paying $30,000 a year rentals.

The cost of operating distributing plants remains the same if industrial service is maintained and a full consumption supplied. The replacement value of the pipe-line connecting Sarnia with the Tilbury gas field is over one million dollars and financial returns are not enough to meet the operating expenses and 8⅓ per cent. depreciation charges.

Receipts from the Sarnia line for the month of July, 1916, were $26,257.00; for July, 1919, $3,170.00. The Union Natural Gas Company paid a dividend in 1919 of 3¼ per cent., the greater part of which was paid out of capital. Gas is sold by the Union Company to distributors on the basis of a percentage of the receipts. An appraisal made by the Union Company of their plant as at January 1, 1920, gives $18,620,138.00, added to which were items overlooked but afterwards handed in to the appraiser, making up the total in an amended statement to $19,723,823.00, which includes the valuation of wells and leases amounting to $5,947,096.00. The authorized capital of the company is $6,000,000.00; capital issued 31st December, 1919, $5,224,000.00.

Profits for year December 31, 1919, $57,079.65. Distributed to shareholders in 1919, 1¼ per cent. dividend, $65,300.00, and returned capital, $104,480.00, making a total of $169,780.00.

From January 1, 1912, out of total cash receipts amounting to $8,786,291.20, the sum of $5,869,777.48 has been put back into plant, while the distribution to shareholders was $2,648,928.00, or 7.4 per cent. per annum on the average capital stock employed during that interval.

### Union Natural Gas Co.—Financial Statement.

Cash value of assets turned over by contributory companies in 1911, $1,693,885.87; consideration given in bonds and stock, $3,999,300.00. The difference is between the book value of the assets conveyed and the par value of the stocks and bonds. Book value of capital assets on June 30, 1918, was $7,284,811.89; cash value was $3,319,397.86; capital stock and bonds, $5,437,500.00. The difference between $7,284,811.89 and $3,319,397.86 is $3,965,414.03. Made up by stock dividends declared and charged to investment, $1,660,000.00. Excess of par value of capital stock and bonds issued to contributory companies over cash value of assets, $2,305,414.13. Total, $3,965,414.13.

Stock dividends should be paid out of surplus and not charged to investment, which is inflating the valuation and leaving the surplus intact.

### Contributory Companies.

| | Cash Value of Assets. | Consideration. |
|---|---|---|
| Volcanic Oil and Gas Co. | $989,435 33 | |
| Capital stock | | $1,649,600 00 |
| Bonds | | 550,000 00 |
| Total book value of assets acquired | | $2,199,600 00 |

| | | |
|---|---|---|
| United Fuel Co. | $542,100 54 | |
| Capital stock | | $1,025,000 00 |
| Bonds | | 450,000 00 |
| Total book value of assets acquired | | $1,475,000 00 |
| Ridgetown Fuel Supply Co., estimated | $162,350 00 | |
| Capital stock | | $324,700 00 |
| Total book value of assets acquired | | $324,700 00 |
| | $1,693,885 87 | $3,999,300 00 |

Therefore the difference of $1,660,000.00 is bonus stock charged to investment plus the amount of cash value of contributory companies less the amount paid.

Take the $3,999,300.00 and deduct book value of capital stock in other companies:

| | |
|---|---|
| Medina Natural Gas Company | $23,999 99 |
| Northern Pipeline Company | 60,000 00 |
| | $83,999 99 |

leaving available for productive operations, say ............. $3.915,300 00

| | |
|---|---|
| The investment taken over from contributory companies at cash value | $1.693.885 87 |
| Deduct capital stock in other companies: | |
| Medina Natural Gas Co. | $23.999 99 |
| Northern Pipeline Co. | 117,000 00 |
| | $140.999 99 |

leaving value of available investments for productive operations. $1.552.885.88.

The book value exceeds cash value by approximately $2.400.000.00.

The Weymouth appraisal of the Union Natural Gas Company is $8.212.348.37, which, with the addition of $250,000.00 working capital gives a total investment of $8,462,348.37. as at January 1st, 1918. Per cent. deductions reduce it to $6,128,310.74. Weymouth's figures are based upon five year average of prices ending May 1, 1917; Ross gives cash value at January 1, 1918, as $3,223.145.29. Weymouth took actual physical property and appraised it as above; Ross took actual cash expended up to date from the Union Company's books. and the difference is that Weymouth's figures are $5.239.203.08 more than Ross'. Total of Welker's appraisal taken from Weymouth's inventory is $18.620.138.00.

SUMMARY.

Cash value of Union properties 1st January, 1918.

| | |
|---|---|
| According to Ross | $3,223,145.29 |
| " Weymouth | 8,462,348.37 |
| " Welker | 18,620,138.00 |

For six years ending December, 1917, the total operating revenue was $3,994,645.25, an average return of 32.25 per cent. on the average capital employed, or a return of the whole original capital at December 31, 1917. Had a sinking fund of four per cent. been set aside annually out of annual net revenue, the entire investment would have been returned by December 31, 1917. The average capital employed would have earned an average return of eleven per cent. The net earnings over a period of six years, 1912-1917 (inclusive) averaged sixty-seven per cent. of the gross earnings.

Ross' calculations are based upon what was paid for the assets, not on their value in the market. No consideration was given to increased value of properties acquired. The average annual return on cash value productive investments over net operating revenues was 32.31 per cent. This was computed before making any deductions for deterioration or depletion. It would not represent the return made to shareholders, because there should be retained out of that amount the further expenditure on bond issue. Also there were for some years substantial losses on Oil Springs Co., $60,000.00, and on Sarnia Pipeline Co., $105,000.00. Witness claims that the working out of some of the tables is of no value.

Dominion Natural Gas Co.—Further Statistics.

| | |
|---|---|
| Cost of drilling one well (996′) in 1910 | $1,470.94 |
| at present | 3,508.30 |
| Cost of drilling one well (1,293′) in 1912 | 2,611.76 |
| at present | 7,369.14 |
| | |
| Operating revenue per acre, 1916 | $21.49 |
| Operating expense per acre, 1916 | 15.60 |
| Net income per acre | $5.89 |
| | |
| Non-operating income per acre | .73 |
| Gross | $6.62 |
| Deduct for interest paid per acre | 1.20 |
| | $5.42 |
| | |
| Investment per acre (This is the total investment divided by total operated acreage, giving average of 7.14 per cent. on the investment.) | $75.80 |
| | |
| The acreage earnings show a steady decline during the following three years until 1919— | |
| When the total operating revenue per acre was | $15.80 |
| And the total operating expense per acre was | 13.27 |
| Net income per acre | $2.53 |
| Non-operating income | .34 |
| | $2.87 |
| Interest deduction | 1.43 |
| Profit per acre | $1.44 |
| The investment per acre in 1919 was | $59.60 |
| Leaving a final profit of | 2.42 per cent. |
| As compared with 1916 | 7.14 per cent. |

## Development Possibilities

Increased costs of materials and labour prevent development work. Shallow drilling has been almost abandoned. Deep drilling costs have increased from 100 to 120 per cent. The Union Natural Gas Company has stopped drilling operations entirely. Companies cannot get funds invested in the natural gas business sufficient to continue exploration work and the opening up of new producing territory. The cost of drilling a deep well at the present time is from $20,000.00 to $25,000.00, while wells in the Tilbury field cost approximately $2,000.00.

In Dover township, where new gas and oil production has been opened up within the last two years by deep drilling, there are seven producing wells out of twenty, while in Tilbury the Union Natural Gas Company has 166 producing out of 179. The Union Company drilled eight wells in 1919 (four in Dover and four in Tilbury), not all producers, but got more gas in 1919 than in 1918. The Union Company has drilled thirteen deep wells. The Tilbury gas field is now thoroughly drilled. The drilling of twenty wells in the township of Dover was an effort to recover production. One deep well drilled on Rondeau Provincial Park, Kent county, cost $125,000.00 and was a dry hole.

There are large areas of gas producing formation underlying vast districts in the province of Ontario. The large area held by the National Gas Company, consisting of 30,000 acres in the eastern field, admits of great development. After operating for six years ten additional wells were drilled; one of them came in with an output of two million and another of one and a half million cubic feet per day. This company have only eighty-five wells on the 30,000 acres and ten of these have been pulled. The territory is good for 200 wells and the output could be trebled if funds were procurable. There are many dry wells scattered over the eastern gas territory. One opinion claims that there is not enough productive area tributary to the city of Hamilton to furnish that city with a full supply of gas.

Many wells are abandoned in both the eastern and western gas fields, which are not replaced by new drilling; this is a strong factor in decreased production. The Union Natural Gas Company spent $250,000.00 trying to locate more gas when abnormal conditions caused by the war created a shortage.

## Waste

Lack of efficient equipment in the consumption of gas is responsible for a large percentage of waste. There is approximately forty per cent. of waste between transmission of gas and the consumer's burner.

Average Waste Percentage.

| | 1918 | 1919 |
|---|---|---|
| Sarnia | 24.8 | 14.5 |
| Petrolia | 41.5 | 34.0 |

The decrease is caused by the improvements made in the distributing plants.

The unrestricted consumption of gas without charge under leasehold agreements is a very great source of wastage. In January, 1919, 100 free users consumed 46,400 cu. ft., while 100 pay users in Sarnia consumed 24,400 cu. ft., a difference of nearly 100 per cent. Considerable waste was encountered in defective lines in the town of Petrolia, but repairs to these lines resulted in reducing the leakage. Some meters were found to be running slow and these are being repaired and tested. The readjustment of all conditions from the gas field is required to reduce the waste of gas to a minimum.

## Contract Rights

The rights and obligations under which gas is produced, conveyed, distributed and sold all have a direct bearing upon the successful supply to the consuming public. These include set prices given as consideration in franchises and agreements, gas supply without charge, claims on field output, maintenance of certain pressures, etc., and are all set out in the different documents put in as exhibits. No direct evidence was given on these matters as the documents speak for themselves.

# NATURAL GAS IN 1919

By

E. S. Estlin, Commissioner of Natural Gas

## Introduction

The year 1919 saw but little change in the natural gas situation in Ontario.

The winter of 1918-1919 was an unusually mild one, the average temperatures and gas consumption in the Kent field for the months indicated being as follows:—

| | Year 1918-1919 | | | | Mean Temp. for |
|---|---|---|---|---|---|
| | Nov. | Dec. | Jan. | Feb. | 4 months. |
| Average Temperature .. | 42.1° | 35.6° | 31.0° | 28.6° | 34.30° |
| | | | | | Total Cons. |
| Consumption (cu. ft.).... | 765,630 M. | 936,910 M. | 988,047 M. | 926,178 M. | 3,616,765 M. |

The corresponding figures for the same months of 1919-1920 were:—

| | | | | | Mean Temp. for |
|---|---|---|---|---|---|
| | Nov. | Dec. | Jan. | Feb. | 4 months. |
| Average Temperature .. | 37.8° | 22.3° | 16.8° | 21.8° | 24.67° |
| | | | | | Total Cons. |
| Consumption (cu. ft.).... | 757,541 M. | 999,914 M. | 1,029,106 M. | 918,203 M. | 3,704,764 M. |

It was felt that, owing to labour disturbances and the uncertainty of transportation, there was a reasonable possibility that the coal supply would be short, and this, added to the expectation of a more severe winter in 1919-20, prompted the issuing, in July, of a notice to all gas consumers in the Province, containing the following warning:

NOTICE TO NATURAL GAS CONSUMERS.

The Commissioner of Natural Gas wishes to assure all those who use gas in the homes that careful preparations are being made to furnish natural gas to the limit of the fields during the coming winter months. Last winter being very mild, no general shortage was experienced except on a few occasions when the thermometer dropped suddenly.

As we can reasonably expect a colder winter this year, those depending upon natural gas should take steps early enough to obtain a sufficient supply of coal or other fuel to carry them over the severe days when the gas supply is not equal to the sudden heavy pull upon it.

With this suggestion acted upon there should be a minimum of inconvenience or distress.

E. S. Estlin, *Commissioner.*

Chatham, Ont., July 15th, 1919.

P.S.—You can help conserve the gas supply and reduce your gas bills by properly regulating the burner equipment in your stoves and furnaces, also by reporting promptly any leaks no matter where they are, to this office or to the nearest gas office.

While the winter of 1918-1919 was unusually mild, the spring was exceptionally inclement, with the result that a heavy consumption of gas was maintained until later in the year than usual.

## The Natural Gas Act, 1919

Among the chief events of interest during the year, (some of which are mentioned in the Annual Report of the Bureau of Mines, 1919, Vol. XXVIII), was the publication of the Report on natural gas conditions in Ontario, by the Natural Gas Advisory Board, given in full in the above mentioned volume. Following this, the Natural Gas Act, 1918, was superseded by the Act of 1919, which transferred the administration of Natural Gas affairs from the Ontario Railway and Municipal Board directly to the hands of the Minister of Lands, Forests and Mines.

Under the provisions of the latter Act licenses were required for each of the following five separate and distinct branches of the natural gas industry:

(*a*) Prospecting;
(*b*) Drilling;
(*c*) Producing;
(*d*) Transmitting (by pipe-lines);
(*e*) Distributing.

Separator for preventing the oil from a gas well from reaching the gas lines.

As a result of this licensing system, the Department has been enabled to keep in touch more closely with the natural gas situation, and from observation and information obtained many minor adjustments and improvements have been made. Also, systematic compilation and tabulation of statistics have made possible more or less standard bases from which future data may be estimated.

## Field Developments

During the year some seventy-five wells changed hands. With few exceptions these were scattered in location and controlled by individual owners who were unable to operate them as economically as the larger companies to whom they were turned over. The principal transaction of this kind was the purchase, by the Union Natural Gas Company, in March, of the Canadian Gas Company's field in

Tilbury, containing 43 wells. The purchased property, which consists of about 2,281 acres, 2,131 acres of which are operated and the remainder held as a reserve, was taken over with the idea of amalgamating as much as possible all the wells in the vicinity under one management.

Much work has been done in putting these newly acquired wells in the best possible condition, and 23 of them having been found to be wet, a number of pumps have been installed to overcome the water difficulty. This field supplies the Northern pipe-line which carries the gas to Wallaceburg, furnishing fuel for the Dominion Sugar and Dominion Glass companies.

The township of West Dover has been the scene of the year's most interesting drilling operations. In casting about for new territory from which to supplement their Tilbury wells, which evinced unmistakable signs of declining production during the heavy demands made upon them in 1917, the Union Natural Gas Company decided to carry on drilling operations in Dover, and during 1917 and 1918

Drilling derrick after the hurricane in November, 1919.

sank several wells. The best producers, however, were brought in during last year when wells Nos. 10, 11, 12, 13 and 14 were completed.

The Petrol Oil and Gas Company also brought in a producing well in this township, and are carrying on further drilling operations at the present time on the same lease.

In all, over 20 wells have been put down in West Dover, seven of which are producing. As some of these wells produce oil as well as gas, the expense of operation is considerably increased, through the necessity of a system of separators to prevent the oil from reaching the gas mains.

The Trenton formation is struck at an average depth of 2,900 feet, and gas at depths of 2,920 to 3,010 feet. Oil is found just below the gas.

The hurricane of November 29th did considerable damage in this field, blowing down several drilling derricks and resulting in serious delay to the work.

Following is a list of firms and individuals engaged in the various operations of the natural gas industry in Ontario who received licenses from this Department in 1919:—

DRILLERS FOR NATURAL GAS.

| Name. | Address. |
|---|---|
| Barr, D. | St. Thomas, Ont. |
| Berry, R. N., D.D.S. | Caledonia, Ont. |
| Coleman, J. A. | Wellandport, Ont. |
| Dominion Natural Gas Co. | Hamilton, Ont. |
| Featherstone, C. W. | Canboro, Ont. |
| Glenwood Natural Gas Co. | St. Thomas, Ont. |
| Industrial Natural Gas Co. | Thorold, Ont. |
| Jasperson, B. | Kingsville, Ont. |
| Kiser, W. H. | Tillsonburg, Ont. |
| McCutcheon, Thos. J. | Dunnville, Ont. |
| McLister, J. J. | Dunnville, Ont. |
| McKillop, Wm. | Hepworth, Ont. |
| Provincial Natural Gas Co. | Niagara Falls, Ont. |
| Puslinch Oil & Gas Co. | Kitchener, Ont. |
| Patterson, J. H. | Port Maitland, Ont. |
| Ryan, W. T. | Chatham, Ont. |
| Richmond Gas & Oil Co. | Chatham, Ont. |
| Snively, F. L. | 90 Melrose Ave., Hamilton, Ont. |
| Union Natural Gas Co. | Chatham, Ont. |

PROSPECTORS FOR NATURAL GAS.

| | |
|---|---|
| Barr, D. | St. Thomas, Ont. |
| Beaver Oil & Gas Co. | St. Thomas, Ont. |
| Castle Oil & Gas Co. | Niagara Falls, Ont. |
| Dominion Natural Gas Co. | Hamilton, Ont. |
| Glenwood Natural Gas Co. | St. Thomas, Ont. |
| Industrial Natural Gas Co. | Thorold, Ont. |
| Laws, George | Angola, N.Y. |
| Miller, H. N., M.D. | 48 St. John's Pl., Buffalo, N.Y. |
| Minor, L. E. | Smithville, Ont. |
| Northern Gas & Gasoline Co. | Hepworth, Ont. |
| Petrol Oil & Gas Co. | 608 Lumsden Bldg., Toronto. |
| Provincial Natural Gas & Fuel Co. | Niagara Falls, Ont. |
| Pilkington Bros. | Thorold, Ont. |
| Progressive Gas & Oil Co. | Hamilton, Ont. |
| Puslinch Oil & Gas Co. | Kitchener, Ont. |
| Quillinan, J. A. | Niagara Falls, Ont. |
| Symmes, H. D. | Niagara Falls, Ont. |
| United Development Co. | Chatham, Ont. |
| Union Natural Gas Co. | Chatham, Ont. |
| Williams, A. | Ruthven, Ont. |

NATURAL GAS PRODUCERS.

| | |
|---|---|
| Aldrich Gas & Oil Co. | Bk. of Com. Chambrs., Hamilton, Ont. |
| Beaver Oil & Gas Co. | St. Thomas, Ont. |
| Bertie Natural Gas Co. | Ridgeway, Ont. |
| Castle Oil & Gas Co. | Niagara Falls, Ont. |
| Chippawa Development Co. | Chippawa, Ont. |
| Chippewa Oil & Gas Co. | Tavistock, Ont. |
| Coleman, J. A. | Wellandport, Ont. |
| Canfield Natural Gas Co. | Canfield, Ont. |
| Canby, B. F. | R.R. No. 2, Marshville, Ont. |
| Darling Road Co-operative Natural Gas Co. | Canfield, Ont. |
| Dunn Natural Gas Co. | Dunnville, Ont. |
| Duxbury, Wellington | R.R. No. 1, Hagersville, Ont. |
| Dominion Natural Gas Co. | Hamilton, Ont. |

NATURAL GAS PRODUCERS.—*Continued.*

| Name. | Address. |
|---|---|
| Dunnegan Oil & Gas Co. | Chatham, Ont. |
| Diener Gas & Mfg. Co. | Dunnville, Ont. |
| Empire Limestone Co. | 191 Hudson St., Buffalo, N.Y. |
| Emerson, Laidlaw & Troughton | Attercliffe Sta., Ont. |
| Eastside Gas Co. | Lowbanks, Ont. |
| Glenwood Natural Gas Co. | St. Thomas, Ont. |
| Hamilton Gas & Oil Co. | Spectator Bldg., Hamilton, Ont. |
| Hendee Gas Co. | Cayuga, Ont. |
| Industrial Natural Gas Co. | Thorold, Ont |
| Jasperson, B. | Kingsville, Ont. |
| Kindy, D., & Son | Selkirk, Ont. |
| Kindy Gas Co. | R.R. No. 2, Cayuga, Ont. |
| Lalor & Vokes | Dunnville, Ont. |
| Lalor, F. R. | Dunnville, Ont. |
| Liesinger-Lembke Co. | 42 Linden Park, Buffalo, N.Y. |
| Lamb, A. | Selkirk, Ont. |
| May, A. G. | 75 Melrose Ave., Hamilton, Ont. |
| Midfield Natural Gas Co. | Hamilton, Ont. |
| Medina Natural Gas Co. | Chatham, Ont. |
| Marshall, J. | Hamilton, Ont. |
| National Gas Co. | Hamilton, Ont. |
| North Shore Gas Co. | c/o Bruce, Bruce & Counsell, Hamilton. |
| Northern Gas & Gasoline Co. | Hepworth, Ont. |
| Ontario Gypsum Co. | Paris, Ont. |
| Oil Springs Oil & Gas Co. | Oil Springs, Ont. |
| Pilkington Bros. | Thorold, Ont. |
| Port Colborne-Welland Natural Gas Co. | Port Colborne, Ont. |
| Provincial Natural Gas Co. | Niagara Falls, Ont. |
| Rolston & Bennett | Dunnville, Ont. |
| Richmond Gas Co. | Chatham, Ont. |
| Sparham, A. F. | Caledonia, Ont. |
| Sterling Natural Gas Co. | Port Colborne, Ont. |
| Union Natural Gas Co. | Chatham, Ont. |
| United Gas Companies | St. Catharines, Ont. |
| Vacuum Gas & Oil Co. | 608 Lumsden Bldg., Toronto. |
| Weylie, Wm. | Glanford, Ont. |
| Wainfleet & Moulton Gas Co. | R.R. No. 1, Lowbanks, Ont. |

NATURAL GAS DISTRIBUTORS.

| | |
|---|---|
| Azoff Natural Gas Co. | Canfield, Ont. |
| Bertie Natural Gas Co. | Ridgeway, Ont. |
| Belmont Gas & Light Co. | Belmont, Ont. |
| Brantford Gas Co. | Brantford, Ont. |
| Beaver Gas & Oil Co. | St. Thomas, Ont. |
| Coleman, J. A. | Wellandport, Ont. |
| Central Pipeline Co. | Chatham, Ont. |
| Chippawa Development Co. | Chippawa, Ont. |
| Corporation of Town of Leamington | Leamington, Ont. |
| Chatham Gas Co. | Chatham, Ont. |
| Castle Oil & Gas Co. | Niagara Falls, Ont. |
| Dominion Natural Gas Co. | Hamilton, Ont. |
| Erie Beach Gas Co. | Chatham, Ont. |
| Fisherville Gas Co. | Fisherville, Ont. |
| Gas & Oil Co. of Springvale, Ltd. | Hagersville, Ont. |
| Glenwood Natural Gas Co. | St. Thomas, Ont. |
| Industrial Natural Gas Co. | Thorold, Ont. |
| Ingersoll Gas Light Co. | Ingersoll, Ont. |
| Lake Shore Natural Gas Co. | 294 Baynes St., Buffalo, N.Y. |
| Midfield Natural Gas Co. | Hamilton, Ont. |
| Manufacturers' Natural Gas Co. | Hamilton, Ont. |
| Northern Gas & Gasoline Co. | Hepworth, Ont. |
| Oil Springs Oil & Gas Co. | Oil Springs, Ont. |
| Petrolia Utilities Co. | Petrolia, Ont. |

NATURAL GAS DISTRIBUTORS.—*Continued.*

| Name. | Address. |
|---|---|
| Provincial Natural Gas & Fuel Co. | Niagara Falls, Ont. |
| Port Colborne-Welland Natural Gas Co. | Port Colborne, Ont. |
| Relief Gas Co. | St. Catharines, Ont. |
| Rosehill Natural Gas Co. | Buffalo, N.Y. |
| Robinson Road Gas Co. | Dunnville, Ont. |
| Sterling Natural Gas Co. | Port Colborne, Ont. |
| Sarnia Gas Co. | Sarnia, Ont. |
| Shetland Gas Co. | Florence, Ont. |
| Southern Ontario Gas Co. | St. Thomas, Ont. |
| Union Natural Gas Co. | Chatham, Ont. |
| United Gas Companies | St. Catharines, Ont. |
| United Gas & Fuel Co. | Hamilton, Ont. |
| Windsor Gas Co. | Windsor, Ont. |
| Wallaceburg Gas Co. | Wallaceburg, Ont. |
| Woodstock Gas Light Co. | Woodstock, Ont. |

PIPE-LINE OPERATORS.

| | |
|---|---|
| Beaver Oil & Gas Co. | St. Thomas, Ont. |
| Castle Oil & Gas Co. | Niagara Falls, Ont. |
| Central Pipeline Co. | Chatham, Ont. |
| Dominion Natural Gas Co. | Hamilton, Ont. |
| Glenwood Natural Gas Co. | St. Thomas, Ont. |
| Northern Pipeline Co. | Chatham, Ont. |
| Southern Ontario Gas Co. | St. Thomas, Ont. |
| United Gas Companies | St. Catharines, Ont. |
| Union Natural Gas Co. | Chatham, Ont. |

## Consumption of Natural Gas

The total consumption of natural gas in Ontario during the year 1919 was 11,563,304,000 cubic feet, a reduction of 1,512,000,000 cubic feet from 1918.

Of the 1919 consumption, 7,891,304,000 cubic feet were taken from the Kent field and 3,672,000,000 cubic feet from the Eastern fields. As complete returns were not available, the figures for the Eastern field are approximate, but the quantities have varied so little during the past few years that they will be very close to the actual returns.

The heat units derived from the 1919 consumption of natural gas are equivalent to 578,120 tons of coal, or 16,517 car-loads, a fact that is especially interesting when it is remembered that because of labour troubles and uncertainties of transportation, the delivery of coal was impeded all over the continent.

It is not generally known that approximately 15 per cent. of the population of Ontario have depended largely on natural gas for household cooking, heating and lighting, and unless active measures are taken to prevent waste and misuse of this commodity, serious inconvenience to many will result.

The following list gives the consumption of natural gas during 1919 by the cities mentioned:—

CONSUMPTION BY CITIES, 1919.

| | | |
|---|---|---|
| Brantford | 251,837,000 | cubic feet. |
| Chatham | 1,019,916,000 | " " |
| Coatsworth | 28,772,000 | " " |
| Dresden | 66,754,700 | " " |
| Essex | 69,165,400 | " " |
| Galt | 144,733,000 | " " |
| Hamilton | 1,012,292,000 | " " |
| Ingersoll | 157,700,000 | " " |
| Kingsville | 80,464,000 | " " |
| Leamington | 178,495,000 | " " |
| Paris | 70,580,000 | " " |
| Petrolia | 142,638,300 | " " |
| Ridgetown | 79,053,500 | " " |
| Sarnia | 597,685,000 | " " |
| Tupperville | 7,740,500 | " " |
| Tilbury | 74,111,000 | " " |
| Tecumseh | 23,605,400 | " " |
| Windsor | 1,759,223,000 | " " |
| Woodstock | 194,371,000 | " " |
| Wheatley | 35,739,000 | " " |
| | 5,994,875,800 | " " |

The following list shows the owners of natural gas wells and the number of wells respectively owned by them:—

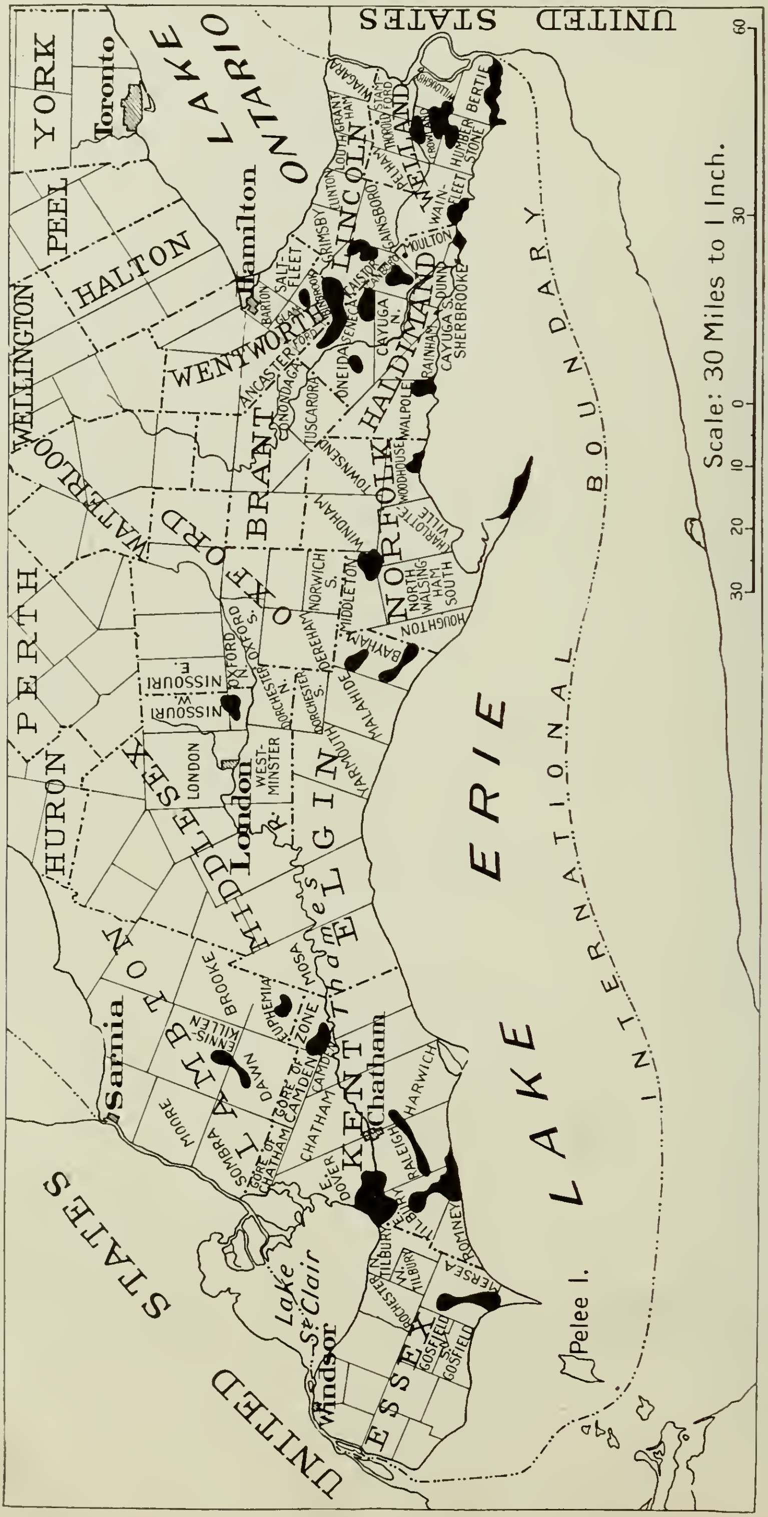
OWNERS OF NATURAL GAS WELLS, 31ST DECEMBER, 1919.

| | | No. of Wells. |
|---|---|---|
| Aikens, W. J. | Dunnville | 1 |
| Aldrich Gas & Oil Co. | Hamilton | 10 |
| Azoff Natural Gas Co. | Canfield | 1 |
| Battle Natural Gas Co. | Hamilton | 8 |
| Brown, W. G. | Cainsville | 1 |
| Binbrook Gas Co. | Binbrook | 1 |
| Bertie Natural Gas Co. | Ridgeway | 8 |
| Beaver Oil & Gas Co. | St. Thomas | 25 |
| Castle Oil & Gas Co. | Niagara Falls | 8 |
| Canadian Steel Foundries | Thorold | 8 |
| Coleman, J. A. | Wellandport | 7 |
| Canfield Natural Gas Co. | Canfield | 3 |
| Canby, B. F. | Marshville | 2 |
| Chippawa Development Co. | Chippawa | 8 |
| Chippewa Oil & Gas Co. | Tavistock | 40 |
| Darling Road Co-operative Natural Gas Co. | Canfield | 6 |
| Diener Gas Co. | Dunnville | 3 |
| Dominion Natural Gas Co. | Hamilton | 802 |
| Dunnegan Oil & Gas Co. | Chatham | 1 |
| Duxbury, Wellington | Hagersville | 1 |
| Dunn Natural Gas Co. | Dunnville | 19 |
| Eastside Gas Co. | Lowbanks | 6 |
| Emerson, Laidlaw & Troughton | Attercliffe Sta. | 4 |
| Empire Limestone Co. | Buffalo, N.Y. | 4 |
| Fairbank, J. H., Estate | Petrolia | 1 |
| Fletcher, J. I. | Hannon | 1 |
| Fisherville Gas Co. | Fisherville | 2 |
| Gas & Oil Co. of Springvale | Hagersville | 2 |
| Glenwood Natural Gas Co. | St. Thomas | 73 |
| Hager, Ham. | Middleport | 1 |
| Hamilton Gas & Oil Co. | Hamilton | 6 |

Owners of Natural Gas Wells, 31st December, 1919.—*Continued.*

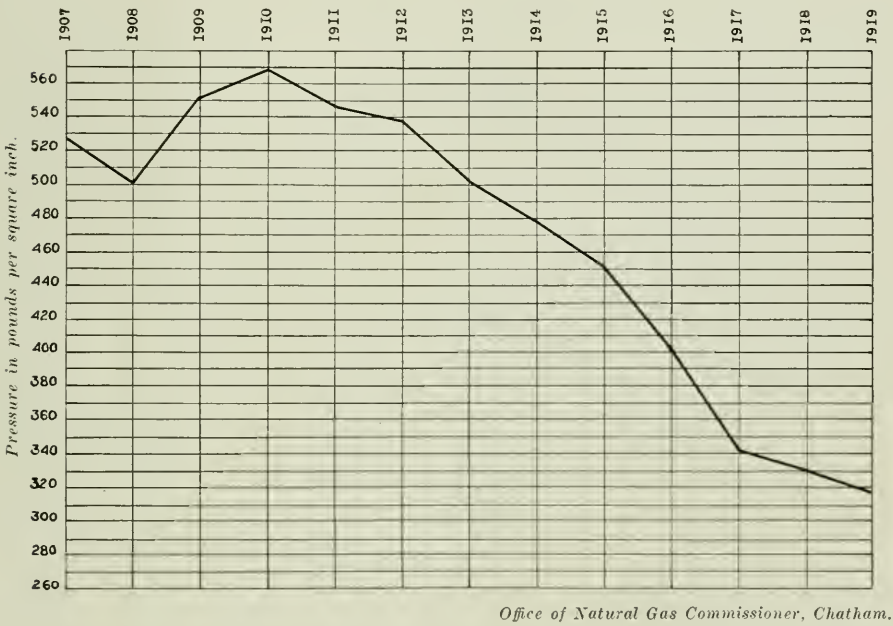
| | | No. of Wells. |
|---|---|---|
| Hart & Harrington | | 2 |
| Hendee Natural Gas Co. | Cayuga | 6 |
| Hoover, D. E. | Selkirk | 1 |
| Industrial Natural Gas Co. | Thorold | 32 |
| Jones, J. S. | Port Maitland | 3 |
| Jones, Nelson | Attercliffe Sta. | 2 |
| Jasperson, B. | Kingsville | 3 |
| Kindy Gas Co. | South Cayuga | 6 |
| Kindy & Sons | Selkirk | 6 |
| Kohler, May & Hoover | Selkirk | 14 |
| Lalor, F. R. | Dunnville | 5 |
| Lalor & Vokes | Dunnville | 10 |
| Lamb, Alfred | Selkirk | 4 |
| Liesinger & Lembke | Buffalo, N.Y. | 1 |
| Medina Natural Gas Co. | Chatham | 21 |
| Midfield Natural Gas Co. | Hamilton | 11 |
| Miller, Dr. | Buffalo, N.Y. | 1 |
| Marshall, Jas. | Hamilton | 11 |
| Martin, Ed. | Dunnville | 2 |
| May, A. G. | Hamilton | 3 |
| McKillop, Kohler, May & Hoover | Selkirk | 4 |
| Mickle & McKeehnie | Ridgetown | 5 |
| Niagara Natural Gas & Fuel Co. | Fenwick | 3 |
| North Shore Gas Co. | Hamilton | 8 |
| Northern Gas & Gasoline Co. | Hepworth | 2 |
| National Gas Co. | Hamilton | 74 |
| Oil Springs Oil & Gas Co. | Oil Springs | 6 |
| Ontario Gypsum Co. | Paris | 4 |
| Pilkington Bros. | Thorold | 4 |
| Producers Fuel & Light Co. | Sarnia | 1 |
| Port Colborne-Welland Natural Gas Co. | Pt. Colborne | 24 |
| Progressive Gas Co. | Hamilton | 1 |
| Provincial Natural Gas Co. | Niagara Falls | 209 |
| Rolston & Bennett | Dunnville | 3 |
| Richardson, J. W. | Caledonia | 1 |
| Richmond Gas & Oil Co. | Chatham | 4 |
| Robinson Road Gas Co. | Dunnville | 4 |
| Sparham, A. F. | Caledonia | 6 |
| Stevensville Gas Co. | Stevensville | 3 |
| Sterling Natural Gas Co. | Port Colborne | 68 |
| Sundy Gas Well Co. | Dunnville | 3 |
| Union Natural Gas Co. | Chatham | 171 |
| United Gas Companies | St. Catharines | 43 |
| Vacuum Gas & Oil Co. | Toronto | 2 |
| Vansickle, A. W. | Onondaga | 2 |
| Wainfleet & Moulton Gas Co. | Lowbanks | 3 |
| Welland Co. Lime Works | Port Colborne | 29 |
| Wedrick, M. | Nanticoke | 2 |
| Weylie, Wm. | Glanford | 4 |
| | Total | 1,900 |

During the past year some 93 wells were drilled in the Province. Of these new wells 77 were producing, and 16 non-producing. The total increase of gas made available by these wells is approximately 20,000,000 cubic feet daily, or an average for each of the producing wells drilled of some 265,000 cubic feet per day. The following map shows the locations of the areas where drilling operations were carried on during the year:—




Map of Western Ontario, showing zones (solid black) of drilling operations in 1919.

Notwithstanding the fact that the natural gas supply was so materially augmented by the addition of these new wells, the production showed a decided falling off from the previous year. This, to a great extent, is due to the gradually declining rock pressures in the fields themselves as shown by the accompanying graph:—




Rock pressures, Kent field.

Following is a list of the companies or individuals for whom wells were sunk during the year:—

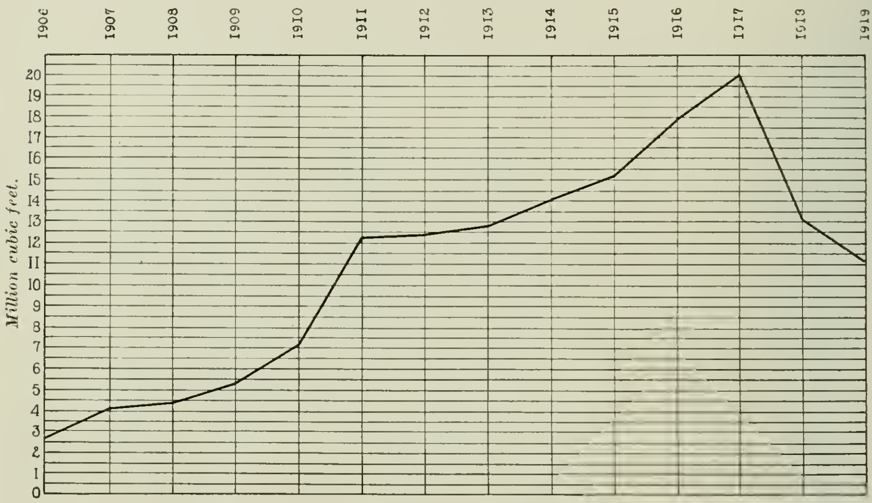
GAS WELLS DRILLED IN 1919.

| Owner. | Locality. Lot. | Con. | Township. | County. | Oil or Gas. | Production per day. (cu. ft.) | Date of completion. 1919. |
|---|---|---|---|---|---|---|---|
| Jasperson, B. | 15 | 13 | Tilbury ....... | Kent ....... | Gas | 272 M. | Sept. 27 |
| Glenwood Natural Gas Co. .......... | 13 | 1 | Mersea ....... | Essex ...... | " | 160 M. | April 22 |
| | 20 | 11 | Raleigh ....... | Kent ....... | " | Dry | March 12 |
| | 22 | 1 | Harwich ...... | " | " | " | Sept. 3 |
| | 185 | Talbot Road | Romney ...... | " | " | " | March 12 |
| | 15 | 8 | Mersea ....... | Essex ...... | " | 60 M. | May 31 |
| | 12 E½ | 1 | " | " | " | Dry | Aug. 23 |
| | 14 | 1 | " | " | " | 125 M. | Nov. 18 |
| | 13 S. | Middle Road | Tilbury ....... | Kent ....... | " | 800 M. | Nov. 3 |
| | 1 | 12 | Raleigh ....... | " | " | 525 M. | March 8 |
| Petrol Oil & Gas Co. | 1 | 1 | Dover ........ | " | " | 600 M. | Nov. 1 |
| Canby, B.F. ........ | 25 | 1 | Wainfleet ..... | Welland .... | " | 25 M. | Jan. 1 |
| | 26 | 1 | " | " | " | 25 M. | Feb. 18 |
| Dominion Natural Gas Co. .......... | 26 | 7 | Binbrook ..... | Wentworth . | " | 45 M. | Aug. 30 |
| | 31 | 8 | " | " | " | 25 M. | July 28 |
| | Broken Front | 5 | Woodhouse .... | Norfolk ..... | " | 104 M. | Sept. 25 |
| | " | 4 | " | " | " | 157 M. | July 28 |
| | 24 | 14 | Walsingham .. | " | " | 297 M. | Aug. 11 |
| | 41 | 3 | Middletown ... | " | " | 157 M. | Aug. 21 |
| | 41 | 3 | " | " | " | 96 M. | Feb. 21 |
| | 9 | 1 | Seneca ....... | Haldimand . | " | 157 M. | Aug. 21 |
| | 10 | 1 | " | " | " | 45 M. | Sept. 19 |
| | Nelles Tract | | " | " | " | 68 M. | Aug. 26 |
| | " | " | " | " | " | 62 M. | Sept. 20 |
| | 4 | 1 | " | " | " | 25 M. | Oct. 22 |
| | 11 | 1 | " | " | " | 30 M. | July 4 |
| | 24 | 4 | Oneida ....... | " | " | 21 M. | July 28 |
| | 41 | 5 | " | " | " | 17 M. | June 27 |
| | 3 | 8 | Canboro ....... | " | " | 96 M. | Aug. 2 |
| | 7 | 3 | " | " | " | 157 M. | Sept. 6 |
| | 6 | 3 | " | " | " | 37 M. | Nov. 22 |
| | 8 | 3 | " | " | " | 62 M. | Jan. 8 |
| | 8 | 3 | " | " | " | 51 M. | Feb. 17 |
| | 9 | 3 | " | " | " | 24 M. | Dec. 24 |
| | Nelles Tract | | Seneca ....... | " | " | 96 M. | Dec. 12 |
| | 27 | 3 | Bayham ...... | Elgin ....... | " | Dry | June 2 |
| | Nelles Tract | | Seneca ....... | Haldimand .. | " | " | Oct. 18 |
| | 39 | 2 | Middletown ... | Norfolk ..... | " | " | April 25 |
| | 27 | 7 | Binbrook ...... | Wentworth .. | " | 96 M. | Jan. 10 |
| | B | 1 | Seneca ....... | Haldimand .. | " | 34 M. | Jan. 24 |
| | 27 | 7 | Binbrook ...... | Wentworth .. | " | 62 M. | Jan. 21 |
| | 28 | 7 | " | " | " | 43 M. | March 13 |
| | 29 | 7 | " | " | " | 58 M. | April 9 |
| | 30 | 8 | " | " | " | 231 M. | June 3 |
| | 30 | 7 | " | " | " | 70 M. | May 7 |
| | 30 N. | 8 | " | " | " | 43 M. | July 5 |
| | 8 | 3 | Canboro ...... | Haldimand .. | " | 68 M. | June 11 |
| | 8 | 3 | " | " | " | 27 M. | July 11 |
| | 7 | 3 | " | " | " | 48 M. | Oct. 2 |
| | 7 | 3 | " | " | " | 85 M. | Nov. 3 |
| | 7 | 3 | " | " | " | 34 M. | March 7 |
| | 7 | 3 | " | " | " | 57 M. | Jan. 28 |
| | 3 | 4 | Binbrook ...... | Wentworth .. | " | Plugged | Sept. 27 |

Gas Wells Drilled in 1919.—*Continued.*

| Owner. | Locality. | | | | Oil or Gas. | Production. per day. (cu. ft.) | Date of completion, 1919. |
|---|---|---|---|---|---|---|---|
| | Lot. | Con. | Township. | County. | | | |
| Drilled for Dr. Miller, Buffalo, by J. A. Coleman | 15 | 2 | Moulton ...... | Haldimand.. | Gas | 25 M. | Nov. 28 |
| Coleman, J. A...... | 38 | 4 | Wainfleet ..... | Welland .... | " | 15 M. | May 29 |
| Port Colborne-Welland Gas and Oil Co............. | 68 | 1 | Onondaga ..... | Brant ...... | " | 68 M. | Feb. 27 |
| Welland Gas and Oil Co.......... | 66 | 1 | " | " | " | 110 M. | Jan. 29 |
| | 68 | 1 | " | " | " | 40 M. | April 11 |
| Union Natural Gas Co............. | 3 | 3 | Dover ........ | Kent ....... | Gas | 100 M. | |
| | | | | | Oil | 20 Bbls. | Jan. 2 |
| | 3 | 3 | " | " | Gas | 7,760 M. | May 31 |
| | 2 | 3 | " | " | " | 500 M. | Oct. 11 |
| | 2 | 3 | " | " | Gas | 200 M. | |
| | | | | | Oil | 20 Bbls. | Jan. 9 |
| | 2 | 3 | " | " | Gas | 2,500 M. | May 24 |
| | 14 | 13 | Tilbury....... | " | " | 450 M. | June 4 |
| | 11 | 13 | " | " | " | 150 M. | June 4 |
| | 14 | 13 | " | " | " | 336 M. | July 29 |
| | 14 | 14 | " | " | " | 478 M. | April 2 |
| Drilled for Standard Steel Construction Co. by Industrial Natural Gas Co............. | 203 | ........ | Thorold....... | Welland .... | " | Plugged | June |
| Industrial Natural Gas Co......... | 4 | 5 | Crowland ..... | " | " | 20.5 M. | May 21 |
| | 1 | 7 | " | " | " | Plugged | Aug. 18 |
| | 13 | 4 | Humberstone.. | " | " | 50 M. | Nov. 6 |
| | 4 | 5 | " | " | " | 36 M. | Feb. 18 |
| | 1 | 7 | Crowland ..... | " | " | 60 M. | July 5 |
| | 1 | 7 | " | " | " | 149.2 M. | June 3 |
| | 1 | 7 | " | " | " | 25 M. | April 14 |
| | 5 | 6 | " | " | " | 23.5 M. | April 18 |
| Beaver Oil and Gas Co., Ltd. ........ | 190 | Talbot Road W. | Romney ...... | Kent ....... | " | 360 M. | July 25 |
| | 28 | 2 | " | " | " | 350 M. | Oct. 10 |
| | W. ½ 185 | Talbot Road | " | " | " | Dry | March 12 |
| Midfield Natural Gas Co., Ltd. .... | 51 | 1 | Oneida ....... | Haldimand.. | " | 17 M. | Oct. 24 |
| | 52 | 1 | N. Cayuga .... | " | " | 125 M. | Dec. 29 |
| Northern Gas and Gasoline Co..... | 3 | 10 | Amabel....... | Bruce ...... | " | 80 M. | Sept. — |
| Bertie Natural Gas Co............. | 22 | 1 | Bertie ........ | Welland .... | " | Plugged | |
| Binbrook Gas Co. .. | 5 | 4 | Binbrook ..... | Wentworth.. | " | 45.9 M. | Nov. 1 |
| Castle Oil & Gas Co. | 27 | 5 | Euphemia .... | Lambton.... | " | 175 M. | Oct. 17 |
| | 25 | 5 | " | " | " | ............ | June 25 |
| | 25 | 4 | " | " | " | ............ | March 1 |
| Chippewa Oil & Gas Co............. | 3 | ........ | Caistor ....... | Lincoln ..... | " | Dry | Nov. 11 |
| | 2 | ........ | " | " | " | " | Oct. 1 |
| Provincial Natural Gas Co......... | 32 | Broken Front | Bertie ........ | Welland .... | " | " | Aug. 8 |
| | 33 | " | " | " | " | " | Feb. 23 |

The following chart shows the consumption or production for the years 1906 to 1919 inclusive:—




*Office of Natural Gas Commissioner, Chatham.*

Consumption of Natural Gas in Ontario, 1906-1919.

The following table shows the relation between temperature and pressure for the Tilbury field:—

Average Temperatures and Pressures, 1919.

| Month. | Temperature. | Pressure. |
|---|---|---|
| January | 30.1 | 122.0 lbs. |
| February | 32.2 | 157.0 " |
| March | 37.0 | 167.1 " |
| April | 44.6 | 173.1 " |
| May | 57.1 | 199.6 " |
| June | 76.3 | 207.0 " |
| July | 77.0 | 189.2 " |
| August | 73.6 | 203.1 " |
| September | 69.6 | 199.3 " |
| October | 60.8 | 197.2 " |
| November | 41.6 | 177.1 " |
| December | 36.2 | 139.3 " |

During Year 1920.

| | | |
|---|---|---|
| January | 17.0 | 129.2 " |
| February | 27.5 | 121.1 " |

The average temperature for 1919 was 52.17 deg. F., and the average pressure, 177.58 lbs.

The following are typical logs of gas wells drilled during the year 1919. The terms descriptive of the strata are those used by the drillers.

LOG No. 1.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 25 | 1 | Wainfleet. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 78 Feet |
| Lime and Shale | 79 " | 321 " |
| Niagara | 400 " | 250 " |
| Shale | 650 " | 50 " |
| Clinton | 700 " | 34 " |
| Red Medina | 734 " | 50 " |
| Grey Shale | 784 " | 66 " |
| White Medina | 850 " | 15 " |
| Red Shale | 865 " | 12 " |

Total Depth: 877 ft.

LOG No. 2.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 26 | 1 | Wainfleet. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 146 Feet |
| Lime and Shale | 147 " | 243 " |
| Niagara | 390 " | 250 " |
| Shale | 640 " | 50 " |
| Clinton | 690 " | 35 " |
| Red Medina | 725 " | 50 " |
| Grey Shale | 775 " | 68 " |
| White Medina | 843 " | 15 " |
| Red Shale | 858 " | 12 " |

Total Depth: 870 ft.

LOG No. 3.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 1 | 2 | Dover W. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 92 Feet |
| Shale | 93 " | 10 " |
| Upper Soap | 103 " | 115 " |
| Middle Lime | 218 " | 15 " |
| Lower Soap | 233 " | 74 " |
| Onondaga | 307 " | 1,214 " |
| Rock Salt | 1,521 " | 70 " |
| Niagara Lime | 1,591 " | 351 " |
| Niagara Shale | 1,942 " | 50 " |
| Red Shale | 1,992 " | 50 " |
| Grey Shale | 2,042 " | 30 " |
| Shale | 2,072 " | 10 " |
| Clinton Dolomite | 2,082 " | 60 " |
| Red Shale | 2,142 " | 60 " |
| White Medina | 2,202 " | 20 " |
| Red Medina Shale | 2,222 " | 280 " |
| Hudson Shale | 2,502 " | 300 " |
| Utica Shale | 2,802 " | 101 " |
| Trenton | 2,903 " | 408 " |

Total Depth: 3,311 ft.

### Log No. 4.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 5 | 5 | Binbrook. | Wentworth. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clay | 0 Feet | 68 Feet |
| Brown Lime | 69 " | 76 " |
| Niagara | 145 " | 115 " |
| Casing Shale | 260 " | 40 " |
| Clinton | 300 " | 30 " |
| Red Medina | 330 " | 35 " |
| Blue Shale | 365 " | 55 " |
| White Medina | 420 " | 10 " |
| Red Shale | 430 " | 20 " |
| Total depth: | 450 ft. | |

### Log No. 5.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 1 | 7 | Crowland. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 82 Feet |
| Lime, Shale and Niagara | 83 " | 400 " |
| Shale | 483 " | 44 " |
| Clinton | 527 " | 40 " |
| Red Medina | 567 " | 50 " |
| Shale | 617 " | 50 " |
| White Medina | 667 " | 16 " |
| Red Shale | 683 " | 32 " |
| Total Depth: | 715 ft. | |

### Log No. 6.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 4 | 5 | Humberstone. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 85.6 Feet |
| Niagara | 86.6 " | 453.4 " |
| Clinton | 540.0 " | 25 " |
| Red Medina | 565 " | 56 " |
| Shale | 621 " | 38 " |
| White Medina | 659 " | 16 " |
| Red Shale | 675 " | 36 " |
| Total Depth: | 711 ft. | |

### Log No. 7.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 1 | 7 | Crowland. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 76 Feet |
| Lime and Niagara | 77 " | 399 " |
| Shale | 476 " | 44 " |
| Clinton | 520 " | 40 " |
| Red Medina | 560 " | 53 " |
| Shale | 613 " | 50 " |
| White Medina | 663 " | 16 " |
| Red Shale | 679 " | 40 " |
| Total Depth: | 719 ft. | |

Log No. 8.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 4 | 5 | Crowland. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 87 Feet |
| Lime and Shale | 88 " | 100 " |
| Niagara | 188 " | 237 " |
| Shale | 425 " | 41 " |
| Clinton | 466 " | 34 " |
| Red Medina | 500 " | 67 " |
| Shale | 567 " | 30 " |
| White Medina | 597 " | 26 " |
| Red Shale | 623 " | 32 " |

Total Depth: 655 ft.

Log No. 9.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 5 | 6 | Crowland. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 89 Feet |
| Limestone and Shale | 90 " | 117 " |
| Niagara | 207 " | 240 " |
| Shale | 447 " | 50 " |
| Clinton | 497 " | 35 " |
| Red Medina | 532 " | 68 " |
| Shale | 600 " | 51 " |
| White Medina | 651 " | 21 " |
| Red Shale | 672 " | 34 " |

Total Depth, 706 ft.

Log No. 10.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 13 | 4 | Humberstone. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 63 Feet |
| Lime and Shale | 64 " | 184 " |
| Brown Lime | 248 " | 42 " |
| Shale | 290 " | 15 " |
| Brown Lime | 305 " | 25 " |
| Niagara | 330 " | 197 " |
| Shale | 527 " | 62 " |
| Clinton | 589 " | 33 " |
| Red Medina | 622 " | 56 " |
| Grey Shale | 678 " | 38 " |
| White Medina | 716 " | 12 " |
| Red Shale | 728 " | 10 " |

Total Depth: 738 ft.

Log No. 11.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 1 | 7 | Crowland. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 66 Feet |
| Limestone, Shale and Niagara | 67 " | 359 " |
| Shale | 426 " | 48 " |
| Clinton | 474 " | 40 " |
| Red Medina | 514 " | 53 " |
| Shale | 567 " | 50 " |
| White Medina | 617 " | 12 " |
| Red Shale | 629 " | 11 " |

Total Depth: 640 ft.

### Log No. 12.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 1 | 7 | Crowland. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 66 Feet |
| Lime and Niagara | 67 " | 417 " |
| Shale | 484 " | 40 " |
| Clinton | 524 " | 40 " |
| Red Medina | 564 " | 53 " |
| Shale | 617 " | 50 " |
| White Medina | 667 " | 16 " |
| Red Shale | 683 " | 45 " |

Total Depth: 728 ft.

---

### Log No. 13.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 52 | 1 | N. Cayuga. | Haldimand. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clay | 0 Feet | 8 Feet |
| Flint | 9 " | 23 " |
| Grey Lime | 32 " | 75 " |
| Shale | 107 " | 49 " |
| Guelph Lime | 156 " | 145 " |
| Shale and Lime | 301 " | 123 " |
| Niagara Lime | 424 " | 240 " |
| Casing Shale | 664 " | 16 " |
| Grey Shale | 680 " | 38 " |
| Clinton | 718 " | 29 " |
| Red Medina | 747 " | 46 " |
| Blue Shale | 793 " | 45 " |
| White Medina | 838 " | 12 " |
| Red Shale | 850 " | 20 " |

Total Depth: 870 ft.

---

### Log No. 14.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 51 | 1 | Oneida. | Haldimand. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 3 Feet |
| Flint | 4 " | 16 " |
| Sand Rock | 20 " | 5 " |
| White Lime | 25 " | 28 " |
| Gypsum | 53 " | 10 " |
| Brown Lime | 63 " | 19 " |
| Grey Lime | 82 " | 55 " |
| Shale | 137 " | 21 " |
| Guelph Lime | 158 " | 118 " |
| Shale | 276 " | 35 " |
| Lime and Shale | 311 " | 75 " |
| Shale | 386 " | 30 " |
| Niagara Lime | 416 " | 235 " |
| Casing Shale | 651 " | 47 " |
| Clinton | 698 " | 27 " |
| Red Medina | 725 " | 44 " |
| Blue Shale | 769 " | 53 " |
| White Medina | 822 " | 17 " |
| Pocket in Red Shale | 839 " | 20 " |

Total Depth: 859 ft.

### Log No. 15.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 3 | 10 | Amabel. | Bruce. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 27 Feet |
| Niagara | 28 " | 200 " |
| Green Shale | 228 " | 10 " |
| Red Shale | 238 " | 50 " |
| Blue Shale | 288 " | 40 " |
| Clinton | 328 " | 50 " |
| Red Shale | 378 " | 85 " |
| Blue Shale | 463 " | 70 " |
| Red Shale | 533 " | 20 " |
| Hudson River | 553 " | 447 " |
| Utica | 1,000 " | 25 " |
| Trenton | 1,025 " | 390 " |

Total Depth: 1,415 ft.

---

### Log No. 16.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 15 | 2 | Moulton. | Haldimand. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 99 Feet |
| Limestone | 100 " | 140 " |
| Niagara | 240 " | 160 " |
| White Sand | 400 " | 20 " |
| Slate | 420 " | 49 " |
| Clinton | 469 " | 34 " |
| Red Medina | 503 " | 35 " |
| Slate | 538 " | 55 " |
| White Medina | 593 " | 10 " |
| Red Shale | 603 " | 68 " |

Total Depth: 671 ft.

---

### Log No. 17.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 2 | 3 | W. Dover. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 74 Feet |
| Shale | 75 " | 55 " |
| Soap | 130 " | 151 " |
| Lime | 281 " | 864 " |
| Shale and Lime Shale | 1,145 " | 165 " |
| Lime | 1,310 " | 120 " |
| Shale and Lime Shale | 1,430 " | 120 " |
| Lime | 1,550 " | 195 " |
| Niagara Lime | 1,745 " | 245 " |
| White Shale | 1,990 " | 25 " |
| Red Shale | 2,015 " | 65 " |
| White Shale | 2,080 " | 40 " |
| White Medina | 2,120 " | 125 " |
| Red Shale | 2,245 " | 105 " |
| Lime | 2,350 " | 25 " |
| Shale | 2,375 " | 195 " |
| Brown Shale | 2,570 " | 233 " |
| Trenton | 2,803 " | 455 " |

Total Depth: 3,258 ft.

LOG NO. 18.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 20 | 2 | Raleigh. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Drift Clay | 140 Feet | 360 Feet |
| Lime | 500 " | 60 " |
| White Lime | 560 " | 30 " |
| Yellow Lime | 590 " | 70 " |
| Settling Sand | 660 " | 60 " |
| White Lime | 720 " | 34 " |
| Lime Stone | 754 " | 146 " |
| White Lime | 900 " | 45 " |
| Yellow Lime | 945 " | 380 " |
| Lime | 1,325 " | 130 " |
| Water Sand | 1,455 " | 50 " |
| Niagara Lime | 1,505 " | 49 " |
| Grey Lime | 1,554 " | 8 " |
| Lime | 1,562 " | 54 " |
| Water Sand | 1,616 " | |

LOG NO. 19.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 185 | Talbot Road. | Romney. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Drift Clay | 154 Feet | 106 Feet |
| Soap | 260 " | 180 " |
| Big Lime | 440 " | 160 " |
| Lime | 600 " | 120 " |
| Flint | 720 " | 560 " |
| Lime | 1,280 " | 150 " |
| Salt | 1,430 " | 110 " |
| Lime | 1,540 " | |

LOG NO. 20.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | E. ½ 12 | 1 | Mersea. | Essex. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clay | 73 Feet | 217 Feet |
| Lime | 290 " | 320 " |
| Grey lime | 610 " | 50 " |
| Blue lime | 660 " | 315 " |
| Lime | 975 " | 16 " |
| Salt Sand | 991 " | |

LOG NO. 21.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 28 | 2 | Romney. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clay | 170 Feet | 330 Feet |
| Lime | 500 " | 60 " |
| Sharp Sand | 560 " | 75 " |
| Lime | 635 " | 60 " |
| Grey Lime | 695 " | 10 " |
| Lime | 705 " | 80 " |
| Grey Lime | 785 " | 65 " |
| Lime | 850 " | 510 " |
| Grey Lime | 1,360 " | |

### Log No. 22.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 190 | Talbot Rd. W. | Romney. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clay | 172 Feet | 263 Feet |
| Lime | 435 " | 105 " |
| Sharp Sand | 540 " | 630 " |
| Lime | 1,170 " | 209 " |
| Gas Sand | 1,379 " | |

---

### Log No. 23.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 3 | 3 | Caistor. | Lincoln. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 68 Feet |
| Niagara Lime | 68 " | 178 ' |
| White Lime | 246 " | 60 " |
| Casing Shale | 306 " | 35 " |
| Clinton | 341 " | 25 " |
| Red Medina | 366 " | 38 " |
| Blue Shale | 404 " | 61 " |
| White Medina | 465 " | 18 " |
| Red Shale | 483 " | 30 " |

Total Depth: 513 ft.

---

### Log No. 24.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 32 | Broken Front. | Bertie. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clinton | 770 Feet | 30 Feet |
| Red Medina | 800 " | 95 " |
| White Medina | 895 " | 20 " |
| Red Shale | 915 " | 930 " |
| White Shale | 1,845 " | 818 " |
| Trenton | 2,663 " | 722 " |
| Potsdam and Salt Water | 3,385 " | 25 " |

Total Depth: 3,410 ft.

---

### Log No. 25.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 33 | Broken Front. | Bertie. | Welland. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clinton | 742 Feet | 30 Feet |
| Red Medina | 772 " | 98 " |
| White Medina | 870 " | 15 " |
| Red Shale | 885 " | 925 " |
| White Shale | 1,810 " | 795 " |
| Trenton | 2,605 " | 733 " |
| Potsdam | 3,338 " | 29 " |

Total Depth: 3,367 ft.

## Log No. 26.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 13 | 1 | Mersea. | Essex. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clay | 44 Feet | 26 Feet |
| White Lime | 70 " | 560 " |
| Grey Lime | 630 " | 70 " |
| Dark Grey Lime | 700 " | 75 " |
| Grey Lime | 775 " | 65 " |
| Dark Grey Lime | 840 " | 143 " |
| Brown Lime | 983 " | |

## Log No. 27.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 14 | 1 | Mersea. | Essex. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Sand | 14 Feet | 71 Feet |
| Clay | 85 " | 50 " |
| Brown Lime | 135 " | 40 " |
| Lime | 175 " | 55 " |
| Blue Lime | 230 " | 215 " |
| Grey Lime | 445 " | 165 " |
| Dark Grey Lime | 610 " | 195 " |
| Grey Lime | 805 " | 80 " |
| Blue Shale | 885 " | 65 " |
| Gas Sand | 950 " | 31 " |
| Grey Lime | 981 " | |

## Log No. 28.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 22 | 1 | Harwich. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Drift Clay | 85 Feet | 65 Feet |
| Shale and Gravel | 150 " | 239 " |
| Soap and Shale | 389 " | 35 " |
| Yellow Lime | 424 " | 146 " |
| Grey Lime | 570 " | 80 " |
| Gypsum | 650 " | 100 " |
| Grey Lime | 750 " | 30 " |
| Brown Sand | 780 " | 90 " |
| Sharp Sand | 870 " | 10 " |
| Grey Lime | 880 " | 15 " |
| Blue Lime | 895 " | 85 " |
| Grey Lime | 980 " | 35 " |
| Brown Lime | 1,015 " | 71 " |
| Blue Shale | 1,086 " | 39 " |
| Blue Lime | 1,125 " | 31 " |
| Grey Lime | 1,156 " | 69 " |
| Yellow Lime | 1,225 " | 115 " |
| White Lime | 1,340 " | 60 " |
| Salt Sand | 1,400 " | 100 " |
| Brown Lime | 1,500 " | 75 " |
| Grey Lime | 1,575 " | 50 " |
| Brown Lime | 1,625 " | 40 " |
| Red Sand | 1,665 " | 35 " |
| Brown Sand | 1,700 " | 20 " |
| Grey Sand | 1,720 " | 10 " |
| Grey Lime | 1,730 " | 55 " |
| Sharp Sand | 1,785 " | 15 " |
| Total Depth: | 1,800 ft. | |

### Log No. 29.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 13 | S. Middle Road. | Tilbury. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Drift Clay | 0 Feet | 166 Feet |
| Clay | 167 " | 31 " |
| Soap | 198 " | 62 " |
| White Lime | 260 " | 175 " |
| Sharp Sand | 435 " | 185 " |
| Settling Sand | 620 " | 125 " |
| Lime | 745 " | 165 " |
| Blue Lime | 910 " | 80 " |
| Grey Lime | 990 " | 65 " |
| Blue Lime | 1,055 " | 15 " |
| Gas Sand | 1,070 " | 115 " |
| Brown Lime | 1,185 " | 35 " |
| Grey Lime | 1,220 " | 55 " |
| Gas Sand | 1,275 " | 10 " |

Total Depth: 1,285 ft.

---

### Log No. 30.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 1 | 12 | Raleigh. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clay | 143 Feet | 57 Feet |
| Brown Shale | 200 " | 110 " |
| Soap | 310 " | 290 " |
| Lime | 600 " | 170 " |
| Sharp Sand | 770 " | 599 " |
| Lime | 1,369 " | |

---

### Log No. 31.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 15 | 8 | Mersea. | Essex. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Clay | 140 Feet | 745 Feet |
| Lime | 885 " | 95 " |
| Gas Sand | 980 " | 26 " |
| Salt Sand | 1,006 " | |

---

### Log No. 32.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 3 | 3 | W. Dover. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 64 Feet |
| Shale | 65 " | 15 " |
| Lime Shale | 80 " | 15 " |
| Soap | 95 " | 160 " |
| Lime | 255 " | 1,750 " |
| Red Shale | 2,005 " | 55 " |
| Blue Shale | 2,060 " | 40 " |
| Clinton | 2,100 " | 85 " |
| Red Shale | 2,185 " | 255 " |
| Blue Lime | 2,440 " | 360 " |
| Brown Shale | 2,800 " | 100 " |
| Trenton | 2,900 " | 25 " |

Total Depth: 2,925 ft.

## Log No. 33.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 3 | 3 | W. Dover. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 100 Feet |
| Black Shale | 100 " | 50 " |
| Soapstone | 150 " | 68 " |
| Soapstone and Middle Lime | 218 " | 32 " |
| Lime | 250 " | 268 " |
| Brown Lime | 518 " | 402 " |
| Blue Lime | 920 " | 54 " |
| Gypsum | 974 " | 40 " |
| Lime | 1,014 " | 48 " |
| Lime and Shale | 1,062 " | 20 " |
| Lime | 1,082 " | 88 " |
| Lime and Shale | 1,170 " | 80 " |
| Lime | 1,250 " | 46 " |
| Blue Shale | 1,296 " | 84 " |
| Lime | 1,380 " | 65 " |
| Shale | 1,445 " | 60 " |
| Lime | 1,505 " | 470 " |
| Shale | 1,975 " | 25 " |
| Red Shale | 2,000 " | 35 " |
| Blue Shale | 2,035 " | 54 " |
| White Medina | 2,089 " | 77 " |
| Red Shale | 2,166 " | 229 " |
| Lime and Shale | 2,395 " | 55 " |
| Blue Shale | 2,450 " | 450 " |
| Trenton | 2,900 " | 385 " |

Total Depth: 3,285 ft.

---

## Log No. 34.

| Location: | Lot. | Concession. | Township. | County. |
|---|---|---|---|---|
| | 2 | 3 | W. Dover. | Kent. |

| Formation. | Depth. | Thickness. |
|---|---|---|
| Surface | 0 Feet | 40 Feet |
| Shale | 40 " | 5 " |
| Soap | 45 " | 205 " |
| Lime | 250 " | 790 " |
| Gypsum | 1,040 " | 680 " |
| Niagara Lime | 1,720 " | 250 " |
| Slate | 1,970 " | 95 " |
| Red Medina | 2,065 " | 35 " |
| White Medina | 2,100 " | 798 " |
| Trenton | 2,898 " | 288 " |

Total Depth: 3,186 ft.

## Permits

During the year 1919 permits were issued according to the following classification, under the permit system provided for by the passing of the Natural Gas Act, 1919, which came into force on June 1st:—

| | |
|---|---|
| General Manufacturing Purposes | 5 |
| Public Utilities | 3 |
| Gas Engines | 11 |
| Food Products | 11 |
| Clayworkers | 13 |
| Bakers | 6 |
| Total | 49 |

View showing how the natural gas man makes his own fittings in the field. Welding is rapidly taking the place of threaded joints and is far more leak-proof.

# INDEX

TWENTY-NINTH ANNUAL REPORT

OF THE

# ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXIX, PART VI,

1920

# The Stratigraphy and Paleontology

OF

# Toronto and Vicinity

Part I.—By Beatrice Helen Stewart

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

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## PREFATORY NOTE

The need for a revision of the Paleozoic geology in the vicinity of Toronto has long been apparent to local workers, as no serious publication dealing with this subject has appeared since the "Geology of Canada" of 1863.

The need for such revision is two-fold: (*a*) to furnish a more modern and scientific revision of the stratigraphy and paleontology; (*b*) to provide an illustrated handbook for the guidance of local collectors.

It is proposed to issue this revision in three parts: the first to deal with the Pelecypoda (Lamellibranchiata); the second to contain an account of the other fossil organisms; and the third to treat of the stratigraphy and correlation. This arrangement of the subject matter, while not in accord with the best practice, has been rendered necessary by the conditions under which the work has been carried on.—W. A. P.

# THE STRATIGRAPHY AND PALEONTOLOGY

of

# TORONTO AND VICINITY

## PART I.

## THE PELECYPODA

by

Beatrice Helen Stewart

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### Introductory

The Paleozoic rocks exposed at Toronto were formerly included in the Hudson River group, a sub-division which is no longer recognized by geologists. Of recent years the strata have generally been referred to the Lorraine formation of the State of New York. While this correlation is in part correct, there is reason to believe that our strata present relationships also with the Upper Ordovician formations of the Ohio valley. It is hoped that a continuation of the investigations will furnish a more satisfactory correlation.

The detailed examination of the local strata was begun by an investigation of a few localities in the immediate vicinity of Toronto. In these exposures one is impressed by the abundance of pelecypods. For this reason it has been thought advisable to present first an account of this preponderating group and to leave the important question of correlation until more extensive data have been obtained.

The exposures examined were six in number: the Don brickyard or quarry, situated in the eastern part of Toronto; the old Humbervale quarry on the Humber River between Lambton Mills and Weston; the mill-race near the Humbervale quarry; two cuts on the banks of the Humber between the railway bridges and the bridge at Lambton village; and the old shale pits in Lambton village. It is thought that these exposures are sufficiently representative to furnish all species of pelecypods that are to be found in the immediate vicinity of Toronto.

The pelecypod fauna proved to be unexpectedly rich, containing sixteen genera represented by about sixty species; of these, nine species are new, and several specimens show varietal differences of more or less significance.

Most of the material used in the investigation was collected during the autumn of 1919, but the extensive collections of the Royal Ontario Museum of Paleontology were also freely used.

The conclusions arrived at have been confirmed, for the most part, by Dr. W. A. Parks, to whom I am indebted for assistance in the carrying on of the work and in the preparation of the final text. I wish also to acknowledge the assistance of Prof. MacLean and Mr. W. S. Dyer in the field work and in the securing of material.

In the preparation of the illustrations I wish to acknowledge the assistance of Dr. W. A. Parks, Mr. E. B. S. Logier, and Mr. Will Frost.

## Description of Species

As final conclusions regarding correlation must await the examination of the other zoological groups, as well as the investigation of more numerous localities, it is thought advisable to defer to Part III a discussion of the stratigraphic relationships, but to append to this part a tentative correlation of the strata as a whole, based on the evidence supplied by the Pelecypoda alone. The following description of species contains, therefore, no comments on correlation. The classification adopted is that given by Bassler in "Bibliographic Index of American Ordovician and Silurian Fossils."

### Order PRIONODESMACEA

### Family GRAMMYSIIDAE

### Genus CUNEAMYA, *Hall and Whitfield*

CUNEAMYA, *Hall and Whitfield*. Pal. Ohio 2, 1875, p. 90.

The original description of this genus is as follows:

> Thin, fragile, bivalve shells, with ventricose valves, and strong, prominent, incurved beaks. Cardinal line straight, or gently curved. Hinge edentulous. Valves united by an external ligament of greater or less extent, posterior to which the margins of the valves overlap each other to the extent of the cardinal line. Margins of the valves inflected along the cardinal border, forming a narrow escutcheon posterior to the beaks, and anteriorly a well-defined lunule is situated below the beaks. Adductor muscles, at least two, are anterior and posterior. Pallial line simple.

This genus is represented by two species and one variety, as follows:

### CUNEAMYA NEGLECTA (*Hall and Whitfield*)
Plate I, Figure 4.

GRAMMYSIA NEGLECTA, *Hall and Whitfield*. Geol. Surv. Ohio, Pal. 2, 1875, p. 91, Plate 2, Figure 11.
CUNEAMYA *cf.* NEGLECTA, *Hall and Whitfield* (non *Meek*). Foerste. Geol. Surv. Can., Mem. 83, 1916, p. 64.

The species originally described as *Sedgwickia neglecta* by Meek (Proceedings Acad. Nat. Sci., Philadelphia, 1872, p. 325) was founded on a poorly preserved specimen. The form described as *Grammysia neglecta* by Hall and Whitfield (*op. cit.*) differs in some respects from that of Meek. While Bassler in his revision considers the two species to be identical, Foerste intimates that they are distinct. Our collections contain three small specimens, which are undoubtedly nearer to Hall and Whitfield's type than to that of Meek. The specimen here figured is very close to that figured by Hall and Whitfield but is of smaller size. The anterior extremity is rather more rounded, but the general form, wide beaks and position of the unbonal ridge very strongly suggest Hall and Whitfield's type.

*Locality.*—25-foot level, Humber River cut, Toronto.
No. 1022 H.R., Royal Ontario Museum of Paleontology.

### CUNEAMYA SCAPHA, *Hall and Whitfield*
Plate I, Figure 2.

CUNEAMYA SCAPHA, *Hall and Whitfield*. Geol. Surv. Ohio, Pal. 2, 1875, p. 92, Plate 2, Figure 12.
CUNEAMYA SCAPHA, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, p. 32.

The original description given by Hall and Whitfield is as follows:

Shell of medium size, transversely elongate ovate, largest at the anterior end, with prominent, incurved, nearly terminal beaks; cardinal and basal margins parallel, or nearly so; posterior end broad, obliquely truncate, and rounded from the extremity of the hinge line to the postero-basal angle; anterior end very slightly prolonged beyond the beaks, the upper margins inflected, forming a rather large sized lunule, below which the border slopes abruptly backwards to the basal line, forming a somewhat obtuse or undefined angle at their junction; basal line gibbous at the anterior and posterior third of its length, flattened or somewhat sinuate in the middle. Surface of the valves convex for the anterior two-thirds of the length and to the crest of the umbonal ridge, beyond which it slopes abruptly to the postero-cardinal margin, being almost concave between the two points, and giving a rather abrupt or sub-angular umbonal ridge, which curves in its course from the beaks to the postero-basal angle. The middle of the shell is marked by a broad, usually undefined, but sometimes distinct, oblique, mesial sulcus, extending from the beaks to the basal margin, and occupying almost the entire space between the umbonal ridge and the anterior prominence. Cardinal slope broad, marked by a faint secondary ridge extending from behind the beaks to the middle of the postero-cardinal body. Surface of the shell marked by fine, somewhat even, concentric lines of growth, but without evidence of concentric ridges or plicae.

A small specimen of this species was found at the top of a cut on the Humber river, west of Toronto. It differs somewhat from the type, in the basal margin, which is slightly arcuate rather than straight; in the presence of at least four distinct plications at the anterior end; and in the absence of the faint secondary ridge mentioned as occurring in the post-cardinal region. In all other respects, however, it agrees with the type. The dimensions of the specimen figured are: length 15 mm., height at beak and posteriorly 7 mm.

*Locality.*—25-foot level, Humber River cut, Toronto.
No. 1021 H.R., Royal Ontario Museum of Paleontology.

### CUNEAMYA SCAPHA BREVIOR, *Foerste*
Plate I, Figure 1.

CUNEAMYA SCAPHA BREVIOR, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 307, Plate 2, Figure 12.
CUNEAMYA SCAPHA BREVIOR, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 6, 55, 150.

Foerste's description of this variety follows:

Shell closely related to *C. scapha*, but relatively shorter, and hence with a less inclined umbonal ridge and mesial sulcus. The angle between the umbonal ridge and the hinge-line is approximately 45 to 50 degrees, the median part of the mesial sulcus forming an angle of about 70 degrees. The mesial sulcus has a width of about 15 mm. near the basal margin, and is distinct even close to the beak, although this may be only an individual characteristic. The beak is broader and far less acute than is indicated in the figure of the type represented in the second volume of the Palaeontology of Ohio. The anterior outline, however, is closely similar. The umbonal ridge is rounded, not angular, and the posterior margin is more evenly rounded posteriorly. Concentric striae or low narrow undulations fairly distinct anteriorly, becoming fainter along the umbonal ridge and on the cardinal slope.

The specimen figured here is closely similar to *Cuneamya scapha brevior,* and agrees with the description in the broad beak, rounded umbonal ridge, and distinct anterior undulations; also in the fact that it is relatively shorter than the type of

*C. scapha.* It differs, however, in the following points: the mesial sulcus is not distinct; the anterior outline is somewhat straighter than in either *C. scapha* or *C. scapha brevior;* the basal margin is not sinuate as in Foerste's variety nor almost straight as in the type of the species but gently convex; and the number of concentric undulations or plicæ is greater than that shown by the figure *C. scapha brevior.* With regard to the concentric undulations it is to be noted that Hall states distinctly that this feature is entirely absent in *C. scapha.* The figured shell has a length of 31 mm., a height of 18 mm. at the beaks, and a posterior height of 16.5 mm.

*Locality.*—Below 8-foot level, Don brickyard, Toronto.
No. 987 H.R., Royal Ontario Museum of Paleontology.

### Family CTENODONTIDAE

### Genus Ctenodonta, *Salter*

Ctenodonta, *Salter.* Rep. British Assoc. Adv. Sci., 1851, p. 63.

The description given by Salter in Decade I, of Canadian Organic Remains. is as follows:

> Nearly equilateral, generally transverse, anterior side largest; beaks approximate, not prominent; hinge-line with a double series of bent teeth, connected by smaller ones beneath the beak; ligament posterior, external, on a fulcrum; no striated area or cartilage pit; muscular impressions strong (with supplementary scars), not bounded by elevated ridges; pallial line simple.

The small shells which have been ascribed to this genus are particularly difficult to determine; this is partly due to their great variability and partly to the fact that only moulds and casts in shale are available. The determinations must be regarded, therefore, as provisional only. A thorough revision of the genus seems to be required in order that definite comparisons may be made with accurately figured and described types.

Of these small forms there seem to be five different types; one is closely related to, if not identical with *C. cingulata;* the remaining forms belong to the group of *C. levata.* The shells ascribed to this group show so great a degree of variation that it seems inadvisable to do more than compare them with the described species which they most closely resemble. Exception is made in the case of one type, which is herein described as a new species.

### Ctenodonta cingulata (*Ulrich*)
Plate I, Figure 25.

Tellinomya cingulata, *Ulrich.* Jour. Cincinnati Soc. Nat. Hist., 2, 1879, p. 23, Plate 7, Figures 19, 19a.
Ctenodonta cingulata, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 680, Plate 48, Figs. 10-12.
Ctenodonta *cf.* cingulata, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 113, 129, 134.

The following description is compiled from Ulrich's original definition of the species and his subsequent amendment. Shell of medium size, nearly circular, with a slight prolongation of the posterior end, which gives a little obliquity to the shell; anterior and basal borders regularly rounded; posterior cardinal margin slightly rounded and sloping to point of greatest extension; beaks small, obtusely pointed, and not incurved; valves moderately convex, somewhat depressed just posterior to the beaks and along the cardinal margin. The hinge teeth are very slender and crowded in the central part of the hinge. Their great length and the unusual width of the hinge plate are the principal peculiarities of the species. Surface ornamented by very fine concentric lines. Muscular impressions and pallial line not observed.

This species is related to *C. pectunculoides*, Hall, but its more circular form, less prolonged posterior border, the fine concentric striae, and its greater size will serve to distinguish it externally, while its wider hinge plate and the more abrupt curvature of the same will separate it internally.

This species is represented in my collection by one somewhat imperfect cast, which is, however, with fair certainty ascribed to *C. cingulata*. The drawing represents the specimen referred to above, but it has been considerably modified by comparison with Ulrich's figure as shown in the Geology of Ohio, Vol. 7.

*Locality.*—17-foot level, Humber River cut, Toronto.
No. 1024 H.R., Royal Ontario Museum of Paleontology.

### CTENODONTA FILISTRIATA, *Ulrich*
Plate I, Figure 5.

TELLINOMYA LEVATA, *Hall and Whitfield.* Pal. Ohio, 2, 1875, p. 82, Plate 1, Figure 23.
CTENODONTA FILISTRIATA, *Ulrich.* Geol. of Minn. 3, pt. 2, 1897, p. 599, Figs. 44a-e.
CTENODONTA *cf.* FILISTRIATA, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 30, 42, 84.

The following description of this species is founded on Ulrich's definition of *C. albertina*, and on his remarks in pointing out the differences between that species and *C. filistriata*. Shell subovate, widest in the anterior half; beaks moderate in size and prominence, situated closer to the anterior extremity: antero-cardinal region compressed; anterior margin rather gently convex above the lower part, where it turns backward into the broadly and uniformly rounded base; posterior margin somewhat obliquely rounded subtruncate; umbonal ridge inconspicuous. Surface ornamented by delicate, crowded, thread-like, concentric lines, which cover the entire surface. Twelve to twenty of these lines may be counted in a space one millimetre wide. The hinge plate is strong, contracted, and bent beneath the beak. Denticles usually twenty-seven in number, twelve anterior and fifteen posterior.

This species is represented in the collection by a specimen, along the postero-basal margin of which the shell is preserved showing the fine, thread-like, concentric lines which separate *C. filistriata* from the closely related species *C. albertina*. These concentric lines are too fine to be shown in the figure.

*Locality.*—25-foot level, Humber River cut, Toronto.
No. 1017 H.R., Royal Ontario Museum of Paleontology.

### CTENODONTA *cf.* FILISTRIATA, *Ulrich*
### CTENODONTA *cf.* ALBERTINA, *Ulrich*
Plate I, Figure 3.

CTENODONTA FILISTRIATA, *Ulrich. Vide supra.*
CTENODONTA ALBERTINA, *Ulrich.* Geol. Minn. 3, pt. 2, 1897, p. 598, Plate 42, Figs. 76-82.
CTENODONTA *cf.* ALBERTINA, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 42, 157.

On the surface of thin limestone layers from Weston, Ontario, the interiors of the valves of a small species of *Ctenodonta* may be seen in a very good state of preservation. These specimens show a characteristic hinge line, in which the number of small teeth is fairly constant. The dentition is of the same general type as that of *C. filistriata* and *C. albertina,* but the denticles are fewer in number than in either of those species. Anterior to the beak there are ten denticles, while twelve of these small teeth occur along the cardinal line posterior to the beak. The hinge here figured resembles the text figure of *C. filistriata* shown on p. 599, Geol. of Minn. 3, pt. 2, but the posterior hinge plate does not show the strong curvature represented in Hall and Whitfield's figure of *Tellinomya levata,* which is considered by Ulrich as co-specific with *C. filistriata.* This hinge may possibly belong to the same species described above as *C. filistriata,* but the number of denticles is too small to accord exactly with Ulrich's type. The same remark applies to the reference of these hinges to *C. albertina,* in which the number of denticles is still greater, but it should be noted in this connection that Ulrich refers to a dentition very similar to this, in the following words: "In a sixth valve, unusually short and possibly not belonging to this species, there are only eleven anterior and thirteen posterior teeth." If it is eventually established that the actual number of teeth is specific one would be justified in erecting a new species to include these small shells.

*Locality.*—Weston, Ontario.
No. 1023 H.R., Royal Ontario Museum of Paleontology.

### Ctenodonta myalta, *sp. nov.*

Plate I, Figures 7 and 11.

In the various horizons and localities of the rocks under review occur small shells of the *C. levata* group, which cannot be ascribed with any certainty to described species. The variations are so numerous that it would be possible to make several new species, but as they all conform more or less to one general type, it is thought advisable to erect but one species and to regard that species as of variable habit.

The shell is small and subovate. The anterior margin is rather evenly rounded from the beak to the ventral margin. The posterior edge is distinctly more acute. The beaks are rather acuminate but not pronounced, and seem to be but slightly incurved. The umbonal ridge is very close to the posterior margin. The surface shows no signs of concentric markings but, of course, it cannot be stated that a perfect shell would not show such lines. The specimen shown in Figure 7 represents a relatively large and elevated type, in which also a small posterior muscle scar occurs in an unusually high position. Between this variety and that shown in Figure 11 many intermediate stages were observed. Nothing is known of the interior of the shell or the character of the hinge. The larger shell measures 6.5 mm. in length and 5.25 mm. in height. The smaller shell measures 4 mm. in length and 3 mm. in height.

*Localities.*—15-foot level, Humbervale quarry (Fig. 7).
Below 8-foot level, Don brickyard (Fig. 11).
Nos. 1025 and 1026 H.R., Royal Ontario Museum of Paleontology.

CTENODONTA, *sp. indet.*
Plate I, Figure 18.

The collection contains a single example of a species of *Ctenodonta* that seems to be distinct from all others. The general form is somewhat like that of *C. myalta,* but there is a faint indication of a broad mesial sulcus and also slight evidence of concentric lines toward the margin. The specimen is in too poor a state of preservation to justify a specific name at present. The shell is certainly related to *C. myalta* on the one hand, and on the other to C. *nuculiformis,* Hall. This latter relationship depends on the presence of a sulcus, but it is less pronounced and less oblique than in Hall's figure. The dimensions for the specimen are: length 6.2 mm., height 4.5 mm.

*Locality.*—3-foot level, Don brickyard.
No. 1027 H.R., Royal Ontario Museum of Paleontology.

Family LEDIDAE

Genus CLIDOPHORUS, *Hall*

CLEIDOPHORUS, *Hall.* Pal. New York, 1, 1847, p. 300, footnote.

Hall defines the genus as follows:

The shells of this genus may be characterized as, equivalved, inequilateral; hinge without teeth or crenulations; surface (particularly in casts) marked by an oblique linear depression, extending from the anterior cardinal margin towards the base, indicating the place of the clavicle; surface concentrically striated.

Shells showing the distinctive characteristics of this genus are common in our rocks. Four described species are recognized, and to these has been added a fifth, which is regarded as a new species.

CLIDOPHORUS PLANULATUS (*Conrad*)
Plate I, Figure 12.

NUCULITES PLANULATA, *Conrad.* 5th Ann. Rep. New York Geol. Surv., 1841, p. 50.
CLEIDOPHORUS PLANULATUS, *Hall.* Pal. New York, 1, 1847, p. 300, Plate 82, Figs. 9a-e.
CLIDOPHORUS PLANULATUS, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 302.
CLIDOPHORUS PLANULATUS, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 6, 7, 9, 31, 51, 55, 75, 85, 139, 150.

Hall describes the species as follows:

Subelliptical, with the anterior extremity narrowed, regularly rounded; posterior side broader; beak scarcely elevated; a distinct impressed line extending from before the beak, half way to the base; hinge line straight; posterior extremity obliquely truncated; shell uniformly convex; a round elevated ridge extending from the beak to the posterior basal margin, between which and the cardinal line a narrow portion of the shell is closely compressed.

Foerste, in describing Pulaski forms of *Clidophorus planulatus* states that they are relatively longer than the Turin forms figured by Hall and that the clavicular impressions are more nearly vertical.[1] The Toronto forms do not

[1] Foerste, Bull. Sci. Lab. Denison Univ., 17, 1914, p. 302.

appear to be longer than the Turin forms and the position of the clavicular impression varies greatly: in some cases it is almost vertical and in others it is fully as oblique as in any of Hall's figures. On this account it seems inadvisable to attempt a separation of these forms into different species.

The characteristic features of this species appear to be the concave post-umbonal region and the obliquely truncated posterior extremity. These shells are very common in the Toronto rocks and range from the lowest to the highest levels. The specimen figured has the following measurements: length 18 mm., height at beak 8 mm.

*Locality.*—3-foot level, Don brickyard.
No. 988 H.R., Royal Ontario Museum of Paleontology.

### CLIDOPHORUS PRAEVOLUTUS, *Foerste*

Plate I, Figure 10.

CLIDOPHORUS PRAEVOLUTUS, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 303, Plate 1, Figs. 6 and 12.
CLIDOPHORUS PRAEVOLUTUS, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 15, 23, 42, 43, 44, 64, 65, 149, 150, 163.

The following description applies to this species: shell elongate; posterior cardinal and basal margins sub-parallel; posterior cardinal margin practically straight for a distance of about 8 mm. from the beak, curving rather sharply into the posterior extremity; anterior extremity evenly rounded, broader than the posterior extremity, which is oblique; just anterior to the beak there is a slightly sigmoid, oblique clavicular impression, extending toward the anterior basal margin for a distance of about 4 mm.; anterior to this impression, extending from the beak to the anterior basal margin, a shallow depression, bounded by an angular ridge, which also extends from the beak to the anterior basal margin; anterior to this ridge a second depression much less pronounced than the first.

The specimen here figured differs from the type in the less narrowly rounded extremities and in the presence of the slight secondary depression, but agrees with it in the possession of the characteristic depression and ridge anterior to the clavicular impression; this feature differentiates the species from *C. planulatus*, Conrad. *C. praevolutus* differs further from *C. planulatus* in the less truncate posterior extremity and in the practical absence of the subalate, concave features in the post-umbonal region. Measurements of the specimen figured are as follows: length 16 mm., height 8 mm.

*Locality.*—Don brickyard, Toronto.
No. 1028 H.R., Royal Ontario Museum of Paleontology.

### CLIDOPHORUS OBLIQUUS, *sp. nov.*

Plate I, Figure 9.

In the higher levels of the strata in the Humber River region a species of *Clidophorus* occurs which differs from any of the species hitherto described; it is distinguished by the rather posterior position of the beak and more particularly by the long, highly oblique, clavicular impression.

The shell is elongate, with a rather straight posterior cardinal margin, which passes abruptly into the posterior margin. The ventral edge is distinctly convex and the anterior extremity is somewhat less quadrangular than the posterior. Fine concentric lines are distinctly shown on the cast.

The specimen selected as the type is much more elongate than other examples which are considered to belong to this species, indicating that there is a considerable degree of variation in form, although the long, highly inclined clavicular impression is constant. The measurements for the type are: length 13.5 mm., height 6 mm.

*Locality.*—17-foot level, Humber River cut.
No. 1018 H.R., Royal Ontario Museum of Paleontology.

### Clidophorus fabulus (*Hall*)
### Plate I, Figure 8.

Clidophorus (Nucula) fabula, *Hall.* Amer. Jour. Sci. Arts, 43, 1845, p. 295.
Clidophorus (Nuculites) fabula, *Meek.* Geol. Surv. Ohio, Pal. I, 1873, p. 138, Plate 11, Figs. 10a, b.
Clidophorus fabula, *Miller.* N.A. Geol. Pal., 1889, p. 471, Fig. 796.

Meek describes this species as follows:

> Shell minute, or very small, transversely elliptic, moderately convex; extremities narrowly rounded, the anterior end being narrower than the posterior; basal margin forming a broad semi-elliptic curve; beaks rather depressed, slightly tumid and placed a little in advance of the middle; dorsal margin sloping gently from the beaks, the anterior slope being rather less gradual than the other, and, in the cast, a little concave in front of the beaks. Anterior muscular impression distinctly defined by the internal ridge, which leaves a rather deep furrow just in advance of each beak in casts of the interior.

This species very closely resembles *C. neglectus* of Hall, differing from it principally in its smaller size; it is regarded by many authors as merely a dwarf variety of that species. This small shell is somewhat variable, some examples being of less length than the type figured; it is not uncommon in the Toronto district. The specimen figured has the following measurements: length 8 mm., height 4 mm.

*Locality.*—15-foot level, Humbervale quarry.
No. 1019 H.R., Royal Ontario Museum of Paleontology.

### Clidophorus *cf.* faberi, *Miller*
### Plate I, Figure 6.

Clidophorus faberi, *Miller.* N.A. Geol. Pal., 1889, p. 471, Fig. 795.

The shell here figured agrees with *C. faberi* in the rather high form and in the pointed, anteriorly situated beaks; it differs, however, in the more attenuated posterior end, and in the concave rather than convex antero-cardinal margin. Further specimens may serve to separate it from *C. faberi* but it is provisionally compared to that species. The specimen figured has the following dimensions: length 7 mm., height 5 mm.

*Locality.*—25-foot level, Humber River cut.
No. 997 H.R., Royal Ontario Museum of Paleontology.

## Family CYRTODONTIDAE
### Genus Ischyrodonta, *Ulrich*

Ischyrodonta, *Ulrich.* Amer. Geol. 6. 1890, p. 173; Geol. Surv., Ohio, 7, 1893, p. 671.

Ulrich describes this genus as follows:

Short or moderately elongate, thick bivalve shells, having small, anteriorly situated beaks, with the hinge line straight or arcuate and extended posteriorly. Hinge plate wide and strong, without posterior lateral teeth, but with two strong cardinal teeth in the left valve, and one large one, and occasionally a small one on each side of it, in the right valve. Ligament internal, posterior to the beaks, linear, supported by from one to three subcardinal ribs. Anterior adductor impression large, deep, subovate, sharply defined on the inner and upper side by a ridge extending from the cardinal teeth to the base of the scar. A small pedal muscle was attached to the underside of the hinge plate immediately above the inner side of the anterior adductor scar. Posterior muscular scar faintly defined, generally but little larger than the anterior scar, situated a short distance beneath the posterior extremity of the hinge. Pallial line simple. Test thick, chiefly calcareous, without the dark epidermis of the *Modiolopsidae* and *Ambonychiidae*.

In casts of the interior the beaks are prominent and strongly compressed, and a more or less well defined sulcus, corresponding to an internal thickening of the shell, extends from the umbones more than half the distance to the centre of the basal margin.

Of this genus there are two species in our collections: *I. unionoides* and *I. elongata.*

### Ischyrodonta unionoides (*Meek*)
Plate I, Figure 13.

Anadontopsis ? unionoides, *Meek.* Amer. Jour. Sci. Arts, 2, 1871, p. 299.
Anadontopsis (Modiolopsis?) unionoides, *Meek.* Pal. Ohio, Vol. I, 1873, p. 141, pl. 12, fig. 2.
Ischyrodonta unionoides, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 677, pl. 54, figs. 1-3.
Ischyrodonta curta, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 298, pl. 3, fig. 14.
Ischyrodonta curta, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 7, 9, 68, 75.

Three specimens of *I. unionoides* are included in the collections of the Royal Ontario Museum of Palaeontology; two from the Humber River region and one from the Don valley.

Ulrich describes this species in the following terms:

Shell of medium size, subovate, a little the highest posteriorly, compressed convex, thickest slightly above and in advance of the middle. Anterior margin regularly but rather narrowly rounded; base forming a broad semi-elliptic curve; posterior margin broadly rounded, very slightly oblique; dorsal outline more or less strongly arcuate, passing gradually into the ends. Beaks small, compressed, projecting very little beyond the hinge margin, placed between one-fourth and one-fifth of the length of the valves behind the anterior extremity; umbonal ridge scarcely distinguishable. Surface showing only a few distant subimbricating marks of growth.

Hinge comparatively weak for the genus, with one oblique cardinal tooth in the right valve and two (?) in the left. The ridge-like internal ligament support leaves a linear depression within the dorsal edge extending posteriorly from the beak for a distance equalling about one-third of the length of the shell. Anterior adductor and pedal muscle attachments having the characters usual for the genus, except that they are, with respect to the beaks, more anterior in position for the reason that the anterior end is uncommonly long.

The collection contains one specimen which very closely resembles the figures given by Foerste.[1] The text accompanying the above figures contains the following description:

A species which cannot be distinguished from *Ischyrodonta unionoides*. . . . What must be called the basal margin is slightly less convex, so that the angle with the cardinal margin becomes more acute, and the curvature at the anterior margin correspondingly greater. Moreover, the cardinal margin posterior to the beak is straighter, for a distance about as far as the anterior margin extends forward from the beak; in consequence, the angle between the cardinal margin and the posterior is slightly more angular. The oblique lines being accentuated, the shell is slightly less rotund, but the differences are scarcely specific.

[1] Bull. Sci. Lab. Denison Univ. 17, 1914, pl. 3, figs 14a-b.

The specimen represented by Plate I, Fig. 13, is fairly typical and shows the anterior and posterior muscle scar impressions.

Foerste retains the species *I. curta,* but this species is disregarded by the majority of authors, as it was founded by Hall on three distinct species.

This is not a very common species in the Toronto district. Foerste mentions having identified it from rocks on the western side of the Humber River at Weston, where a vertical exposure of about eight feet of rock occurs a short distance down stream from the forty-foot bluff exposure on the eastern side of the river.[1]

The measurements of the specimen figured are as follows: length 32.5 mm., height 35 mm.

*Locality.*—Don brickyard, Toronto.
No. 1006 H.R., Royal Ontario Museum of Paleontology.

### Ischyrodonta elongata, *Ulrich*

Plate III, Figure 4.

Ischyrodonta elongata, *Ulrich.* American Geologist, Vol. 6, 1890, p. 175, figs. 12a-c.
Ischyrodonta elongata, *Ulrich.* Geol. of Ohio, 7, 1893, p. 675, pl. 54, figs. 20 and 21.

Ulrich's description of this species is as follows:

Shell large for the genus, transversely elongate-ovate, widest posteriorly, strongly convex, with point of greatest convexity a little in front of the centre. Beaks rather large, compressed, almost terminal; umbonal ridge rather strong, mesial sulcus broad. Cardinal margin strongly arcuate; posterior margin nearly vertical in the middle and lower part, uniformly rounded above, sharply curved at the base; ventral margin faintly and broadly sinuate; anterior end very short and abruptly rounded. Surface marked with strong and irregular lines of growth.

In casts of the interior the beaks are very prominent, incurved, and greatly compressed by the deep umbonal sulcus, behind which the somewhat curved and sharply elevated umbonal ridge is distinguishable almost to the basal line. Anterior muscular scar deep, subrhomboidal, sharply defined on the upper side, radially marked and situated immediately beneath the beak. Just above it is the small pedal muscle scar. Posterior scar faint, ovate; pallial line distinct in the basal part of the valves.

This fine species, though closely related to *I. truncata,* is readily distinguished by its much greater length. The next species (*I. miseneri*) is also related, but is smaller and widely different in the post-cardinal part of its outline.

One specimen (a cast of the interior), in the collections of the Royal Ontario Museum of Palaeontology, is identified with this species. The specimen presents two striking characteristics: (1) anterior to the deep umbonal sulcus of the type, and practically parallel to the umbonal ridge, there is a secondary ridge, shorter than the primary and with a length of about 10 mm.; (2) the pallial line is distinct posteriorly and runs downward from the posterior adductor scar, with a marked inward inflection. Ulrich states that the pallial line in the type is distinct basally only, and his figure does not show the inflection above referred to.

The anterior adductor scar, which is strongly ridged concentrically and radially striated, appears to be situated somewhat closer to the beak than in the type. Further, the shell itself is relatively longer.

Despite the above points of difference it seems advisable to refer our specimen to *I. elongata,* for the following reasons: the prominent incurving umbonal ridge,

[1] Geol. Surv. Can., Mem. 83, 1916, p. 75.

the deep umbonal sulcus, the much compressed beaks, and the general form of the shell.

Owing to the imperfections in outline of our shell the figure herein given was drawn from Ulrich's type figure but has been modified to show the pallial line and secondary ridge. The position of the anterior adductor scar has not been altered.

*Locality.*—Humber River region, Toronto.
No. 989 H.R., Royal Ontario Museum of Paleontology.

### Genus Whitella

Whitella, *Ulrich.* Amer. Geol., 6, 1890, p. 176; Geol. Minn. 3, pt. 2, 1897, p. 564; Geol. Surv. Ohio, 7, 1893, p. 678.

Ulrich's description follows:

Shell thin, obliquely quadrangular or suboval, equivalve, inequilateral, more or less ventricose. Umbones very prominent, the beaks strongly incurved; umbonal ridge prominent, subangular or sharply rounded. Cardinal margin straight or slightly convex, the edges inflected to form a sharply defined escutcheon extending beyond the beaks sometimes quite to the anterior extremity of the shell; area finely striated longitudinally. Hinge line straight, from one-half to two-thirds the length of the shell; with two to five rather oblique folds or teeth in front of the beaks. Posterior portion of hinge apparently edentulous. Ligament probably both external and internal. The latter only along the posterior third of the hinge line, where it was supported by an internal ridge in each valve. Two simple adductor impressions, the posterior one very faint; pallial line simple, marginal; interior of shell lined with a nacrous film. Surface of shell with fine concentric lines, and sometimes with stronger concentric undulations.

This genus is very common, particularly in the lower levels of the Don brickyard or quarry. It is represented by eight species. These seem to be divisible into two rather distinct groups, characterized chiefly by the presence or absence of radiating lines anterior to the umbonal ridge. If this feature were absolutely constant it might serve as the basis for the construction of a new genus, but as there seems to be more or less variation in the strength of development of these lines, it seems inadvisable to do more than group the species as below:

#### GROUP A

*Forms without anterior plications*

#### Whitella hindi (*Billings*)

Plate II, Figure 4.

Cyrtodonta Hindi, *Billings.* Pal. Fossils, Geol. Surv. Can., Vol. I, 1865, p. 151, fig. 131, a, b.
Cyrtodonta Hindi, *Billings.* Geology of Canada, Geol. Surv. Can., 1863, p. 214, fig. 218.
Whitella Hindi, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, p. 74.

Billings' original description of this species is as follows:

Obliquely ovate, or subrhomboidal, tapering from the middle to a narrow rounded point at the posterior extremity, strongly ventricose in the anterior half; beaks closely incurved; a sharp umbonal ridge running from the beak nearly to the posterior extremity; from this ridge the surface descends with a concave slope to the hinge-line and dorsal margin; hinge-line straight, with a well developed concave area. The anterior extremity is small and rounded; the ventral margin strongly convex in the anterior half and somewhat straight behind.

Several shells of the general type of *W. hindi* have been found in the Toronto strata, and, making use of the description alone, they might be definitely referred to that species. On the other hand, when comparisons are made with the type figure, there are none of the specimens that accurately agree. A restricted number, however, come so close to the figure that they are ascribed to the species. These (Plate II, Fig. 4) show the following points of difference from the type: the anterior end does not project so far beyond the beak, is fuller and rounds directly under the beak without the intervention of the concavity shown in the type figure; the slight sinuosity in the postero-basal region of the figure is not shown; the umbonal ridge is rather less oblique, bounding a wider cardinal slope. Measurements for the specimen figured are: length 38 mm., height, 49 mm.

A second specimen (Plate II, Fig. 1), provisionally referred to this species, departs much more from the type. The relative length is much less and the umbonal ridge less elevated. This form also resembles *W. sterlingensis* of Meek and Worthen, and might, with equal reason, be ascribed to that species. As the shell shows signs of considerable distortion, I hesitate to express a definite opinion as to its exact specific relationships. The measurements are: length 38 mm., height 55 mm.

*Locality.*—Humber river, Toronto.
Nos. 490, 1007 H.R., Royal Ontario Museum of Paleontology.

WHITELLA TORONTONENSIS, *sp. nov.*
Plate II, Figure 5.

In the collections of the Museum there are two specimens of the genus *Whitella* which are very similar to and yet distinctly different from *W. hindi*. These forms may be defined as follows: large, quadrangular in outline, length greater than height; beaks large, prominent and somewhat compressed; strong umbonal ridge running from the beaks almost to the sharply rounded postero-basal extremity, angular for a distance of about 30 mm. from the beak, thence rounding gradually into the general convexity of the shell; hinge line straight, turning abruptly into the slightly truncate posterior margin; postero-basal extremity narrowly rounded; basal margin almost straight in the central part, curving upward into the broadly rounded anterior margin; anterior cardinal margin straight; anterior end quadrate. Surface marked by fine concentric lines of growth.

This species differs from *W. hindi* in the wider, more quadrangular form, longer hinge line, straighter anterior cardinal margin, and more quadrangular anterior end. It is not so ventricose in the anterior half, but as it is a shale fossil the difference in that respect is probably not so great as it appears. It differs from *W. umbonata* of Ulrich in the more pointed postero-basal extremity, straighter basal margin, smaller beaks, longer hinge line, and more prominent and quadrangular anterior end.

The dimensions of the specimen figured are: length 66 mm., height 50 mm.; measurement from the beak to the postero-basal extremity, along the umbonal ridge, 65 mm.

*Locality.*—Vicinity of Toronto, probably Don Valley.
No. 1033 H.R., Royal Ontario Museum of Paleontology.

GROUP B

*Forms with anterior plications*

WHITELLA GONIUMBONATA, *Foerste*
Plate I, Figures 16, 22.

WHITELLA GONIUMBONATA, *Foerste*. Bull. Sci. Lab. Denison Univ. 17, 1914, p. 301, pl. 1, fig. 3.
WHITELLA GONIUMBONATA, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 139, 150, 152.

The description given by Foerste follows:

Shell small, short, subrhomboidal. Beaks nearly terminal, enrolled toward the hinge line so as to produce a concave anterior area 11 mm. long along the anterior margin, and 2 mm. in width on the single valve. Present convexity of the single valve about 5 mm., but the original form of the shell probably was more ventricose, producing a more prominent umbonal area and a greater width for the anterior concave area. Umbonal ridge, at its junction with the cardinal slope, angular, the angle being sharply defined from the beak for a distance of about 17 mm. toward the lower posterior angle of the shell, and then becoming more rounded. Concentric striae rather faintly defined.

Foerste ascribed this species to the group of *Whitella obliquata* on account of the general resemblance to that species. In our specimens the presence of an elongated escutcheon is distinctly shown: as the escutcheon of *W. obliquata* is particularly short it seems impossible to associate the present form closely with that species. All our specimens show distinctly four or five radiating plications anterior to the umbonal ridge. As this feature is not shown in the type figure of *W. goniumbonata,* and not mentioned in the description, it was at first thought that our species might be distinct. Through the kindness of Dr. E. M. Kindle an opportunity was afforded for a comparison with the type specimen: in this, these anterior plications, although very faint, are yet distinctly visible. There can be no doubt as to the identity of the forms from Toronto. The character of the hinge is not determinable from the type: in our specimens, however, there is a distinct elongated impressed line posterior to the beaks, enclosing a relatively long cardinal area.

The locality from which the type of the species was obtained is somewhat in doubt.[1] Foerste, in his tables, ascribes the species to the Waynesville, yet in certain parts of the text he suggests that it may come from the upper part of the Lorraine.[2] The associations of this species at Toronto are certainly with the Maysville or Pulaski, rather than with the Waynesville. This species, as far as our collections are concerned, is confined to the lower eight feet of the Don brickyard, where it is fairly abundant, particularly so at the six-foot level. This horizon appears to hold also for the other species of this group.

The dimensions for the specimen represented by Plate I, Fig. 16, are: length 21.5 mm., height 29 mm.; for the specimen represented by Plate I, Fig. 22: length 18.5 mm., height 22.5 mm.

*Locality.*—Lower eight feet of Don brickyard, Toronto.
Nos. 1009, 1010 H.R., Royal Ontario Museum of Paleontology.

[1] Bull. Sci. Lab. Denison Univ., 17, 1914, p. 301.
[2] Geol. Surv. Canada, Mem, 83, 1916, pp. 245, 250.

WHITELLA IMPRESSATA, *sp. nov.*
Plate II, Figures 2, 3, 6.

This species is very similar to the preceding, particularly in respect to its general shape and the presence of the long ligamental area, which is easily half the total height of the shell and relatively of the same width in the two species. Likewise, the anterior plications are very similar in the two species. The present species differs, however, in that it is larger, with broader beaks, less angular umbonal ridge, higher anterior end, and longer posterior cardinal margin.

*Measurements.*—Length 40 mm., height 54 mm. (Fig. 2).
Length 29 mm., height 44 mm. (Fig. 3).
Length 30 mm., height 41 mm. (Fig. 6).
*Locality.*—Lower eight feet of Don brickyard, Toronto.
No. 1011 H.R., Royal Ontario Museum of Paleontology.

WHITELLA LATA, *sp. nov.*
Plate III, Figure 7.

A description of this species follows: shell subrhomboidal, fairly ventricose, with point of greatest convexity above the middle; beaks broad, slightly incurved, umbones compressed; anterior end short, narrowly rounded above, convex, curving into the broadly rounded basal margin, which in turn curves regularly into the broad posterior margin; hinge line long; umbonal ridge well marked, angular near the beak, extending about half the height of the shell; cardinal slope slightly concave; ligamental area or escutcheon about two-thirds the height of the shell; surface marked by very fine concentric striae and by six radiating plications, curving from the beak to the antero-basal margin.

This species is closely related to the preceding, but is relatively a much broader form, particularly in the basal region, with broader beaks, more tumid umbones, and a longer cardinal line.

The form figured has the following dimensions: length 27.5 mm., height 32 mm.

*Locality.*—Lower eight feet of Don brickyard, Toronto.
No. 1012 H.R., Royal Ontario Museum of Paleontology.

WHITELLA PARKSI, *sp. nov.*
Plate I, Figure 17.

This species may be defined as follows: shell elongate-ovate, ventricose, very oblique; beaks prominent, sharp, strongly incurved; antero-cardinal end small, narrowly rounded into the gently convex anterior margin; basal margin narrowly rounded; posterior margin evenly convex; umbonal ridge prominent, angular, extending nearly two-thirds of the height of the shell, rounding into the general convexity of the shell in the ventral region; hinge line comparatively short, edges inflected to form a distinct escutcheon, which has a length equal to about half the total height of the shell. In the postero-basal region there is a distinctly defined circular elevation, representing a muscle scar. This has been observed, in the same position, in several specimens. The surface is marked by very fine concentric striae, and most specimens show several indistinct anterior radiating plications.

This species belongs to the same general group as the three preceding species, but it is considered to be distinct on account of its more elongated form, its narrower posterior extremity, its sharper beaks, and its more sharply rounded basal extremity. It differs, also, in the presence of the muscle scar in the postero-basal region, which appears to be characteristic of all well preserved casts of this species.

In outline the species very closely resembles *W. praecipta* of Ulrich. Ulrich, however, places *W. praecipta* very close to *W. obliquata*: it is to be inferred, therefore, that the ligamental area in *W. praecipta* is short, as in *W. obliquata*. In the present species the ligamental area is very long, indicating a distinct difference from *W. praecipta*. Further, no note is made of radiating lines in the description of *W. praecipta,* nor is there any reference to the postero-basal muscle scar impression.

The dimensions of the specimen figured are: length 23.5 mm., height 36 mm., convexity of single valve about 6 mm.

The figure, as far as outline and general features are concerned, is founded on one rather perfect specimen, in which, however, the anterior cardinal region is uncertain and the anterior radiating lines are not apparent; these have been restored from other specimens undoubtedly belonging to this species.

*Locality.*—6-foot level Don brickyard, Toronto.
No. 1013 H.R., Royal Ontario Museum of Paleontology.

### Whitella acutiumbonis, *sp. nov.*

Plate I, Figures 19, 20, 21.

The collections contain a considerable number of shells of the genus *Whitella* which vary greatly and yet seem to possess certain features in common. Some of these shells might be regarded as young forms of some of the species hereinbefore described. All these shells, however, possess certain features in common which seem to justify the erection of a species for their reception. It is frankly admitted, however, that rather diverse forms are included, and that more extensive collections may eventually necessitate the removal of some of them to other species. The striking characteristics, which are common to all the forms herein included are: the very sharp umbonal ridge which extends, in all specimens sufficiently perfect to reveal it, quite to the basal margin; the pronounced concavity posterior to the umbonal ridge which continues upwards and causes the umbones proper to be very sharply defined and overhanging.

The outline of the shell, as shown in Plate I, Fig. 19, is derived from a smaller example of these variable forms. It will be observed that it is very similar to that of *W. goniumbonata*. The drawings representing the cardinal region (Figures 20 and 21) were made from two examples of considerably greater size but which are too imperfect to show the general shape of the ventral portion of the shell. All specimens, large or small, show distinctly a varying number of anterior radiating plications.

*Locality.*—Lower 8 feet of Don brickyard, Toronto (Fig. 19);
Don brickyard, Toronto (Figs. 20, 21).
No. 1014, 1015 H.R., Royal Ontario Museum of Paleontology.

WHITELLA RADIATA, *sp. nov.*
Plate III, Figure 3.

The collections contain a single specimen, undoubtedly from the vicinity of Toronto but of which the exact horizon is unknown, differing from all the species of *Whitella* hitherto described and approaching somewhat the structure of *Byssonychia*. This form seems to represent a type of *Whitella* in which the anterior radiating plications become so prominent and pronounced that they constitute a conspicuous element in the shell, at once suggesting a comparison with *Byssonychia*.

Both valves of the specimen are preserved and the right is almost perfect, except for a degree of wear.

The description follows: shell sub-quadrate in outline, ventricose: umbones high, prominent, fairly broad, carinate, very strongly incurved; hinge line straight, turning abruptly into the almost vertical posterior margin, which curves rather sharply into the rounded basal margin; anterior margin convex, slightly flattened, almost parallel to the posterior margin, giving the shell a sub-quadrate outline; umbonal ridge prominent, posterior, extending more than half way down the shell before merging into the general convexity; anterior surface marked by six well defined radiating plications; posterior to the umbonal ridge concentric lines of growth only; post umbonal region concave; cardinal line relatively short: escutcheon broad, well defined, extending the full length of the cardinal line posterior to the beaks; surface in the anterior umbonal region marked by faint lines crossing the radiating plications.

The drawing (Plate III, Figure 3) represents the right valve, with a certain amount of restoration in the anterior cardinal region. The left valve in the specimen is distinctly higher, and the beak more anterior: it is questionable whether this feature is due to a difference in the two valves or to pressure.

Dimensions of the specimen figured are: length 21 mm., height 18.5 mm., thickness 16 mm.

*Locality.*—Probably Don brickyard, Toronto.
No. 1002 H.R., Royal Ontario Museum of Paleontology.

Family AVICULIDAE

Genus PTERINEA, *Goldfuss*

PTERINEA, *Goldfuss.* Petrefacta Germaniae 1826, p. 133; ibid., 2nd ed., pt. 2, 1863, p. 126.

The shells of this genus are inequivalve, and the right valve is flat or practically so. Both the anterior and posterior extremities are alate, the anterior alation being short and the posterior drawn out. The anterior teeth are obscure: the posterior, of which there are several, are elongate and practically parallel to the cardinal margin. The posterior adductor scar is large; the anterior is small but strong, and is inserted below the anterior wing. The pallial line is simple and there is a byssal notch in the smaller valve.

Of this genus we have two species, the common *Pterinea demissa* and *Pterinea cincinnatiensis*.

## Pterinea demissa (*Conrad*)

Plate I, Figure 28.

Avicula demissa, *Conrad.* Jour. Acad. Nat. Sci. Philadelphia, 8, 1842, p. 242, pl. 13, fig. 3.
Avicula demissa, *Hall.* Pal. New York 1, 1847, p. 292, pl. 80, figs. 2a, b.
Avicula demissa, *Billings.* Geol. Canada, Geol. Surv. Can., 1863, p. 215, fig. 220.
Pterinea demissa, *McCoy.* Br. Pal. Rocks, Foss., 1854, p. 260, pl. 1, fig. 7.
Caritodens demissa, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 269, pl. 1, fig. 10; pl. 3, fig. 11.
Pterinea demissa, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 9, 20, 23, 24, 31, 42, 44, 45, 47, 65, 66, 74, 84, 85, 90, 98, 102, 110, 115, 121, 125, 130, 131, 133, 134, 135, 138, 139, 143, 144, 145, 149, 150, 153, 154, 157, 164, 166.

This species is quite variable in form, but the following features appear to be fairly constant: the posterior and anterior margins are approximately parallel; the posterior wing is longer than the anterior wing and projects well beyond the body of the shell; the surface is marked by sharp concentric striae crowded together on the wings of the shell; there is a distinct umbonal ridge extending from the beak toward the posterior margin and a less prominent ridge in front of the beaks toward the anterior margin.

Specimens collected from this locality vary from 8 mm. to almost 50 mm. in length. The length of the specimen figured is 42 mm. and the height 30 mm.

*Locality.*—Humber River region, Toronto.
No. 652 H.R., Royal Ontario Museum of Paleontology.

## Pterinea cincinnatiensis, *Miller and Faber*

Plate I, Figures 14 and 15.

Pterinea cincinnatiensis, *Miller and Faber.* Jour. Cincinnati Soc. Nat. Hist., 17, 1894, p. 25, pl. 1, figs. 11-17.

From the higher levels of the exposures on the Humber river a number of small shells referable to the genus *Pterinea* were obtained. These small shells are extremely variable in form and detail, and in most cases are in too poor a state of preservation to warrant their reference to described species. Some of them, however, show affinities to *P. cincinnatiensis.* That species, as shown by the type figures, is variable in form.

The original description of *P. cincinnatiensis,* as given by Miller and Faber, is as follows:

> Shell oblique, sub-rhomboidal in outline, with the basal margin rounded and the posterior side contracted below the point of the wing. Left valve depressed, convex in the central part, and flattened toward the alations; right valve nearly flat, though slightly convex in the umbonal region; hinge line straight, longer than the body of the shell, though not equal to the height; anterior wing short, extending, however, in the older shells somewhat acutely beyond the margin of the shell; posterior wing triangular, extending in mature forms as far as the body of the shell and terminating in an acute point; surface of the left valve marked by fine concentric striae that become more and more distant from each other from the beak to the base. There are no longitudinal radii or lines. Surface of the right valve smooth except that a series of wrinkles on each wing are directed obliquely from the cardinal line toward the body of the shell, but fade away at the sulci.

In some of our specimens of the left valve the striae are clearly shown and appear to become farther apart as they approach the basal margin, therein agreeing with Miller and Faber's description. In some of the specimens collected there is a strong ridge extending from the beak toward the antero-basal margin. Nevertheless, as there are transitions from a sharp ridge to no ridge at all, it is concluded, until further and stronger positive evidence is available, that this ridge is due to pressure.

Some of these imperfect shells approach *P. rugatula,* Miller and Faber, but the evidence is insufficient to justify the statement that that species occurs in our rocks. All these little shells, therefore, are provisionally placed under *P. cincinnatiensis.*

Plate I, Fig. 14, represents the best preserved left valve, in which the anterior ear is missing. Plate I, Fig. 15, shows the umbonal and posterior parts of a broken specimen of the right valve.

*Locality.*—25-foot level Humber River cut, Toronto.
No. 1003 H.R., Royal Ontario Museum of Paleontology.

### Family AMBONYCHIIDAE

### Genus BYSSONYCHIA, *Ulrich*

BYSSONYCHIA, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 629; Geol. Minn., 3, pt. 2, 1897, p. 498.

In this genus there is a well defined byssal opening in the upper half of the anterior side. There is a posterior, but no anterior alation. The hinge carries several small cardinal teeth and generally two or three slender lateral teeth near the posterior extremity. A striated ligamental area is present. The posterior adductor impression is large and is situated a little behind the centre of the valves. There is a simple pallial line which terminates in the rostral cavity.

Of this genus we have four established species in our rocks, *B. radiata, B. praecursa, B. alveolata,* and *B. vera.* A new variety of *B. vera* has been added.

### BYSSONYCHIA RADIATA, (*Hall*)

Plate IV, Figure 3.

AMBONYCHIA RADIATA, *Hall.* Pal. New York, 1, 1847, p. 292, pl. 80, figs. 4a-l.
AMBONYCHIA RADIATA, *Billings.* Can. Nat. Geol., 1, 1856, p. 44, fig. 7.
AMBONYCHIA RADIATA, *Billings.* Geol. Canada, Geol. Surv. Can., 1863, p. 215, fig. 219.
AMBONYCHIA RADIATA, *Chapman.* Can. Jour., n.s. 7, 1862, p. 166, fig. 110; ibid., 8, 1863, p. 206, fig. 205.
AMBONYCHIA RADIATA, *Chapman.* Expos. Min. Geol., Canada, 1864, p. 120, fig. 110, p. 178, fig. 205.
AMBONYCHIA RADIATA, *Nicholson.* Rep. Pal. Prov. Ontario, pt. 2, 1875, p. 35, fig. 11.
BYSSONYCHIA RADIATA, *Ulrich.* Geol. Minn. 3, pt. 2, 1897, p. 477, text, fig. 35 VI.
BYSSONYCHIA RADIATA, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 6, 7, 9, 15, 19, 20, 24, 25, 31, 32, 35, 36, 38, 42, 44, 45, 51, 53, 55, 56, 64, 66, 75, 85, 88, 102, 111, 115, 116, 121, 122, 129, 130, 134, 135, 138, 139, 144, 149, 151, 153, 154, 164, 166.
BYSSONYCHIA RADIATA, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 273, pl. 3, figs. 12a-c.

Hall gives as his description of this species the following:

Equivalve, obliquely obovate, extending into acute curving beaks; anterior slope nearly straight above, and rounded below; posterior slope oblique, scarcely alate; surface marked by 25 to 40 strong simple radii, which are crossed by fine concentric striae; radii flattened upon the top; the intermediate spaces are regularly concave grooves, narrower than the radii and marked by the concentric striae.

While the great majority of the numerous specimens collected conform more or less closely to the above description, there is one specimen which by reason of a peculiarity merits a short account. This specimen alone has been figured. It will be understood that the ordinary type differs from the figure in that the plications extend to the beak and are not interrupted as shown.

In the specimen figured there are about 35 radiating striae. It is peculiar in the possession of an impressed line, which runs across the shell from a point on the anterior margin about 12 mm. below the beak, describes an irregular elliptic curve and terminates on the wing at a point about 11 mm. below the beak. Above this impressed line the anterior three-fourths of the shell is devoid of striae. On the posterior fourth the striae cross the impressed line and converge to a point on the wing, near the beak. The impression, as well as the cast, is available, and a careful examination of both indicates that the surface has not been subsequently affected, above the impressed line. The peculiarity, therefore, probably existed in life, but its significance is hard to judge from a single specimen. Measurements for the shell figured are: length 30 mm., height 43 mm.

*Locality.*—5-foot level Humbervale quarry, Toronto.
No. 1001 H.R., Royal Ontario Museum of Paleontology.

### Byssonychia praecursa, *Ulrich*

Plate I, Figure 27.

Byssonychia praecursa, *Ulrich*. Geol. of Ohio, 7, 1893, p. 633, pl. 45, figs. 1 and 2.
Byssonychia praecursa, *Ulrich* var. *Foerste*. Geol. Surv. Can., Mem. 83, 1916, p. 125.

*B. praecursa* is very closely related to *B. radiata* and differs from that species chiefly in the flattening of the anterior side; it is also somewhat narrower across the central part of the valves.

In the specimen herein figured the beak is somewhat sharper and the hinge line shorter than in the type figure, but it is essentially the same form.

Foerste, on page 75 of "Upper Ordovician Faunas of Ontario and Quebec" lists *Byssonychia radiata borealis* from rocks in the vicinity of Weston. The type is in the possession of the Geological Survey at Ottawa, and the label accompanying it has been changed from "*Byssonychia radiata borealis*" to "*Byssonychia praecursa borealis*." As it was not possible to compare our specimens of *Byssonychia praecursa* with the above mentioned type, and as no figure or description has yet been published, I am not in a position to say whether this variety occurs in our collections or not.

### Byssonychia alveolata, *Ulrich*

Plate IV, Figures 1 and 2.

Byssonychia alveolata, *Ulrich*. Geol. of Ohio, 7, 1893, p. 631, pl. 48, figs. 1-3.

Ulrich describes the species as follows:

Shell of medium size, moderately convex, obliquely acuminate-ovate, wider than usual, with the basal half of the outline semi-circular; cardinal margin somewhat shorter than the middle length of the shell; umbones full, beaks but little incurved, separated; ligamental area very large; beneath the beaks the anterior side is impressed, forming an obscurely defined subcordate lunule, in the lower part of which the byssal opening is situated. Surface marked by about 50 rounded radiating costae.

This species is at once differentiated from *B. radiata, B. praecursa,* and *B. vera,* by the wide ligamental area.

The specimens from which the drawings have been made are very imperfect, particularly that of the right valve. In consequence the outline is not to be regarded as definitely determined.

*Locality.*—16-foot level Humbervale quarry, Toronto.
No. 983 H.R., Royal Ontario Museum of Paleontology.

### Byssonychia vera, *Ulrich*
Plate I, Figures 23 and 24.

Byssonychia vera, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 629, figs. a, b, c.
Amboxychia cincinnatiensis, *Miller and Faber.* Jour. Cincinnati Soc. Nat. Hist., 17, 1894. p. 24, pl. 1, figs. 8-10.
Byssonychia vera, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 24, 25, 88.

Miller and Faber's description of this species is as follows:

Shell below the medium size and more or less subacutely ovate in outline, varying a little in the extent of the wing bearing the lateral teeth in the different specimens. Posterior side only slightly winged and rounding into the base below. Anterior border of the valves truncated below the beaks, where there is a moderately large byssal opening, and below this the valves very gently round into the base. Base evenly rounded. Umbones low, subangular, below which the valves are depressed convex. Beaks slightly incurved, pointed, terminal and extending beyond the cardinal teeth and hinge. Surface marked by tolerably fine radiating striae and occasional concentric lines of growth.

*B. vera* closely resembles *B. radiata,* but differs in the greater number of striae, there being about 50 in *B. vera*; it also differs in the shorter hinge line, more evenly convex valves, and shorter byssal opening. It is, moreover, a smaller shell.

The specimen here figured resembles closely Ulrich's figures.[1]

Another specimen from the same locality is very similar in outline to Miller and Faber's figure.[2] Measurements for the specimen figured are: length 20 mm., height 30.5 mm.

*Locality.*—6-foot level Humbervale quarry, Toronto.
No. 985 H.R., Royal Ontario Museum of Paleontology.

### Byssonychia vera *var.* plana, *var. nov.*
Plate I, Figure 26.

In the Toronto district there occurs a shell which is apparently of the same species as the one described above. It is, however, much flatter, the convexity of a single valve being not more than 4 mm., as opposed to 8 mm. in the type. This shallowness results in the anterior margin being less strongly truncated below the beaks. Despite this peculiarity, the identity in general form, number of plica-

[1] Geol. Surv. Ohio, 7, 1893, p. 629, figs. a and b.
[2] Jour. Cincinnati Soc. Nat. Hist., 17, 1894, p. 24, pl. 1, fig. 8.

tions, and length of the hinge line, with *B. vera* indicates that the two are co-specific. The pronounced flattening above referred to, however, seems to justify the making of a new variety to receive this shell.

The dimensions of the specimen figured are as follows: length 18 mm., height 31 mm.

*Locality.*—Humber River, Toronto.
No. 345 H.R., Royal Ontario Museum of Paleontology.

### Family LYRODESMIDAE

### Genus Lyrodesma, *Conrad*

Lyrodesma, *Conrad.* Ann. Geol. Rep. New York, 1841, p. 51.

In this genus the length of the shell is greater than the height. The beaks are small and situated anterior to the central part of the shell. The posterior umbonal ridge is prominent and often angular. The surface is concentrically striated, and, in the majority of the species, the post-cardinal slope is marked with radiating lines. The thick hinge plate carries from six to eight prominent subequal crenulated teeth, radiating regularly from the beak. The posterior adductor scar is larger than the anterior, and there are two pairs of small pedal muscles. The pallial line is slightly sinuate posteriorly.

The collections contain a considerable number of shells of this genus that fall naturally into three groups, distinguished chiefly by the differences in relative height and length. The well known and most common species, *L. poststriatum*, is intermediate in this respect. A more elongated form is described below as a new variety, and a shorter form is referred to *L. cincinnatiense.*

### Lyrodesma poststriatum (*Emmons*)

Plate IV, Figure 5.

Nuculites post-striatus, *Emmons.* Nat. Hist. New York, Geol., 2, 1842, p. 399, text fig. 4.
Nucula poststriata, *Hall.* Pal. New York 1, 1847, p. 301, pl. 82, figs. 10a, b.
Lyrodesma poststriata, *Billings.* Geol. Sur. Can., 1863, p. 176, figs. 167a, b.
Lyrodesma poststriata, *Nicholson.* Rep. Pal. Prov. Ontario, pt. 2, 1875, p. 36, fig. 11b.
Lyrodesma poststriatum, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 306.
Lyrodesma poststriatum, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 7, 9, 42, 50, 53, 55, 64, 65, 75, 85.

*L. poststriatum* is a common fossil in this district. While a small amount of variation appears in different specimens, they all, nevertheless, agree fairly closely with the following description: ventral margin regularly rounded, turning sharply upwards to both the posterior and anterior extremities; anterior extremity broadly curved; posterior extremity obliquely truncated, meeting the cardinal line at an angle of about 165°; umbonal ridge slightly sigmoid, prominent. extending from the beak to the postero-basal margin; surface of the post-cardinal slope marked by about six, in some specimens eight, strong radiating striae, followed by finer fascicles and crossed by fine concentric markings. The hinge plate carries eight typical lyrodesmoid teeth. Casts of the interior are marked anteriorly by a depression extending obliquely downward from the beak for a distance of from three to four millimetres. Measurements of the specimen figured are: length 21 mm., height 15 mm.

*Locality.*—Don brickyard, Toronto.
No. 553 H.R., Royal Ontario Museum of Paleontology.

LYRODESMA POSTSTRIATUM ELONGATUM, *var. nov.*
Plate IV, Figure 4.

The variety differs from the type of the species chiefly in its more elongated form; the ratio of height to length in *L. poststriatum* is from 1:1.44 to 1:1.56, whereas in this case it is from 1:1.77 to 1:1.81. The anterior outline is straighter and the posterior cardinal margin is not deflected downward as in *L. poststriatum*. This form is not common, but the collections contain a large number of lyrodesmoid teeth which may possibly be referable to this variety.

The measurements for the specimen figured are: length 28.5 mm., height 16.5 mm.

*Locality.*—17-foot level Humber River cut, Toronto.
No. 998 H.R., Royal Ontario Museum of Paleontology.

LYRODESMA CINCINNATIENSE, *Hall*
Plate IV, Figure 7.

LYRODESMA CINCINNATIENSIS, *Hall.* 24th Rep. New York State Cab. Nat. Hist., 1872, p. 227, pl. 7, fig. 28.
LYRODESMA CINCINNATIENSIS, *Hall and Whitfield.* Geol. Surv. Ohio, Pal. 2, 1875, p. 82, pl. 1, fig. 25.

A species of *Lyrodesma* occurs which differs from *L. poststriatum* in the shorter form, the ratio of height to length being about 1:1.2. The anterior extremity is regularly rounded, curving into the more broadly rounded basal margin which is obtusely pointed at the postero-basal angle. The umbonal ridge is sub-angular, extending from the beak to the postero-basal margin. The cardinal slope is narrow and is marked in most cases by eight or nine strong radiating striae, although in one specimen there are but five or six. The number of crenulated teeth given for this species is six. It cannot be stated with certainty that this number holds for the shells here referred to this species, the identification being based upon external form. However, one impression is observed, the hinge plate of which carries six distinct teeth, with indications of two more.

The measurements of the specimen here figured are: length 16 mm., height 14.5 mm.

*Locality.*—Humber River region, Toronto.
No. 986 H.R., Royal Ontario Museum of Paleontology.

Family MODIOLOPSIDAE

Genus COLPOMYA, *Ulrich*

COLPOMYA, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 659; Geol. Minn. 3, pt. 2, 1897, p. 522.

The distinctive external characteristics of this genus are the prominent strongly convex umbonal ridge and the very distinct mesial sulcus. These characteristics separate the genus externally from the closely related genera *Modiolopsis*, *Modiolodon,* and *Orthodesma.* Internally *Colpomya* is characterized by its peculiar dentition. The hinge plate, which is thin behind the beaks and much heavier in front of them, is straight and long. A tooth-like projection from beneath the beak of the right valve fits into a corresponding depression in the left valve. Beneath this depression a strong process projects downward, backward, and toward the right valve; its upper part fits into a socket on the anterior side of the tooth of the right valve, while its lower end curves under that tooth. The adductor scars are large, the anterior strongly defined and the posterior faintly impressed. The pallial line is simple.

Of this genus but one species has been identified from our collections.

### Colpomya faba pusilla, *Foerste*
Plate V, Figure 2.

Colpomya faba pusilla, *Foerste.* Bull. Sci. Lab. Denison Univ., Vol. 17, 1914, p. 275, fig. 10: pl. 3, figs. 4a-b.
Modiolopsis faba, *Hall.* Pal. New York 1, 1847, pl. 82, figs. 4a-b.
Colpomya faba pusilla, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 6, 9, 42.

Foerste describes this variety in the following terms:

Greatest length of largest specimens known about 10 mm., cardinal margin straight for a distance of about 5 mm. posterior to the beak, rounding into the oblique posterior margin of the shell. There is considerable variation in the obliquity of this posterior margin; in the shells having a more vertical posterior margin, the length of the straight hinge line posterior to the beak may equal nearly 6 mm., while in the shells having a strongly oblique posterior margin the straight hinge line may extend but slightly more than 4 mm. beyond the beak. Mesial sulcus strongly defined from the beak to the basal margin, its deepest part forming an angle of about 70 degrees, varying in some shells to 60 degrees, with the cardinal outline. Anterior to the mesial sulcus the shell is only moderately convex. Posterior to this sulcus, however, along the umbonal ridge, the shell is strongly convex, this convexity becoming almost angular toward the beak. The angle between the umbonal ridge and the cardinal margin varies usually between 40 and 45 degrees. Anterior margin more narrowly rounded, extending about 2 mm. anterior to the beak.

Maximum length measured diagonally 10 mm., height posteriorly between 5.5 and 6 mm., height at the beak about 4.5 mm., but varying from a little less to a little more than this height; convexity of the single valve, about 1.75 mm. in shells showing the strongest convexity.

Surface with very fine concentric striae, visible under a lens. Interior with a small muscular scar near the upper anterior margin; hinge unknown, and hence the generic reference is based merely upon the general appearance of the exterior of the shell. . . . .

Compared with typical *Colpomya faba,* the valves of *Colpomya pusilla* are relatively higher posteriorly and lower at the beak, owing to the stronger divergence of the basal margin from the cardinal outline, amounting frequently from 30 to 35 degrees. The beak projects more distinctly above the cardinal margin, and the cardinal part of the anterior margin rises more nearly to the level of the straight cardinal outline of the shell posterior to the beak. The mesial sinus begins at the beak as a depression near the middle of the umbones; it tends to be more oblique than in *Colpomya faba,* but, as a matter of fact, the Lorraine form is scarcely distinguishable from the Trenton types.

This little shell is quite variable in outline in different specimens, but the straight, somewhat alate, posterior cardinal margin, the sharply defined mesial sulcus, and the marked convexity of the shell between the mesial sulcus and the post-umbonal slope, remain constant features.

The measurements of the specimen figured are: length 7 mm., height 4 mm.

*Locality.*—Below 8-foot level Don brickyard, Toronto.
No. 980 H.R., Royal Ontario Museum of Paleontology.

### Colpomya faba (*Emmons*)

Nuculites faba, *Emmons.* Nat. Hist. New York, Geol. 2, 1842, p. 385, fig. 5.
Modiolopsis faba, *Hall.* Pal. New York 1, 1847, p. 158, pl. 35, figs. 6a-d.
Cymatonota, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 661.
Colpomya faba, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 51, 55, 75.

Foerste mentions *C. faba* as occurring in a river bank near Weston, three miles northwest of Toronto. After a careful examination of the many specimens in our collections, I have found none which do not with greater probability fall under the variety described above.

### Genus Cymatonota, *Ulrich*

Cymatonota, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 661.

Ulrich describes this genus as follows:

Elongate solen-like shells, gaping more or less at both ends, with the hinge line long and extending in a straight line anterior and posterior to the small beaks: ventral and dorsal margins subparallel. Hinge plate very thin, edentulous; valves united by a delicate linear external ligament seemingly extending the full length of the hinge. Test very thin, marked externally with fine concentric lines, and on each side of the hinge line by short wave-like furrows. Pallial line and muscular scars so faintly marked that even in the best preserved specimens they cannot be made out with certainty.

Shells of this genus are fairly common in most of the horizons examined: they seem to belong to four species.

### Cymatonota pholadis (*Conrad*)
Plate IV, Figure 6.

Pterinea pholadis, *Conrad.* 2nd An. Rep. Geol. Sur. New York, 1838, p. 118.
Orthonota pholadis, *Hall.* Pal. New York, 1, 1847, p. 299, pl. 82, fig. 6.
Orthonota parallela, *Billings.* Geol. Canada, Geol. Surv. Can., 1863, p. 216, fig. 224.
Cymatonota pholadis, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 663.
Cymatonota pholadis, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 291, pl. 3, fig. 7.
Cymatonota pholadis, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 9, 38, 51, 53, 55, 64.

Conrad's description as quoted by Hall follows:

Shell profoundly elongated, ventricose; dorsal and basal margins parallel; posterior side rugose or with short undulations near the dorsal margin. Length one and three-quarter inches.

Hall also states that it resembles *Orthonota parallela* but is much more elongated and proportionately narrower. Ulrich refers to this species as follows:

*Cymatonota pholadis,* or at any rate a form that we identify with Conrad's *Orthonota pholadis,* is closely related and associated in the same beds with *Cymatonota recta.* It is, however, a more elongate shell, the length being quite five times the height, while its valves are more convex, giving the entire shell a subcylindrical appearance that is quite foreign to *C. recta.*[1]

This species differs further from *C. recta* in that the anterior end is more sharply rounded, the beaks smaller, the umbonal ridge slightly better developed, and the oblique folds on the cardinal margin much more conspicuous than in *C. recta.*

[1] Geol. of Ohio, 7, 1893, p. 663.

In connection with this species Foerste makes the following remarks:[1]

In view of the fact that *Cymatonota pholadis* and *Cymatonota parallela* both come from the same type locality, i.e. Pulaski, and that specimens referred to the latter are common while no other specimen having the exact dimensions of *C. pholadis* have ever been found in New York subsequent to the original description, it becomes pertinent to inquire if *Cymatonota pholadis* may not have been an aberrant specimen of *Cymatonota parallela.* In the absence of the type of *Cymatonota pholadis,* which had been lost apparently even before Hall wrote his work, this question cannot be answered with absolute certainty, but it is extremely probable that the type of this species was merely a compressed specimen of the species later described by Hall as *Orthonota* (*Cymatonota*) *parallela.*

From material collected from this district there appear to be two distinct species, one having a height of one-quarter its length, and the other a height of one-third its length. The more elongate specimens are herein referred to *C. pholadis,* although they show a relationship of 1:4, whereas Conrad's figure indicates a relationship of 1:5. It is possible that Conrad was dealing with an unusually elongate specimen. This opinion is strengthened by the fact that in the collections of the Royal Ontario Museum of Palaeontology there is a specimen, No. 174 R.S., which has almost exactly the proportions indicated by Conrad's figure. Further, its total length is only 4 mm. less than that of the specimen figured by Conrad (41 to 45 mm.).

The form figured by Billings and called by him *Orthonota parallela* agrees in all essentials with the form here called *Cymatonota pholadis.*[2]

The specimen figured herein resembles very closely Foerste's figure, the dimensions and outline being practically identical.[3] In the text accompanying this figure, Foerste describes the specimen as follows:

Basal margin straight, nearly parallel to the cardinal margin. Posterior margin oblique. Concentric striae below and anterior to the umbonal ridge. This ridge is distinct anteriorly but becomes more rounded posteriorly. Oblique folds or undulations along the hinge line conspicuous.

The dimensions of the specimen figured herein are: length 32 mm., height at beak 8 mm., height posteriorly 9 mm.

*Locality.*—Don brickyard, Toronto.
No. 995 H.R., Royal Ontario Museum of Paleontology.

### CYMATONOTA PARALLELA (*Hall*)
Plate IV, Figures 10 and 11.

ORTHONOTA PARALLELA, *Hall.* Pal. New York 1, 1847, p. 299, pl. 82, figs. 7b-c (not 7a, d).
CYMATONOTA PARALLELA, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 8, 9.

Hall's original description of this species is as follows:

Shell extremely elongated and very narrow; anterior extremity rounded, and contracted just forward of the beaks; cardinal margin straight or gently arched; posterior extremity rounded, broader than the anterior; basal margin slightly arcuate; beaks near the anterior extremity having an obscure carina, extending obliquely towards, but not reaching, the posterior basal margin; surface marked by fine concentric striae and a few oblique strong wrinkles along the dorsal margin.

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[1] Bull. Sci. Lab. Denison Univ., 17, 1914, p. 292.
[2] Billings, Geol. Canada, Geol. Surv. Can., 1863, p. 216, fig. 224.
[3] Bull. Sci. Lab. Denison Univ., 17, 1914, pl. I, fig. 14.

This shell bears considerable resemblance to *O. pholadis,* but is less extended. and has a greater width. The width in this species is fully one-third the length, while in the figure of *O. pholadis* the width is less than one-fourth the length. In specimens which are imbedded in shale and much compressed, the surface is regularly convex, and the oblique elevated carina becomes obsolete. The cast is smooth, with scarcely any evidence of the oblique folds on the cardinal margin.

In regard to Hall's statement that the cast is smooth it is pertinent to remark that the casts figured as 7a and 7d, plate 82 of his work, are not casts of *Orthonota* (*Cymatonota*) *parallela,* and that his statement in this respect must, therefore, be disregarded. Figs. 7b and 7c are of *Orthonota* (*Cymatonota*) *parallela.* After examining the original Dr. Foerste states that figure 7c of the above work should be prolonged in the lower part of its posterior margin.

The specimen represented by Plate IV, Figure 10, is a somewhat compressed right valve imbedded in arenaceous shale. It resembles Hall's figure. amended as above by Foerste, and has the following dimensions: length 19 mm., height 6 mm.

In his "Lorraine Faunas of New York and Quebec" Dr. Foerste refers to a species of *Cymatonota* from a locality a mile east of Pulaski, in the following words:

Concentric striations most distinct along the anterior third of the shell, becoming broader and sharply defined posteriorly. Along the umbonal ridge and posterior cardinal slopes, the concentric striae usually are faint.

Our collections contain one specimen, represented by Plate IV, Figure 11. to which this description of the striations applies very well. The shell is much less compressed than in the specimen shown in Figure 10; it has a more marked convexity and a more prominent umbonal ridge. The cardinal folds are most strongly defined for a distance of 11 mm., becoming lower and broader posteriorly. The dimensions of the specimen are: length 16 mm., height at beak 6 mm., height posteriorly 6.5 mm.

In both specimens figured the ratio of height to length is about 1:3, a proportion stated by Hall to maintain in *C. parallela.* The decided difference in this respect shown by the specimens herein referred to *C. pholadis* tends to confirm Hall's opinion as to the distinctness of the two species. A further confirmation is found in the observation that the specimens of *C. parallela* occur at Toronto in higher levels than *C. pholadis.*

It is worthy of note also that all our specimens of this species are much smaller than the type, the greatest length observed being 19 mm.

*Locality.*—4-foot level, old shale pits, Lambton (Figure 10).
Humber river, Toronto (Figure 11).
Nos. 981 and 982 H.R., Royal Ontario Museum of Paleontology.

### Cymatonota recta, *Ulrich*
Plate IV, Figure 8.

Cymatonota recta, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 662, pl. 55, figs. 8 and 9.
Cymatonota recta, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 42, 45, 47.

Ulrich's description of *C. recta* depends for its value largely on the comparisons which he draws with other species of the genus. A brief description of the species, founded on our Toronto material, follows: shell elongate, with dorsal and ventral margins parallel; height to length 3:11; anterior end rather uniformly rounded; posterior margin oblique; beaks not very prominent, situated about one-fifth of the length of the shell behind the anterior extremity; umbonal ridge and mesial sulcus but slightly developed: ventral margin, except at the ends, perfectly straight. Dimensions: length 44 mm., height 13 mm.

Compared with *C. typicalis*, Ulrich, the length is relatively greater, the anterior margin is more uniformly rounded and the posterior margin straighter above, causing a sharper post-cardinal angle; the umbones are smaller and not so distinct from the cardinal region on each side of them. The chief difference, however, consists in the much slighter development of the umbonal ridge and mesial sulcus.

*C. recta* is not uncommon in the Toronto district, and occurs in both the Don and Humber valleys.

*Locality.*—Don brickyards, Toronto.
No. 654 H.R., Royal Ontario Museum of Paleontology.

### CYMATONOTA LENIOR, *Foerste*
Plate IV, Figure 13.

CYMATONOTA LENIOR, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 290, pl. 1, fig. 9.
CYMATONOTA LENIOR, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 75, 150, 153.

Foerste's description of this species follows:

Shell with the general aspect of a *Cymatonota* but with the oblique wrinkles along the hinge line, posterior to the beaks. The hinge line is straight for a distance of at least 37 mm. from the beak, and possibly farther, rounding into the posterior margin of the shell. The latter is rounded. The basal margin is straight as far as a point directly beneath the beak, thence it curves upward toward the anterior margin, which is most convex near its junction with the anterior part of the cardinal outline of the shell. The shell enlarges only moderately posteriorly, the basal margin being subparallel to the hinge line. Umbonal ridge weakly defined even within 15 mm. of the beak, and rounding posteriorly into the general convexity of the shell. Concentric striae most distinct along the anterior parts of the shell, and also along the base; less conspicuous along the posterior border; and rather indistinct along the umbonal ridge and over most of the post-umbonal slope.

Length 70 or 71 mm., greatest height posteriorly 22 mm., height at beak 16 mm., extension of shell anterior to beak estimated at 12 mm., convexity of the single valve about 4 mm.

Foerste lists this species as occurring along the Humber River at Weston.[1] Our collections from Weston are rather meagre at present, and do not contain any undoubted examples of this species: in fact only two very imperfect specimens can possibly be ascribed to it. The figure herein given is reproduced from Foerste's original.

### Genus MODIOLODON, *Ulrich*

MODIOLODON, *Ulrich*. Geol. Minn., 3, pt. 2, 1897, p. 521; Geol. Surv. Ohio, 7, 1893, p. 652.

This genus is characterized by a hinge very similar to that of *Ischyrodonta*, and by a shell of the same composition as that of *Modiolopsis*.

Of this genus two species are identified from our rocks, one of fairly certain identification, *M. suboralis*, and another which is provisionally referred to *M. poststriatus* of Foerste.

[1] Geol. Surv. of Can., Mem. 83, 1916, p. 75.

## MODIOLODON SUBOVALIS, *Ulrich*
Plate IV, Figure 12.

MODIOLODON SUBOVALIS, *Ulrich*. Geol. Ohio, 7, 1893, p. 655, pl. 51, figs. 11-13.

Ulrich's description of this species is as follows:

Shell, as seen in casts of the interior, subovate, highest posteriorly, rather compressed-convex, thickest a little above the middle, the height and length about as two is to three; length varying in different specimens between 35 mm. and 50 mm. Dorsal outline slightly arcuate; posterior margin somewhat oblique, generally a little straightened (scarcely truncate) in the upper half and well rounded in the lower, at other times more uniformly curved; base broadly rounded, ascending anteriorly; anterior end very short and small, regularly curved. Beaks very small, scarcely distinguishable, situated far in front; no distinct umbonal ridge; mesial sulcus comparatively deep in the umbonal half, not sharply defined however anywhere. Anterior muscle scar very faint, prominent, occupying about half of the small anterior end; pallial line moderately distinct, submarginal posterior scar very faint.

This species is closely related to *Modiolodon truncatus*, Hall, but has a more nearly oval outline and deeper umbonal sulcus. It is not a common fossil in the Toronto region.

*Locality.*—Humber River region, Toronto.
No. 1004 H.R., Royal Ontario Museum of Paleontology.

## MODIOLODON *cf.* POSTSTRIATUS, *Foerste*
Plate IV, Figure 9.

MODIOLODON POSTSTRIATUS, *Foerste*. Bull. Sci. Lab. Denison Univ., Vol. 17, 1914, p. 294, pl. 1, fig. 7.
MODIOLODON POSTSTRIATUS, *Foerste*. Geol. Surv. Canada, Mem. 83, 1916, p. 138.

Foerste describes this species in the following terms:

Cardinal margin slightly convex, joining the posterior outline, rather abruptly, at an angle of about 65 or 70 degrees. The basal margin diverges from the cardinal margin at an angle of about 15 degrees, rounding rapidly into the posterior margin and into the anterior outline. The umbonal ridge is rather poorly defined in the specimen at hand. The anterior muscular area is strongly defined. Posteriorly, above the umbonal ridge, the shell is strongly marked by striae which are parallel to the posterior margin; of these striae there are about 9 in a length of 5 mm. Elsewhere on the shell there are only faint indications of concentric striae.

Length 35 mm., height posteriorly 20 mm., height at beak 14 mm., extension of shell anterior to the beak about 3 or 4 mm. . . . .

This species is probably closely related to *Modiolodon truncatus*, Hall, and *Modiolodon subovalis*, Ulrich. At least it presents a similar outline, but there is no evidence of the presence of teeth near the beak.

In our collections there is only one specimen, probably, but not certainly, from the Don brickyard, which, in spite of great imperfections, may be ascribed to this species. The specimen is not complete and apparently has been so crushed that the cardinal margin does not show the convexity. Between the umbonal slope and the basal margin there is a marked concavity which, also, may be due to crushing. The reference of the shell to *M. poststriatus* is based principally on the distinct and strongly defined striae, above the umbonal ridge posteriorly.

The figure is reproduced from that given by Foerste (*op. cit.*).

## Genus Modiolopsis, *Hall*

Modiolopsis, *Hall*. Pal. New York, 1, 1847, p. 157.
Modiolopsis, *Ulrich*. Geol. Minn., 3, pt. 2, 1897, p. 502.

Ulrich's description of this genus follows:

Shell more or less elongate, usually subovate, widest posteriorly; valves moderately ventricose, closing tightly all around. Beaks small, near the anterior extremity; umbones depressed by a flattening or depression which crosses the valves obliquely and widening causes a straightening or sinuation of the basal outline. Hinge of moderate strength, rarely straight, generally somewhat arcuate, without well-marked teeth; an obscure oblique thickening beneath the beak of one valve and a corresponding depression in the other occasionally distinguishable. Ligaments linear, external and internal, chiefly the former. Anterior adductor impression subovate, large, deep, sharply defined on the inner side, occupying the greater part of the small anterior end. Posterior scar very faintly impressed, large, subcircular, situated near the centre of the posterior third of the cardinal slope. Pallial line simple. Anterior pedal muscle forming a minute pit in the under side of the hinge plate beneath the beak. Posterior pedal muscles large, attached just above and in front of the adductor.

Our rocks contain three species of this genus, *M. modiolaris*, *M. concentrica*, and *M. postplicata*.

### Modiolopsis modiolaris (*Conrad*)
Plate III, Figure 1.

Pterinea modiolaris, *Conrad*. 2nd Ann. Rep. Geol. Surv. New York, 1838, p. 118.
Modiolopsis modiolaris, *Hall*. Pal. New York 1, 1847, p. 294, pl. 81, figs. 1a-g; pl. 82, fig. 1.
Modiolopsis modiolaris, *Billings*. Can. Nat. & Geol., 1, 1856, p. 44, fig. 8; Geol. of Canada, Geol. Surv. Can., 1863, p. 213, fig. 217.
Modiolopsis modiolaris, *Chapman*. Can. Jour., n.s., 7, 1862, p. 117, fig. 3; ibid., 8, 1863, p. 206, fig. 206; Expos. Min. Geol. Canada, 1864, p. 120, fig. 3; p. 178, fig. 206.
Modiolopsis modiolaris, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 281, pl. 3, fig. 1; pl. 5, figs. 1, 2.
Modiolopsis modiolaris, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 7, 9.

A description of this species, as given by Hall, follows:

Somewhat obliquely oblong-ovate, narrowed before, expanded and obliquely truncated posteriorly; basal margin usually contracted or slightly arched upwards; cardinal line extended, straight, or slightly curved; beaks moderately prominent, near the anterior extremity; an oblique scarcely defined ridge, extending to the posterior basal margin; surface marked by fine concentric undulations; muscular impression distinct, close to the anterior extremity.

Considerable variation is to be observed in the size and in the detail of shape of shells ascribed to this species. The most characteristic features, which can be depended upon to differentiate it from other similar shells, are: (*a*) the much greater height posteriorly as compared with many species of *Rhytimya*, which small examples somewhat resemble externally; (b) the elongated and narrow anterior region; (c) the absence of any plications other than the concentric markings, which serves to differentiate it from the genus *Whiteavesia*.

This is an extremely common species in the Toronto rocks, particularly in the lower levels of the Don brickyards.

The dimensions of the specimen figured are: length 76 mm., height at beaks 26.5 mm., posterior height 31 mm.

*Locality.*—Lower 8-feet Don brickyard, Toronto.
No. 1029 H.R., Royal Ontario Museum of Paleontology.

### MODIOLOPSIS CONCENTRICA, *Hall and Whitfield*
Plate V, Figure 4.

MODIOLOPSIS CONCENTRICA, *Hall and Whitfield.* Geol. Surv. Ohio, Pal. 2, 1875, p. 86, pl. 2, fig. 18.
MODIOLOPSIS CONCENTRICA, *Ulrich.* Geol. Minn., 3, pt. 2, 1897, p. 510, pl. 37, figs. 15 and 16.
MODIOLOPSIS CONCENTRICA, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 283.
MODIOLOPSIS CONCENTRICA, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, pp. 24, 25, 47, 75, 90, 91, 130, 131, 133, 134, 135, 138.

The original description of this species, as given by Hall and Whitfield, is as follows:

Shell of medium size; elongate ovate in outline; broadest near the posterior end and contracted in front of the beaks. Hinge line arcuate, gradually declining toward the extremity and rounding into the posterior margin, which is more sharply rounded below than above the middle; basal line gently curved, becoming a little sinuate at or about the anterior third of its length; anterior end narrowly rounded. Beaks small, and compressed on the back, projecting but little above the hinge. Surface of the valves moderately convex when not distorted by pressure; most prominent about the umbonal ridge, which is low, and broadly rounded; not forming a conspicuous feature of the valve. A very slight and rather undefined mesial sulcus crosses the valves from the beak to the sinus of the basal margin.

Surface of the shell marked on the cardinal slope and posterior end by regular, even; concentric furrows, from three to four of which occupy the space of one-eighth inch in their strongest parts. These furrows are most distinctly marked near the cardinal margin and become obsolete in crossing the umbonal ridge; existing on the basal portions and anterior end only as fine, irregular, concentric striae of growth. Anterior muscular impressions strongly defined and proportionally large; forming a rather distinct, subcircular or reniform protuberance on the anterior end of the casts; posterior impression not observed; pallial line often distinct on the anterior half; partly composed of detached transverse pustules.

Foerste in describing a specimen from Chambly, Quebec, states:

The curvature of the shell along the hinge line passes gradually into that of the strongly deflected posterior outline, as in *Modiolopsis concentrica*, but the concentric plications along the post-umbonal parts of the shell are far less conspicuous, the umbonal ridge is flatter, the area which should be occupied by a mesial sulcus is scarcely concave, and the basal margin of the shell is scarcely concave.[1]

This description agrees well with the specimen figured here, but it must be stated that other shells from this locality show a more rounded umbonal ridge, a distinct mesial sulcus, and conspicuous concentric plications along the post-umbonal slope, as in the type.

There is in the collections a cast of the interior resembling Ulrich's figure.[2] This specimen has in addition to the ridge defining the posterior side of the mesial sulcus a shorter secondary ridge, starting from practically the same point as the first ridge and extending toward the basal margin. The mesial sulcus is unusually well defined. Should further collecting reveal other forms with these characteristics it may prove to be distinct from *M. concentrica,* at least varietally.

*M. concentrica* may be distinguished from *M. modiolaris* by its smaller size, by the stronger posterior concentric plications, by the presence of a mesial sulcus, and by the fact that in *M. modiolaris* the anterior margin extends conspicuously in front of the beaks.

Measurements of the specimen here figured are: length 43.5 mm., height, 16 mm.

*Locality.*—17-foot level Humber River cut.
No. 994 H.R., Royal Ontario Museum of Paleontology.

[1] Bull. Sci. Lab. Denison Univ., 17, 1914, p. 283.
[2] Geol. Minn., 3, pt. 2, 1897, pl. 37, fig. 16.

### MODIOLOPSIS POSTPLICATA, *Foerste*
Plate V, Figure 9.

MODIOLOPSIS POSTPLICATA, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 284, pl. 1, fig. 4.
MODIOLOPSIS POSTPLICATA, *Foerste.* Geol. Surv. Can., Mem. 83, 1916, p. 15.

Foerste describes this species as follows:

Hinge line arcuate posterior to the beak, gently declining toward the posterior extremity, and gradually rounding into the oblique posterior margin; umbonal ridge broad and low, rounded rather than angulate; mesial sulcus shallow, forming an undefined depression across the valves from the beak toward a point slightly anterior to the middle of the basal margin, where the latter is slightly concave; cardinal or post-umbonal slope marked by regular, even, concentric plications becoming obsolete toward the crest of the umbonal ridge; these plications mark successive growth stages of the posterior margin of the shell; there are about 5 plications in a length of 5 mm., increasing to 6 in the same length posteriorly; within 10 mm. from the posterior margin, fine concentric striae are seen in addition to the plications. Concentric striae are present also on the areas below the umbonal ridge; these striations are faint posteriorly, but become more sharply defined anteriorly, where they also are more crowded. The valves probably were very thin, since not only the position of the anterior muscular scar, but also that of the anterior part of the pallial line, for a distance of 10 mm., is distinctly indicated. Both the cardinal and the basal margins are curved, the curvature of these margins being approximately equal, the margins being subparallel.

Length 58 mm., height 18 mm., height at beak 16 mm., extension of shell anterior to the beak about 10 mm., convexity of the single valve about 4 mm.

The collections contain several casts of interiors which are referred to this species. One of these specimens in particular shows the post-umbonal plications very well. Two of the specimens have a less strongly arcuate outline posterior to the beaks and are, consequently, broader posteriorly. The anterior ends of the casts are not well preserved, but would appear to be approximately as in the type. One specimen from the Humbervale quarry has practically the same dimensions as the type, although unfortunately the terminations are imperfect. Each of the specimens at hand possesses a strong external ligament, both valves being present in each case.

The figure here given is copied from Foerste, on account of the imperfect anterior terminations of our shells.

*Locality.*—Humber River region.

### Genus ORTHODESMA, *Hall and Whitfield*

ORTHODESMA, *Hall and Whitfield.* Pal. Ohio 2, 1875, p. 93.
ORTHODESMA, *Ulrich.* Geol. Minn. 3, pt. 2, 1897, p. 516.

Ulrich defines this genus as follows:

Shell elongate, usually increasing slightly in height posteriorly. Anterior end comparatively long, contracted in front of the beaks. Valves moderately convex, usually with a strong umbonal ridge and a broad mesial depression in front of it, their edges fitting tightly along the straight or sinuate ventral margin, but leaving a narrow gape at each end. Umbones prominent, wide, compressed, often extending posteriorly as low cardinal ridges between which the hinge is sunken. Hinge plate edentulous, very thin, long, extending in almost a straight line from the posterior cardinal angle, past the beaks, nearly to the anterior extremity of the shell. Ligament linear, internal and external, the latter chiefly. Posterior muscular scar large, very faint, elongate ovate; anterior scar large, though scarcely half the size of the posterior, well defined, ovate or approaching semicircular in shape, the vertical diameter the longest. Pallial line simple. Shells thin, marked externally with more or less distinct concentric striae and wrinkles.

Our rocks contain examples of five known species of this genus.

### ORTHODESMA APPROXIMATUM, *Foerste*

Plate V, Figure 10.

ORTHODESMA APPROXIMATUM, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 285, pl. 1, fig. 5.
ORTHODESMA APPROXIMATUM, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, p. 43.

Foerste's original description of this species is as follows:

Shell probably closely related to *Modiolopsis postplicata*, but differing in the absence of conspicuous plications on the post-umbonal slopes. If this species is an *Orthodesma* it belongs to the *Orthodesma curvatum* group. The cardinal margin is slightly curved posteriorly. Excepting near the beak, the umbonal ridge is distinguished only faintly from the general convexity of the shell, and the mesial sulcus is nearly obsolete. The surface is marked by faint concentric striations and wrinkles, which are most distinct below and anterior to the beak. Along the post-umbonal slopes, when held in a very oblique light, very faint concentric wrinkles, about 8 or 9 in a length of 5 mm., may be seen, but it is difficult to imagine these as suggesting identity of the form here described as *Orthodesma approximatum* with *Modiolopsis postplicata*. The position of the anterior muscular scar and of the adjacent part of the pallial line, for a distance of about 10 mm., is distinctly indicated. The general appearance of the shell is smoothish. From the cardinal side of the umbonal ridge, near the beak, a low angulation extends backward, gradually deviating from the cardinal margin, until at a distance of 30 mm. from the beak it is fully 2.5 mm. from this margin. Above this angulation the surface along the cardinal margin is concave, as though the cardinal parts of the two valves had been more or less appressed posteriorly.

Length about 50 mm., height 19 mm., height at beak 17 mm., extension of shell anterior to the beaks 8 or 9 mm., convexity of a single valve about 5 mm.

In the collections of the museum there are three specimens, two from the Don Valley brickyard and one from the Humber River region, which are referable to this species. The latter is, except at the posterior extremity, an excellently preserved cast of the interior in limestone. The positions of the anterior muscle scar and the pallial line for a distance of 15 mm. are clearly shown. It differs from the type in its relatively shorter form, the ratio of height at beak to length being about 1 : 2.8, whereas in the type it is about 1 : 3.5; in the practical absence of the angulation along the cardinal slope; in the slightly straighter posterior cardinal margin; and in the fact that the concentric markings along the post-umbonal slopes, though certainly not conspicuous, can scarcely be said to be "very faint." The dimensions of this specimen are: length 40 mm., height at beak 14 mm., height posteriorly 15 mm.

A specimen imbedded in shale and of practically the same dimensions as the foregoing shows well the concentric striations and wrinkles, which are most distinct below and anterior to the beak. In this specimen the post-umbonal markings might more justly be said to be "very faint."

This species is very similar in outline to *Orthodesma canaliculatum* of Ulrich, but is distinguished by the distinct concentric markings along the post-umbonal slope; by the lack of radiating striae on the mesial sulcus, which is more distinctly defined; and by the fact that *O. canaliculatum* has never been reported as found with valves separate.

*Locality.*—Humber River region.
No. 954 H.R., Royal Ontario Museum of Paleontology.

ORTHODESMA NASUTUM (*Conrad*)
Plate V, Figure 3.

CYPRICARDITES NASUTA, *Conrad*. 5th Ann. Rep. New York Geol. Surv., 1841, p. 52.
MODIOLOPSIS NASUTUS, *Hall*. Pal. New York 1, 1847, p. 159, pl. 35, fig. 7; p. 296, pl. 81, fig. 2.
ORTHODESMA NASUTUM, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 286, pl. 3, fig. 5; pl. 5, fig. 3.
ORTHODESMA NASUTUM, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 7, 68, 75.

The species is defined as follows: posterior cardinal and basal margins subparallel; posterior margin oblique; greatest height at about centre of shell, narrower at the beak, due to the dropping of the cardinal margin; beaks not prominent; umbonal ridge weakly defined, rounding into the general convexity of the shell; no perceptible mesial sulcus. The characteristic feature of this shell is the downward slope of the anterior cardinal margin.

This species, which is not common in the Toronto region, has been found in the vicinity of the Humber river, but not yet from the Don valley.

The dimensions of the specimen figured are: length 41.5 mm., height 15 mm.

*Locality*.—10-foot level Humbervale quarry.
No. 993 H.R., Royal Ontario Museum of Paleontology.

ORTHODESMA *cf.* RECTUM, *Hall and Whitfield*
Plate V, Figure 6.

ORTHODESMA RECTA, *Hall and Whitfield*. Pal. Ohio, 2, 1875, p. 94, pl. 2, figs. 7, 8.

The original description of this species follows:

Shell elongate, solen-like in outline, two and a half to three times as long as wide, the cardinal and basal lines posterior to the beaks straight and parallel: anterior end abruptly contracted beneath the beaks to one-half the width of the body of the shell, somewhat extended and abruptly rounded at the extremity; posterior end as broad as the body of the shell, obliquely rounded, longest at the postero-basal angle, and gently sloping backwards to the extremity of the hinge line; beaks small and compressed; surface of the valves between the umbonal ridge and the anterior contracted portion depressed, forming a broad, shallow, and undefined sulcus, strongest toward the beaks, and becoming obsolete or lost in the general flattening of the shell, before reaching the basal line, in which it scarcely produces any perceptible feature.

The surface of the valves is marked by irregular, concentric lines of growth, and by several stronger undulations, which become somewhat regular on the posterior slope for a short distance below the hinge line. There are also appearances of one or two obscure secondary ridges on the cardinal slope between the umbonal ridge and the cardinal margin, extending from near the beak to the posterior end of the shell. This latter feature is extremely faint, and may be often not observable.

Three of our specimens are referable, provisionally at least, to this species, but the very imperfect condition of the shells does not warrant a certain identification.

The figure here given is copied from Hall and Whitfield.

*Locality*.—Humber River region.

ORTHODESMA SUBANGULATUM, *Ulrich*
Plate III, Figure 5.

ORTHODESMA SUBANGULATUM, *Ulrich*. Geol. of Ohio, 7, 1893, p. 660, pl. 55, figs. 21-23.

The original description is as follows:

This species is closely related to *O. rectum*, H. and W., the type of the genus, but may be distinguished by a number of minor differences, chiefly in the matter of outline. The shell is more elongate, the posterior height being less and only about one-third of the entire length. The ventral margin is straighter, and sinuate rather than convex, while the central and dorsal outlines are more nearly parallel. The anterior end is uniformly rounded, instead of being oblique with the most prominent point in the upper part. Finally the posterior margin is a little less oblique. Of other differences we may mention that the umbones seem to have been somewhat smaller and merely flattened instead of sulcate, while the umbonal ridge is stronger and more curved.

The various collections in the museum contain a half dozen specimens referable to this species: they are all from the Humber region.

The drawing here given has been copied from Ulrich's figure.

*Locality.*—Humber River region, Weston.

## ORTHODESMA *cf.* PARVUM, *Ulrich*

Plate III. Figure 2.

ORTHODESMA PARVUM, *Ulrich.* Geol. of Ohio, 7, 1893, p. 660, pl. 55, figs. 19-20.

Ulrich describes this species as follows:

Shell small, elongate, about 22 mm. long, 7 mm. high at the beaks, and 7.5 mm. near the uniformly rounded posterior end; greatest thickness subcentral, about 5 mm.; anterior end narrowly rounded, almost acute; back straight, base straight in the middle, on the whole very gently convex. Beaks small, not prominent, situated about one-fourth of the length of the shell behind the anterior extremity; umbones and sides of valves flattened; umbonal ridge rather distinct though not angular. About midway between the umbonal ridge and cardinal margin an obscure impressed line. Surface with comparatively coarse concentric lines, strongest and regular on the cardinal slope, faint anteriorly.

The point of greatest convexity is situated farther forward than usual in this genus but in other respects this small species seems to be a true *Orthodesma.* Of described species it is probably nearest *O. rectum,* H. & W., but as it is much smaller and not so high posteriorly, and has a more evenly rounded posterior extremity it is not likely to be confused with that species.

Two specimens from the Humber River region, although very imperfect, may possibly be referred to this species.

The drawing here given is copied from Ulrich's figure.

*Locality.*—Humber River region.

## Genus PSILOCONCHA, *Ulrich*

PSILOCONCHA, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 665; Geol. Minn., 3, pt. 2, 1897, p. 530.

Ulrich defines the genus as follows:

Shell elongate subelliptical, compressed convex, gaping slightly at both ends; inequilateral, with very small beaks, inconspicuous umbonal ridges and smooth or concentrically lined surface. Mesial depression very shallow or wanting; basal outline convex. Shell very thin; hinge plate very narrow, edentulous. Ligament internal, linear. Muscular impressions exceedingly shallow, rarely distinguishable. Anterior adductor scar small, subcircular or ovate, situated in front of the beaks and just within the hinge line. Posterior adductor about three times the size of the anterior, occupying the greater part of the middle third of the space between the beaks and the posterior extremity of the shell. Pallial line simple, more distinctly impressed in the posterior half of the shell than in the anterior.

Of this genus five species, already described, have been recognized in the Toronto rocks.

### PSILOCONCHA SINUATA, *Ulrich*
Plate V, Figure 8.

PSILOCONCHA SINUATA, *Ulrich*. Geol. Surv. Ohio, 7, 1893, p. 668, pl. 52, figs. 15 and 16.
PSILOCONCHA SINUATA, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 21, 46, 47, 64.

Ulrich describes this species as follows:

This species is associated in the same layers with *P. inornata*, but it will be distinguished from that form at once by the unusual development of the mesial depression, which is deep enough to produce a slight sinuation of the ventral margin, and gives a degree of definition to the umbonal ridge that is not equalled in any other species of the genus. The length also is relatively greater than in any of the others, being 36 mm. in a specimen 13 mm. high. Comparing other features *P. subrecta* has a differently shaped posterior outline, and *P. inornata* is more regularly rounded in front. *P. subovalis* seems to me to be the nearest, differing chiefly in its greater height and much less developed mesial depression.

The specimen here described differs from the type in the more strongly deflected cardinal margin. The umbonal ridge and mesial sulcus are, however, well defined, and the anterior margin is closely similar. It differs from Foerste's variety *P. sinuata borealis* in its more quadrangular anterior outline. The length of the specimen figured is 30 mm., the height 11 mm.

This species is found in association with *P. inornata* in the Humbervale quarries, and also in the Don brickyards.

*Locality.*—Don brickyard, Toronto.
No. 977 H.R., Royal Ontario Museum of Paleontology.

### PSILOCONCHA SINUATA BOREALIS, *Foerste*
Plate V, Figure 7.

PSILOCONCHA SINUATA BOREALIS, *Foerste*. Bull. Sci. Lab., Denison Univ., 17, 1914, p. 296, pl. 2, figs. 9a-c.
PSILOCONCHA SINUATA BOREALIS, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, p. 150.

This is a variety of *Psiloconcha sinuata* characterized chiefly by the deflection of the cardinal margin anterior to the beak; in typical *Psiloconcha sinuata* it is more in line with the posterior cardinal edge.

Compared with the type our specimen is somewhat larger and more flattened; otherwise it may be considered a more perfect example than the type.

*Locality.*—Don brickyard, Toronto.
No. 1030 H.R., Royal Ontario Museum of Paleontology.

### PSILOCONCHA INORNATA, *Ulrich*
Plate V, Figure 11.

PSILOCONCHA INORNATA, *Ulrich*. Geol. Surv. Ohio, 7, 1893, p. 667, pl. 52, figs. 11 and 12.
PSILOCONCHA INORNATA, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 45, 47.

Ulrich's description of this species follows:

Shell about 30 mm. long, by 12.7 mm. high in the middle, with regularly rounded, subequal ends, very slightly convex ventral and more strongly arcuate dorsal margin. Beaks very small, umbonal ridge and mesial depression scarcely distinguishable. Surface markings concentric, very obscure, the surface appearing almost smooth in most cases. This shell is closely related to *P. subovalis* but does not attain as great a size, is relatively longer, and has a smoother surface and more regularly rounded anterior margin. The last difference is the most important and may always be relied upon.

This species is not common in our rocks and the specimens found are not in a very good state of preservation; nevertheless, it is with some confidence that they are ascribed to this species. The dimensions of the specimen figured are: length 25 mm., greatest height 11 m.

*Locality.*—15-foot level Humbervale quarry, Toronto.
No. 979 H.R., Royal Ontario Museum of Paleontology.

### Psiloconcha subovalis, *Ulrich*
Plate V, Figure 10.

Orthodesma subovale, *Ulrich*. Jour. Cincinnati Soc. Nat. Hist., Vol. 2, 1879, p. 22, pl. 7, fig. 18.
Psiloconcha subovalis, *Ulrich*. Geol. Surv. Ohio, 7, 1893, p. 666, pl. 52, figs. 5-7.
Psiloconcha subovalis, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 295, pl. 2, fig. 15.
Psiloconcha subovalis, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, pp. 47, 150, 153.

Ulrich's description of this species follows:

Shell exceedingly thin, moderately elongate, subovate, the length equal to twice or twice and nearly a half of the greatest height; cardinal and basal margins sub-parallel; cardinal line straight for one-half the length of the shell posterior to the beaks, beyond which point it gradually curves downward to near the posterior extremity, which is rather abruptly rounded or slightly truncate; anterior end short, equal to less than one-fifth of the entire length of the shell, very slightly contracted beneath the beaks, and more regularly rounded than the posterior margin; beaks small and somewhat pointed. Surface of the valves with a faint, scarcely perceptible umbonal ridge, anterior to which there is a broad, very shallow and undefined depression, crossing the valves from the beaks toward the basal line, and becoming obsolete before reaching it. Internal markings not preserved in the specimens examined.

Surface of the valves marked by fine concentric striae, and by some stronger undulations.

This species, which is not uncommon at Toronto, is characterized by its relatively greater height, the length being usually but one mm. greater than twice the height. The specimen here figured resembles very closely the drawing in the Geology of Ohio, 1893, but the anterior end is more sharply rounded.[1]

The dimensions of our specimen are: length 31 mm., greatest height 15 mm.

*Locality.*—Don brickyard, Toronto.
No. 978 H.R., Royal Ontario Museum of Paleontology.

### Psiloconcha subrecta, *Ulrich*
Plate V, Figure 5.

Psiloconcha subrecta, *Ulrich*. Geol. Surv. Ohio, 7, 1893, p. 667, pl. 52, figs. 13 and 14.

In outline the specimen here figured closely resembles *P. subrecta* of Ulrich, but it is relatively somewhat wider than the type, its dimensions being intermediate between those of *P. subovalis* and *P. subrecta*, as shown by the following measurements:

| | |
|---|---|
| *P. subrecta*, type: | Length 31 mm., greatest height 13 mm., ratio 1 : 2.4 |
| Our specimen: | Length 39 mm., greatest height 18 mm., ratio 1 : 2.17 |
| *P. subovalis*, type: | Length 31 mm., greatest height 15 mm., ratio 1 : 2.07 |

[1] Geol. Surv. Ohio, 7, 1893, pl. 52, fig. 5.

Nevertheless, as the outline, making due allowance for the different ratio, is very similar to that of the type, this specimen is provisionally referred to *P. subrecta.*

Another specimen in the collections approaches even more closely the ratio and outline of *P. subrecta,* the dimensions being: length 56 mm., height 20 mm., ratio 1:2.30.

*Locality.*—10-foot level Humbervale quarry, Toronto.
No. 976 H.R., Royal Ontario Museum of Paleontology.

### Genus Whiteavesia, *Ulrich.*

Actinomya, *Ulrich.* Geol. Surv. Ohio, 7, 1893, p. 656; Geol. Minn., 3, pt. 2, 1894, p. 513.
Whiteavesia, *Ulrich.* Geol. Surv. Ohio, 7, 1893, Expl. pl. 56; Geol. Minn., 3, pt. 2, 1894, p. 628.

Ulrich's description of this genus is as follows:

Shell ovate, more or less elongate, narrowing anteriorly. Valves moderately ventricose, fitting each other tightly. Anterior end short, but not excessively so. Base gently convex, occasionally straight, never sinuate. Mesial sulcus wanting. Beaks comparatively large, full and rather prominent. Umbonal ridge generally strongly rounded, sometimes subangular. Surface with concentric lines of growth and often with radii or divaricating folds; the radii sometimes restricted to the inner side of the shell, showing on casts of the interior and not on the exterior of the shell itself. Muscular scars and pallial line as in *Modiolopsis,* excepting that in the majority of the species they are very faintly impressed. Hinge plate edentulous, very narrow, especially so under the beaks, a little wider and grooved on each side for the reception of a linear internal ligament. A similar external ligament probably also present.

Of this genus we have but one species, *W. pholadiformis.* in our local strata.

### Whiteavesia pholadiformis (*Hall*)
Plate III. Figure 6.

Modiolopsis pholadiformis, *Hall.* Geol. Lake Superior Land Dist., Foster and Whitney's Rep., 1851, p. 213, pl. 30, figs. 1a-e.; pl. 31, fig. 1.
Whiteavesia pholadiformis, *Ulrich.* Geol. Surv. Ohio, 7, 1893, pl. 56, figs. 21, 22.
Pholadomorpha pholadiformis, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 277; pl. 2, fig. 16; pl. 5, fig. 4.
Pholadomorpha pholadiformis, *Foerste.* Geol. Surv. Can., Mem. 83, 1916. pp. 7, 24, 25, 44. 45, 47, 75, 80, 87, 90, 92, 117, 134, 135, 138, 139, 143, 144, 149, 151, 153, 154, 157.

Foerste (*op. cit.* p. 277) describes this species in the following terms:

Cardinal and basal margins diverging at an angle of about 20 degrees. Basal margin almost straight; at a point vertically beneath the beak it rises gradually toward the strongly rounded anterior margin. The latter exceeds 12 mm. anterior to the beak. Posteriorly the cardinal margin is fairly straight for about 35 or 40 mm. and then rounds gradually into the very oblique posterior margin, forming an angle of about 130 or 135 degrees with the latter. The margin is strongly rounded at the posterior extremity of the umbonal ridge. The umbonal ridge is low and very broad; it is moderately distinct for a distance of nearly 30 mm. from the beak, but merges into the general convexity of the shell posteriorly. From this umbonal ridge the slope toward the basal margin and toward the cardinal margin is rather flat. There is no mesial sulcus anterior to the umbonal ridge. The shell is concentrically striated. These striae are most distinct along the anterior half, above this ridge, where the low transverse plications are less distinct or absent. The transverse plications cover the slope beneath the umbonal ridge almost as far to the front as the area beneath the beak, although anteriorly these plications no longer reach the basal margin of the shell. They are approximately vertical to the basal margin, although curving moderately forward on approaching the umbonal ridge. Similar low transverse plications may be detected along the cardinal margin from within 20 mm. of the beak to about 10 mm. beyond the point where the cardinal margin curves downward into the posterior margin of the shell. These plications form angles of about 70° with the cardinal margin, and the longest, posteriorly, scarcely extend more than 5 mm. from the cardinal outline. Along the basal margin, these plications number about 3 in a length of 5 mm.

The form herein figured resembles very closely that figured by Foerste (Bull. Sci. Lab. Denison Univ., 17, 1914, pl. 2, fig. 16), about which he makes the following remarks:

Essentially the same form (as above) occurs in the Lorraine at Gorrell Point, two miles northeast of the Village of Gore Bay, on Manitoulin Island, in Lake Huron. Fig. 16, on pl. 2, represents one of these specimens, collected in 1911 by Aug. F. Foerste. The angle between the cardinal and basal margins is nearer 15 degrees, and the number of transverse plications along the lower half of the shell is nearer 4 or 5 in a length of 5 mm. These differences lie easily within the range of variation of this species.[1]

There are some differences between our form and the one just described, chiefly in the apparently greater convexity of the shell and the unusually well defined surface markings, which are noticeably better developed on the posterior cardinal margin and particularly on the umbonal region than in the specimen figured by Foerste.

The dimensions of the specimen figured are: length 72 mm., height at beak 25 mm., height posteriorly 32 mm.

*Locality.*—16-foot level Humbervale quarry, Toronto.
No. 992 H.R., Royal Ontario Museum of Paleontology.

## Order ANOMALODESMACEA

### Family PHOLADELLIDAE

### Genus RHYTIMYA, *Ulrich*

RHYTIMYA, *Ulrich*. Geol. Minn., 3, pt. 2, 1897, p. 618; Geol. Surv. Ohio, 7, 1893, p. 688.

Ulrich describes the genus in the following terms:

Shell elongate, moderately ventricose, the dorsal and ventral margins subparallel, gaping slightly at one or both ends. Beaks rather prominent, situated from one-third to one-fifth of the entire length behind the anterior extremity; posterior umbonal ridge rounded, never very prominent; mesial sulcus wide, generally very shallow, often, however, causing a sinuosity in the ventral margin. Lunule very narrow, true escutcheon wanting, ligament external, attached to the edges of the valves, extending the greater part of the hinge line posterior to the beaks. Hinge apparently edentulous, test very thin. Muscular and pallial attachments exceedingly faint, not satisfactorily observed; posterior scar large. Surface marked with unequal concentric lines and furrows, gathered into a series of strong folds on the anterior end. On the posterior half or more, the ventral part especially, the concentric lines are crossed by closely arranged radiating series of small granules or spines.

Shells referable to the genus *Rhytimya* occur in some profusion in the Toronto rocks, particularly in the lower levels of the Don brickyard. Owing to the fact that these shells are of a fragile character and are usually more or less imperfect, it is frequently difficult to make specific differentiation.. The three already established species herein recorded are of fairly certain identification; a fourth species has been erected for a form which seems to be new. It is possible that the list may be extended, but hitherto the material found is of too uncertain a nature to justify a greater number of species.

[1] Bull. Sci. Lab. Denison Univ., 17, 1914, p. 277.

### RHYTIMYA GRANULOSA, *Wilson*
Plate V, Figure 12.

RHYTIMYA GRANULOSA, *Wilson*. Ottawa Naturalist, Vol. 29, No. 8, 1915, pp. 85, 86, pl. 2, figs. 1 and 2.
RHYTIMYA GRANULOSA, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, p. 64.

In describing this species the author says:

The shell is of medium size and subelliptical in outline, length and height about as 2 : 5. The valves are very slightly convex. The cardinal margin is straight posterior to the beaks for about two-thirds the length of the shell, making an angle of 45° with the anterior margin, which continues as a straight line nearly to the median transverse axis of the shell, thence curving into the anterior and basal margins. The latter margin bends slightly upward opposite the broad, weakly defined sinus. The posterior end is slightly truncated obliquely but joins the basal margin with a moderately narrow curve. The anterior margin and the straight cardinal margin form a more obtuse angle than that of the posterior end, and the curve with which it joins the ventral margin is less narrow. There is a slight constriction beneath the very moderately raised umbones. The lunule, which is evidently very narrow, is partially destroyed on the specimen examined. The sinus is very shallow, moderately broad and less oblique than in most other species of this genus. The umbonal ridges are not prominent, and become imperceptible in the posterior portion of the shell, which is almost flat. Anterior to the sinus there is a slight inflation. The concentric growth lines are very fine, but anteriorly they are gathered into about a dozen strong ridges, which end abruptly in the oblique cardinal margin. Posteriorly the ridges of growth lines almost disappear.

The most striking characteristic of the species, however, is the unique marking. A series of fine granules crosses the concentric growth lines, radiating from the umbonal region. Near the beak they are very fine, barely visible to the naked eye, but they become much stronger away from it so that in the ventral half of the shell they have almost obliterated the concentric growth lines, except anteriorly where the strong ridges of concentric growth lines are still prominent. On the dorsal half of the posterior portion of the shell there is a still more complex marking. In addition to the very fine concentric growth lines crossed by the radiating series of granules, which here are very minute, there is a very fine double network of lines running obliquely from granule to granule, forming a regular mesh, with one granule at each intersection of the lines. The lines of growth, with a gentle curve towards the posterior margin, pass from apex to apex across the longest diameter of the mesh. Some of this very fine network is worn and in places the granules appear to be shoved up together, but there is much of it that is remarkably well preserved.

The specimen here figured is only about half the size of the type, but in all other respects it is similar. While the surface markings are not quite as distinct as in the type they leave little doubt as to the identity of the forms. Under high magnification the network of lines described by Miss Wilson can be distinguished on the dorsal half of the shell.

In general shape this species somewhat resembles *R. oehana* but it may be distinguished by the fact that it is narrower in the posterior extremity than it is at the beaks, whereas in *R. oehana* the reverse is true. It also presents affinities with *R. compressa,* but it may be distinguished by the presence of a mesial sulcus, by the decided obliquity of the anterior cardinal margin, and by the more pronounced surface markings.

The measurements of the specimen here figured are: length 26 mm., height at beak 10 mm., posterior height 8 mm.

The type is a larger and better preserved specimen than the one in our collections and the type photograph brings out well the characteristic surface ornamentation.

*Locality.*—6-foot level Don brickyard, Toronto.
No. 990 H.R., Royal Ontario Museum of Paleontology.

### Rhytimya oehana, *Ulrich*

Plate V, Figure 15.

Rhytimya oehana, *Ulrich*. Geol. Surv. Ohio, 7, 1893, p. 689, pl. 56, fig. 1.
Rhytimya oehana, *Foerste*. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 307, pl. 1, fig. 11.
Rhytimya oehana, *Foerste*. Geol. Surv. Can., Mem. 93, 1916, p. 42.

Ulrich's description of this species follows:

Shell large, compressed convex, elongate-subrhomboidal, with subparallel dorsal and ventral margins, and obliquely truncate posterior margin; anterior end gently concave in front of the beaks, rounding regularly downward and backward from the obtusely angular antero-cardinal extremity which is but little beneath the line of the hinge; ventral margin distinctly though broadly sinuate, mostly in front of the middle. Beaks of moderate prominence, incurved, situated about one-fourth of the length of the shell from the anterior extremity. Mesial sulcus distinct, broad, directed obliquely backward, the part of the shell lying in front of it slightly inflated, while posteriorly the surface of the valves rises very gently into a broadly convex umbonal ridge; cardinal slope concave, compressed and subalate posteriorly. Concentric surface markings very faint on the post-cardinal third, rather strong and irregular on the anterior and lower side of the umbonal ridge and in the mesial sulcus, becoming finer as they pass over the anterior swelling and finally gathered into strong folds with fine lines between them on the antero-cardinal slope. Radial markings not preserved on the specimen described.

The chief points of difference between our specimen and the type are as follows: the greater relative height, the slighter and more anterior mesial sinus, the more truncate posterior extremity, and the convex postero-ventral margin. The fine pustules are well shown on the posterior part of the shell and there are faint indications of radiating rows of minute granules in the postero-ventral region. In the posterior extremity the Toronto specimen approaches the form described by Foerste from the Richelieu River at Chambly, Quebec. The measurements are: length 25 mm., height at beak 11 mm., posterior height 12 mm.

*Locality*.—Lower eight feet of Don Valley brickyard, Toronto.
No. 1020 H.R., Royal Ontario Museum of Paleontology.

### Rhytimya compressa, *Ulrich*

Plate V, Figure 14.

Rhytimya compressa, *Ulrich*. Geol. Surv. Ohio, 7, 1893, p. 692, pl. 56, fig. 13.
Rhytimya *cf.* compressa. *Foerste*. Geol. Surv. Can., Mem. 83, 1916, p. 42.

Ulrich describes the species in the following terms:

Shell of medium size, compressed-convex, elongate, the length two and one-half times the greatest height. Beaks small, very little prominent, about one-fifth of the entire length behind the anterior extremity; umbonal ridges very inconspicuous; mesial sulcus scarcely distinguishable. Cardinal margin long, about seven-eighths of the entire length of the shell, straight posterior to the beaks, declining very little anterior to them; anterior end wide, sharply rounded above, uniformly curved in the middle and below; ventral margin gently but almost regularly convex throughout; posterior margin oblique; strongly rounded in the lower half, subtruncate in the upper; post-cardinal extremity obtusely angular. Concentric surface markings as usual for the genus. Radial markings not shown by the specimen figured, which is the best seen.

The specimen here figured is very close to the type, but it is slightly shorter relatively, the ratio of height to length being 1 : 2.3 whereas in the type it is 1 : 2.5. The dimensions for our form are: length 19 mm., height 8.5 mm.

This species is readily distinguished from *R. oehana* and *R. granulosa* by the practical absence of a mesial sinus and by the very slight deflection of the anterior cardinal margin.

*Locality.*—Lower eight feet of the Don brickyard, Toronto.
No. 991 H.R., Royal Ontario Museum of Paleontology.

RHYTIMYA COLEMANI, *sp. nov.*
Plate V, Figure 13.

This species may be defined as follows: shell elongate: posterior cardinal margin very long and straight; anterior cardinal margin strongly oblique to the posterior margin; mesial sinus anterior in position and strongly defined. producing a sinuate ventral edge; umbonal ridge very strongly marked; concentric markings coarse for the size of the shell.

*R. colemani* resembles *R. granulosa, R. oehana, R. producta* and *R. radiata.* From *R. granulosa* it is chiefly differentiated by the stronger umbonal ridge, better defined sinus, and less obtuse angle between the cardinal and posterior edges. The much less vertical extent of the posterior portion serves to distinguish it from *R. oehana.* The anterior part of the shell is very like that of *R. producta* but the posterior region is so different that there is no danger of confusion. The resemblance to *R. radiata* is quite strong but the new species may be differentiated by the well developed mesial sinus.

The type does not reveal any of the granulation characteristic of the genus but in view of its close approach in form to other species of *Rhytimya* it is confidently included here.

The specimen figured has the following dimensions: length 18 mm.. height 7 mm.

*Locality.*—Don brickyard, Toronto.
No. 1031 H.R., Royal Ontario Museum of Paleontology.

## General Correlation

It is not proposed, on the basis of the pelecypods alone, to attempt, as yet, a sub-division of the strata exposed at Toronto. As a preliminary, however, to such classification it seems advisable to present a statement of the present views of geologists regarding the sub-division of the upper part of the Ordovician system. The following table indicates the views which have been expressed by some recent authorities on this question.

## Classification of the Upper Ordovician of North America

| | General Time Scale | Bassler: Cincinnati dome | Bassler: New York | Bassler: Ontario | Foerste: New York | Foerste: Canadian (general) | Foerste: Manitoulin Is. |
|---|---|---|---|---|---|---|---|
| Richmond[1] | Elkhorn (Ind.)..... | Elkhorn. (Belfast) ...... | | | | | |
| Richmond[1] | Whitewater (Ind.)..... | Whitewater-Saluda...... | ...................... | ...................... | Queenston Shale | Queenston Shale | Kagawong |
| Richmond[1] | Maquoketa (Iowa).... | | | | | | |
| Richmond[1] | Liberty (Ind.)..... | Liberty................ | Queenston Shale (?) | Queenston Shale (?) | | | |
| Richmond[1] | Waynesville (Ohio) .... | Waynesville............ | ...................... | ...................... | ................... | Waynesville | |
| Richmond[1] | Fernvale (Tenn.) ... | | | | | | |
| Richmond[1] | Arnheim (Ohio)..... | Arnheim................ | | | | | |
| Richmond[1] | Dubuque (Iowa).... | | | | | | |
| Cincinnatian: Maysville | McMillan (Ohio)..... | Mt. Auburn............ Corryville.............. Bellevue................ | Oswego Sandstone | Pulaski Shale | Salmon R. Sandstone | | Wekwemik-ongsing |
| Cincinnatian: Maysville | Fairview (Ohio)..... | Fairmount............ Mt. Hope................ | Pulaski Shale | | Pulaski | Pulaski | |
| Cincinnatian: Eden | Eden (Ohio)..... | McMicken.............. Southgate.............. Economy............... | Indian Ladder Shale | Eden | Lower Lorraine Shales unnamed (near Eden of Cincinnatian) | Unnamed Division near Eden of Cincinnatian | Sheguindah |
| | Frankfort (New York) | | Frankfort............ | | Frankfort........ | | |
| | Utica ...... | Utica ................ | Utica................ | Utica ................ | Utica........... | Utica.......... | |

[1]Ulrich and Bassler remove the Richmond to the Silurian System.

As already stated, no definite attempt will be made, on the basis of pelecypods alone, to fit the Toronto rocks into the series of formations indicated in the table above. Nevertheless, in view of the great abundance of pelecypods in our strata a few preliminary attempts at general correlation may not be out of place.

It is worthy of note that of the pelecypods listed by Foerste in "Upper Ordovician Formations of Ontario and Quebec" nearly all those from the Pulaski and Lower Lorraine shales of the State of New York occur here. All the pelecypods listed from Vars near Ottawa (Lorraine and Waynesville) occur, and the majority of the forms listed from Quebec (Lorraine and Waynesville) are found. On the other hand, a number of pelecypods which occur at Toronto and in the State of New York are not listed by Foerste from the exposures in the Province of Quebec, e.g. *Modiolopsis modiolaris, Orthodesma nasutum,* and *Ischyrodonta unionoides.*

Certain of the Toronto strata undoubtedly bear a fauna more or less comparable with that of the Eden, but pelecypods play so small a part that the consideration of it must be left to a later date.

The strong resemblance of our fauna to the Maysville of the Ohio valley is as striking as its resemblance to the Pulaski fauna of New York State, but the number of our species is far less than have been described from the Maysville. Most of the Maysville fossils identified at Toronto are contained in Foerste's lists from the Quebec localities. A few species found at Toronto seem to be unrepresented in either the Quebec or New York strata but occur in the typical Maysville regions of the western area. It would appear, therefore, that the Toronto pelecypod fauna represents in general a horizon comparable with the Pulaski on the one hand and the Maysville on the other, but with a stronger commingling of Maysville forms than occurs in the rocks of New York. The Quebec rocks show a similar commingling of forms, but with a weaker Maysville fauna than in the case of Toronto. The similarity of the Toronto fauna to that described by Foerste from Quebec is accentuated by the fact that most of the new species founded by him from the Quebec rocks have been collected from the Toronto strata.

A very significant feature of the Toronto pelecypod fauna is the association with the typical Maysville and Pulaski fauna of a restricted number of species regarded as characteristically Richmond (Waynesville and Whitewater).

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Unless otherwise stated all figures are of natural size and drawn from internal casts.

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| Fig. 2. | *Cuneamya scapha* | Right valve | Humber river.. | 7 |
| Fig. 3. | *Ctenodonta* { c.f. *filistriata* / c.f. *albertina* } | Inside of right valve, showing dentition, × 2 | Humber river.. | 9 |
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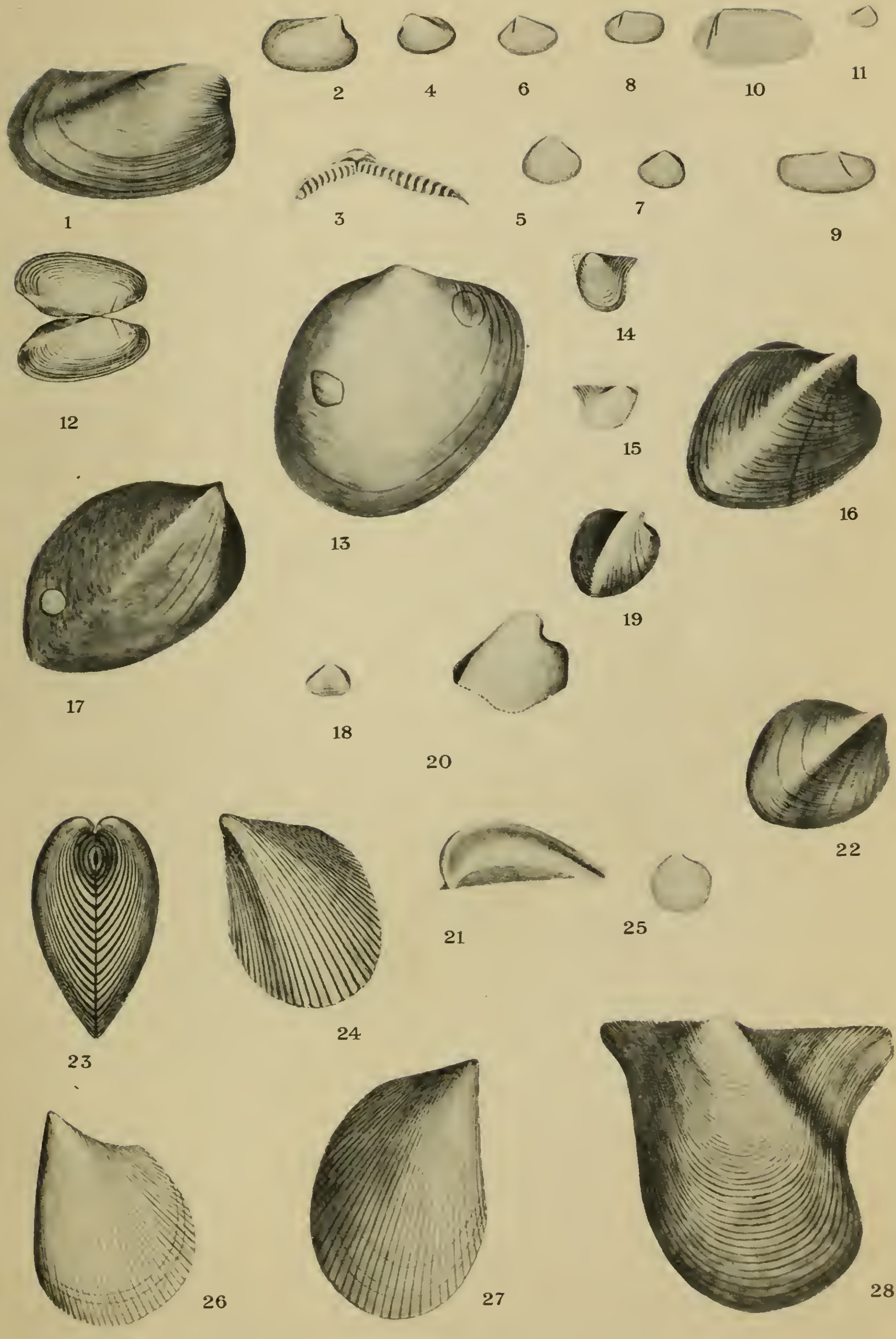
## Plate I



## Explanation of Plate II

All figures are of natural size and drawn from internal casts.

| | Fossil. | | Locality, | Page |
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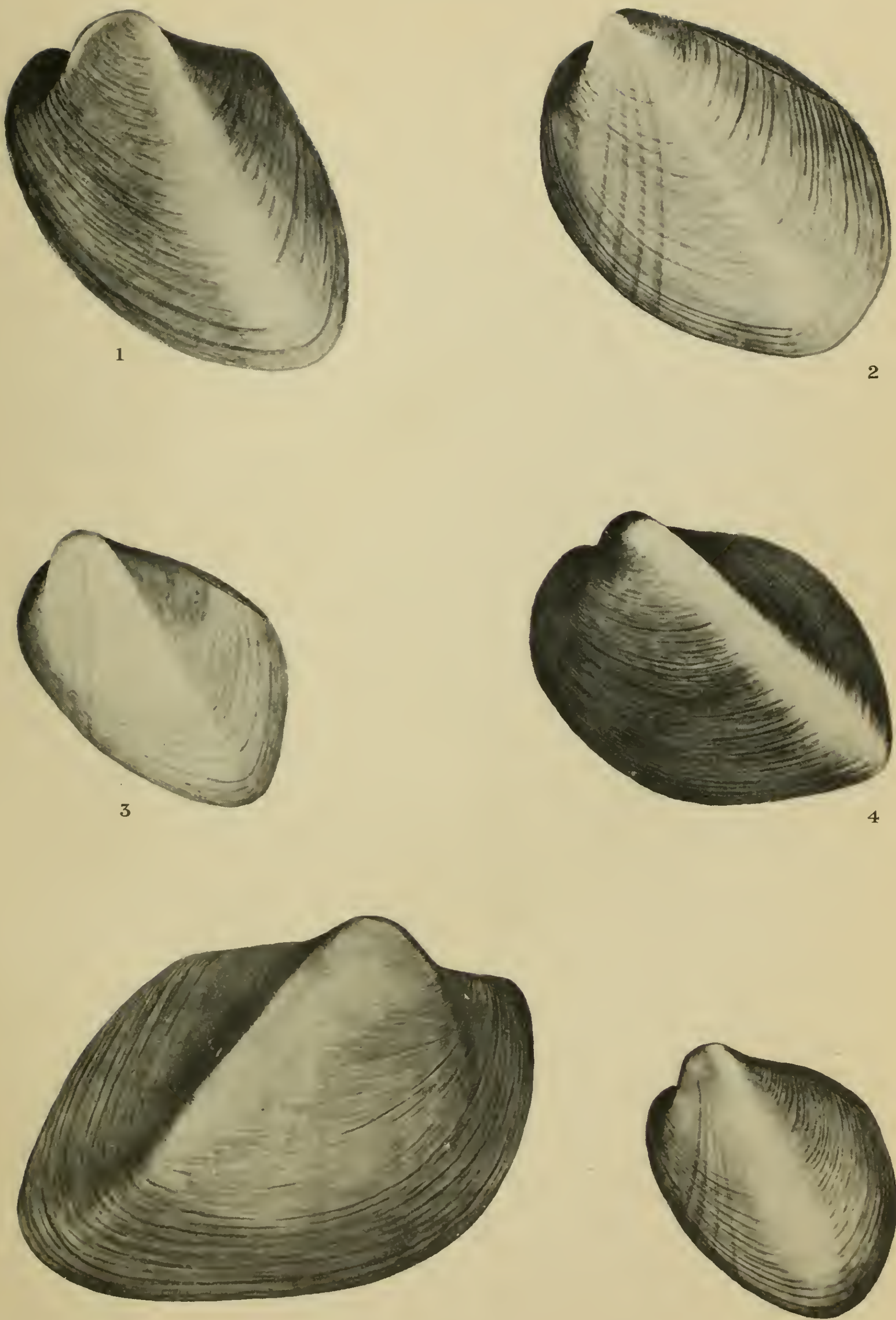
Plate II



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All figures are of natural size and represent casts of the interior.

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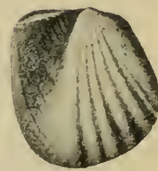
## Plate III

1

2



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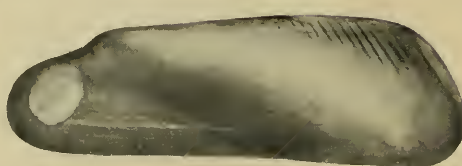

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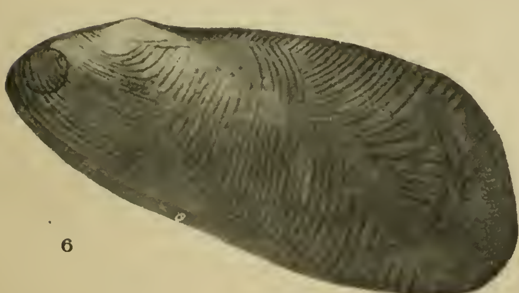

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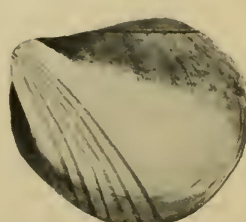

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All figures are of natural size and drawn from casts of the interior.

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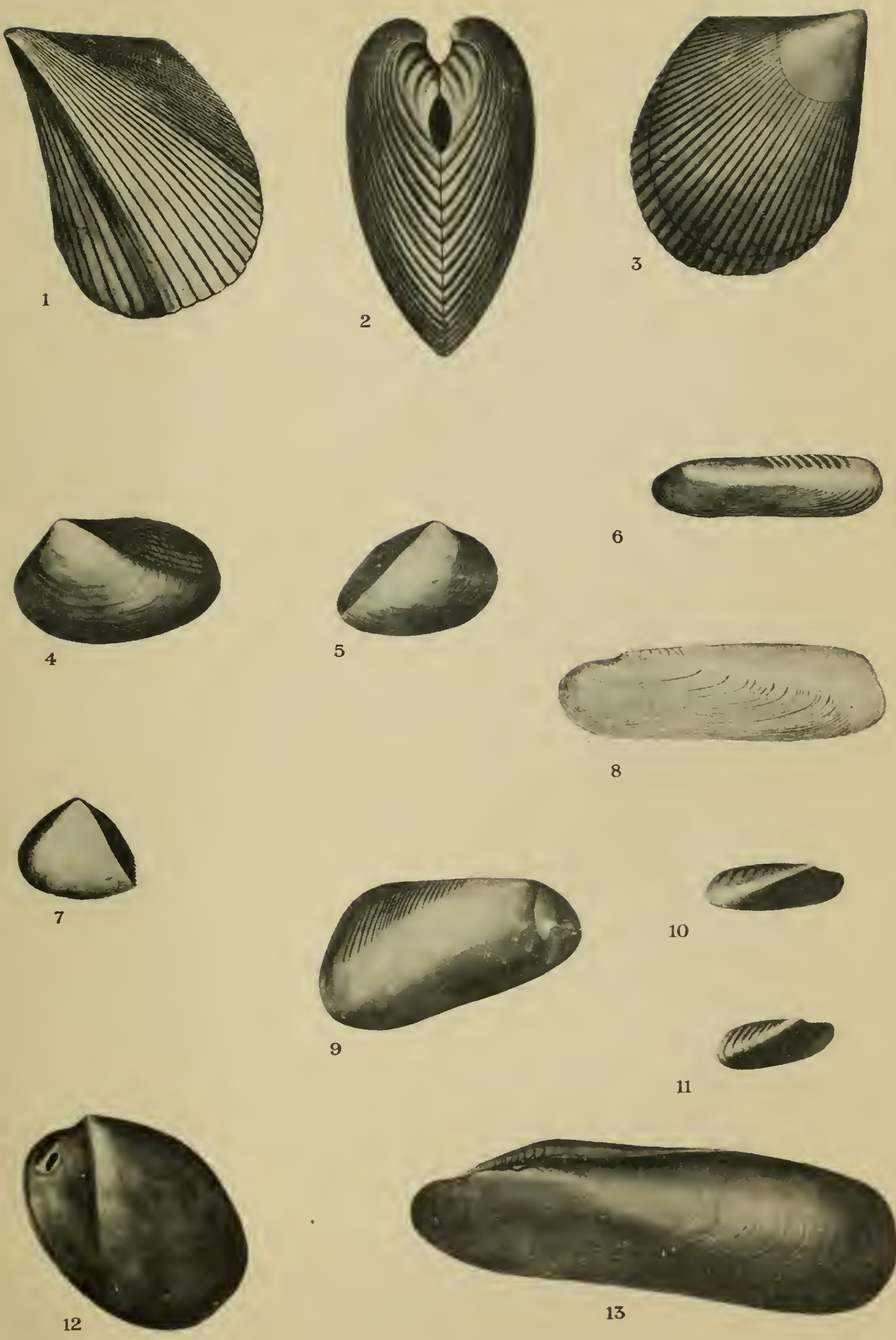
Plate IV



## Explanation of Plate V

All figures are of natural size and drawn from casts of the interior.

| | Fossil. | | Locality, | Page |
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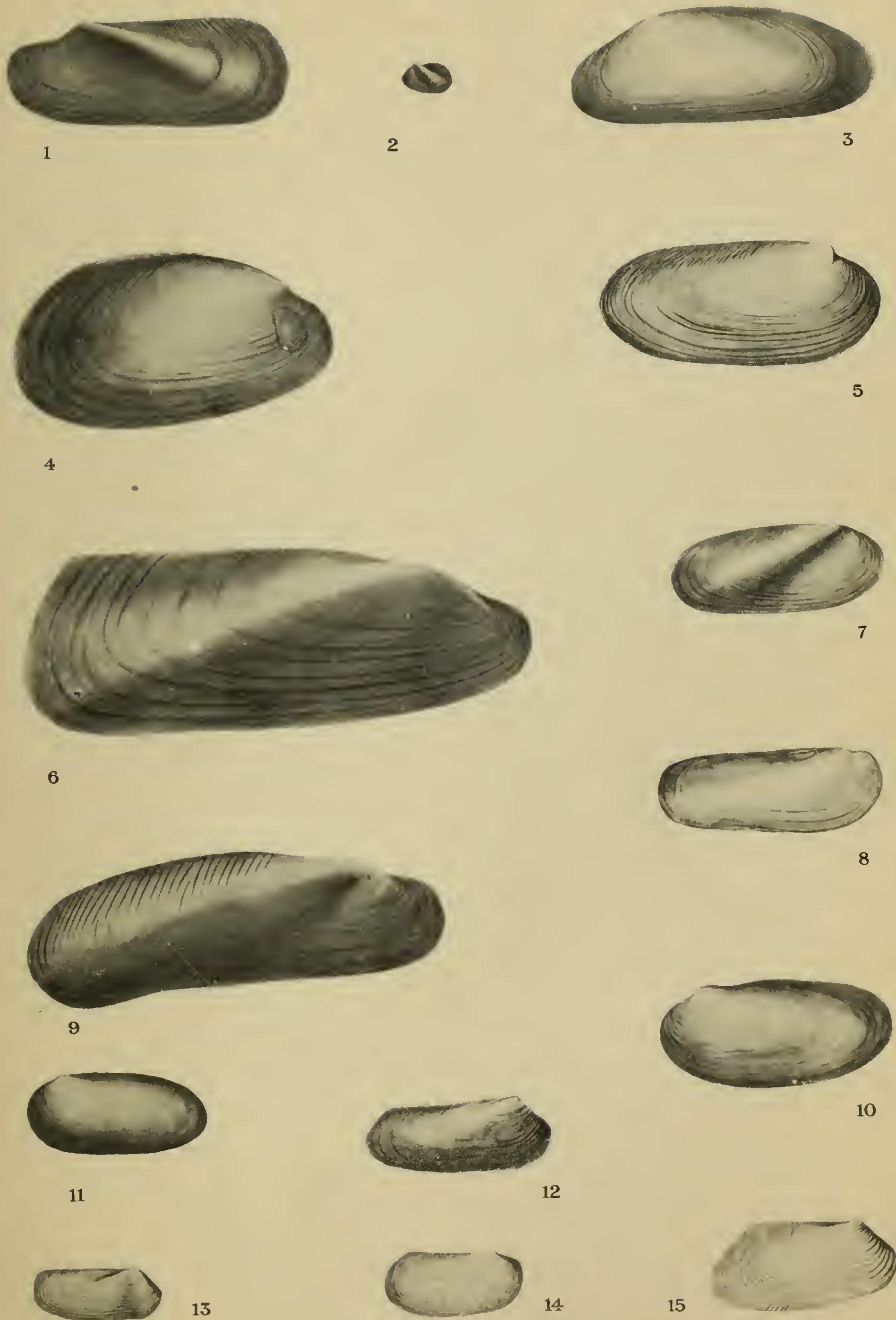
Plate V



PROVINCE OF ONTARIO

DEPARTMENT OF FORESTS AND MINES

BUREAU OF MINES

Hon. H. Mills, *Minister*    Willet G. Miller, *Provincial Geologist*

## EXPLANATION OF COLOURS

PRE-CAMBRIAN

Keweenawan—

Diabase

INTRUSIVE CONTACT

Algoman (?)

Syenite, feldspar-porphyry, quartz-porphyry

Keewatin

Volcanic rocks consisting of basalt, andesite, rhyolite, grey lavas, pillow lava, amygdaloids, volcanic fragmental rocks, and ankerite rocks. There is an intrusion of serpentine on the west boundary of the township of Tannahill which is probably younger than the Keewatin.

Note. The term "grey lava" has been frequently used on the map. It was found to be a convenient field term to describe those lavas of intermediate composition between such basic rocks as basalts, on the one hand and rhyolites, on the other. Some of the "grey lavas" may be rhyolites. The volcanic fragmental rocks are made up of angular fragments of fine-grained or slag-like lavas.

## EXPLANATION OF SIGNS

Geological boundaries.

Boundary of Burnt Area.

Altitude in feet above sea-level *

Altitude above general land

Hill or Mountain

Swamp

Road


## NOTES

The Ben Nevis area is in the district of Timiskaming, midway between Larder Lake and Lake Abitibi, contiguous to the province of Quebec. The area may be entered by way of Dane station on the Temiskaming and Northern Ontario railway. From Dane the Larder lake road leads to Beaverhouse lake, a distance of about 18 miles.

### Geology

The entire area included within the Ben Nevis map is made up almost wholly of lavas consisting of basalts or andesites and to a less extent of rhyolites or other closely related rocks. These lavas are believed to be Keewatin in age. All of them are massive and are rarely altered to schists, except in a few isolated areas noted here and there on the map. This non-schistose condition of the Keewatin lava flows is evidently due to the absence of large intrusions of granite, syenite, or porphyry. Only in the southeast part of Katrine township is there an intrusion of rock of any volume, and this mass of syenite is but two miles long and less than half a mile wide. There is also, in the northwest corner of Pontiac township, an intrusion of syenite about half a mile long and a quarter of a mile wide. Elsewhere throughout the area there are small dikes or other masses of feldspar-porphyry, quartz-porphyry, felsite and other rocks.

The rocks are covered in many localities with boulder clay, sand and clay. The sandy deposits are widespread in Arnold and Clifford townships.

It may be noted here that the geological work for the Ben Nevis area took less than two months' time during the summer and early autumn of 1919. The area has consequently not been worked out in any great geological detail and the map must therefore be considered as a reconnaissance one in its nature.

### Economic Notes

The Ben Nevis area constitutes part of that great belt of Keewatin rocks which stretches across northern Ontario and includes such gold-producing camps as Porcupine and Kirkland lake. Since the Ben Nevis area is underlain by dark-coloured Keewatin lavas and intruded by a few masses of syenite and feldspar-porphyry, it is a prospective field in which gold-bearing quartz veins of economic value may be found. It embraces an area of some 300 square miles. Parts of it appear to be practically unprospected, particularly Pontiac township. Other parts, such as the southeast corner of Katrine township, have been prospected more thoroughly during and following the Larder Lake boom in 1906. Already some interesting gold-bearing quartz veins have been found in Katrine township. These discoveries were promising enough to have induced the Nipissing Mining Company of Cobalt to option some claims in the summer of 1919 at the southeast corner of Katrine township, and during that year the company did considerable trenching and sampling with promising results, a gang of 8 or 10 men being employed. Their option, however, was not exercised.

The promising areas to prospect for gold are probably those in the vicinity of syenite, and feldspar and quartz-porphyry intrusions. The areas of schistose rocks, noted here and there on the map, may also be worth prospecting for gold.

While in all probability the locality is one in which prospectors would preferably search for gold, still it may be pointed out that there is an intrusion of serpentine at the west side of Tannahill township. Somewhat similar intrusions elsewhere in Ontario have associated with them deposits of nickel and copper ore. Chrome iron ore, platinum and microscopic diamonds have also been found in Reaume township associated with similar rocks, although not in paying quantities.

Prospectors will do well to be on the keen look-out for tin in northern Ontario. This valuable metal will probably be found in Ontario in paying quantities associated with acid intrusions such as granite, and quartz-porphyry. Tin ore (cassiterite) is very heavy, its specific gravity being about 7. The minerals associated with tin deposits are: quartz, fluorite, scheelite, zinc blende, molybdenite, pyrite, chalcopyrite, wolframite, magnetite, topaz, and other minerals. The borders of granite intrusions and the rocks near these intrusions should be prospected for tin. The ore may occur in grains disseminated through the rocks, or in quartz veins.

### Canoe Routes

There are two canoe routes crossing the area. The most important one follows a chain of long, narrow lakes, namely, Beaverhouse, Misema, Howard, Kennedy, Anrev, Verna, Keith, Marten, Pmaws and Webster. This is part of the old and well known route leading north from Lake Timiskaming by way of the Blanche river, crossing in Ben Nevis township the height of land between the St. Lawrence valley and Hudson Bay and thence down a series of lakes, streams and rivers to Lake Abitibi in the province of Quebec. That part of the route which crosses the Ben Nevis area is reached by way of the Argonaut gold mine (formerly known as La Mine d'Or Huronna) at the northeast corner of Gauthier township, where canoes may be put into Beaverhouse Lake and the south part of Ben Nevis area entered in less than an hour's paddle by canoe. There are in all 13 portages in that part of the route which crosses the Ben Nevis area. Two of these are long, namely, the one running northeast of Marten lake which is two miles long, and the one running northeast of Webster lake to the Abnageeay river which is two and a half miles long. The other portages on the route are not more than half a mile in length—most of them not more than a few chains.

In the preceding paragraph the main canoe route

EXPLANATION OF SIGNS

Road

Trail or Portage

Sources of Information.

Prepared for photo-lithography by H. C. Smith.

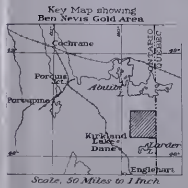

for tin in northern Ontario. This valuable metal will probably be found in Ontario in paying quantities associated with acid intrusions such as granite, and quartz-porphyry. Tin ore (cassiterite) is very heavy, its specific gravity being about 7. The minerals associated with tin deposits are quartz, fluorite, scheelite, zinc blende, molybdenite, pyrite, chalcopyrite, wolframite, magnetite, topaz, and other minerals. The borders of granite intrusions and the rocks near these intrusions should be prospected for tin. The ore may occur in grains disseminated through the rocks, or in quartz veins.

## Canoe Routes

There are two canoe routes crossing the area. The most important one follows a chain of long, narrow lakes, namely, *Beaverhouse, Misema, Howard, Kennedy, Aarev, Verna, Keith, Marten, Pmaws* and Webster. This is part of the old and well known route leading north from Lake Timiskaming by way of the Blanche river, crossing in Ben Nevis township the height of land between the St. Lawrence valley and Hudson Bay and thence down a series of lakes, streams and rivers to Lake Abitibi in the province of Quebec. That part of the route which crosses the Ben Nevis area is reached by way of the Argonaut gold mine (formerly known as La Mine d'Or Huronia) at the northeast corner of Gauthier township, where canoes may be put into Beaverhouse Lake and the south part of Ben Nevis area entered in less than an hour's paddle by canoe. There are in all 13 portages in that part of the route which crosses the Ben Nevis area. Two of these are long, namely, the one running northeast of Marten lake which is two miles long, and the one running northeast of Webster lake to the Abnageezy river which is two and a half miles long. The other portages on the route are not more than half a mile in length—most of them not more than a few chains.

In the preceding paragraph the main canoe route in the area has been briefly described. It may be added that in very high water during early spring it is stated by an Indian that, in place of going by way of Webster lake, across the two long portages, it is possible to take a route which leads out of the northwest end of Marten lake, in the township of Clifford. At this end of Marten lake there is an Indian log cabin, a few chains to the west of which there is a 15-chain portage, partly over rocky ground, into Rat lake, a pond of water a quarter of a mile long. The west branch of the Abnageezy river flows northward out of Rat lake, and is canoeable northward for a mile and a half, or a little beyond the north boundary of Clifford township. North of this to about the south boundary of Holloway township the Abnageezy is said to be navigable only in extremely high water in early spring. The river is, however, navigable in Holloway township, the northeast corner of Tannahill township, and in Dokis township.

The second canoe route in the Ben Nevis area is in the south part of Katrine and Ossian townships. It runs in an east and west direction and leaves the main route, described above, at the east end of Misema lake in the southwest corner of Katrine township. From Misema lake a stream is followed eastward about three-quarters of a mile into Kinabik lake, a body of water about 50 chains in diameter. The portage from this lake is 13 chains long and begins at the southeast corner of the lake. The portage leads to a small, sinuous creek, 40 feet above the lake, which is followed upstream for about half a mile, disclosing low, rocky hills covered with small jack pine, to a 3-chain portage. A feldspar-porphyry dike, striking east and west, is found on the portage. This dike is cut by a fresh-looking dike of diabase. From here, during seasons of high water, the creek may be ascended for about three miles to a small pond on the east boundary of Katrine township, near the southeast corner of the township. When the water is high there is only one portage over a low dam which was built to raise the water in the upper part of the creek and make canoeing less difficult. The dam is found about two-thirds of the distance upstream. The stream is very sinuous and winding and the water in places sluggish. During dry seasons the stream is too low to allow canoes to go beyond the dam, and it is therefore necessary to use the portage which begins at the dam and follows low hills or open beaver meadows to the pond at the east end of Katrine township, a distance of more than a mile. At the east end of the pond the portage into Wawagoshe lake begins. It is 35 chains long and crosses the height of land between the St. Lawrence valley and Hudson Bay. At the northeast corner of Wawagoshe lake a 65-chain portage leads eastward to a small creek, 10 or 15 feet wide, which is extremely sinuous, and passes through a low swampy country supporting a magnificent growth of spruce trees. There are a few places blocked with logs. The creek flows into Waterhen lake, a body of water less than half a mile wide and surrounded by flat country with very fine spruce. The creek flowing out of Waterhen lake is 50 to 75 feet wide. It passes through flat swampy country and flows into Labyrinth lake. The portage is at the north end of Labyrinth lake and the route follows a series of rivers and lakes in the province of Quebec northward to Lake Abitibi, there being few portages and these being short.




Map No 29 e.

# BEN NEVIS GOLD AREA

## DISTRICT OF TIMISKAMING

*To accompany Report by* Cyril W. Knight *in Volume 29, Ontario Bureau of Mines Report, 1920*

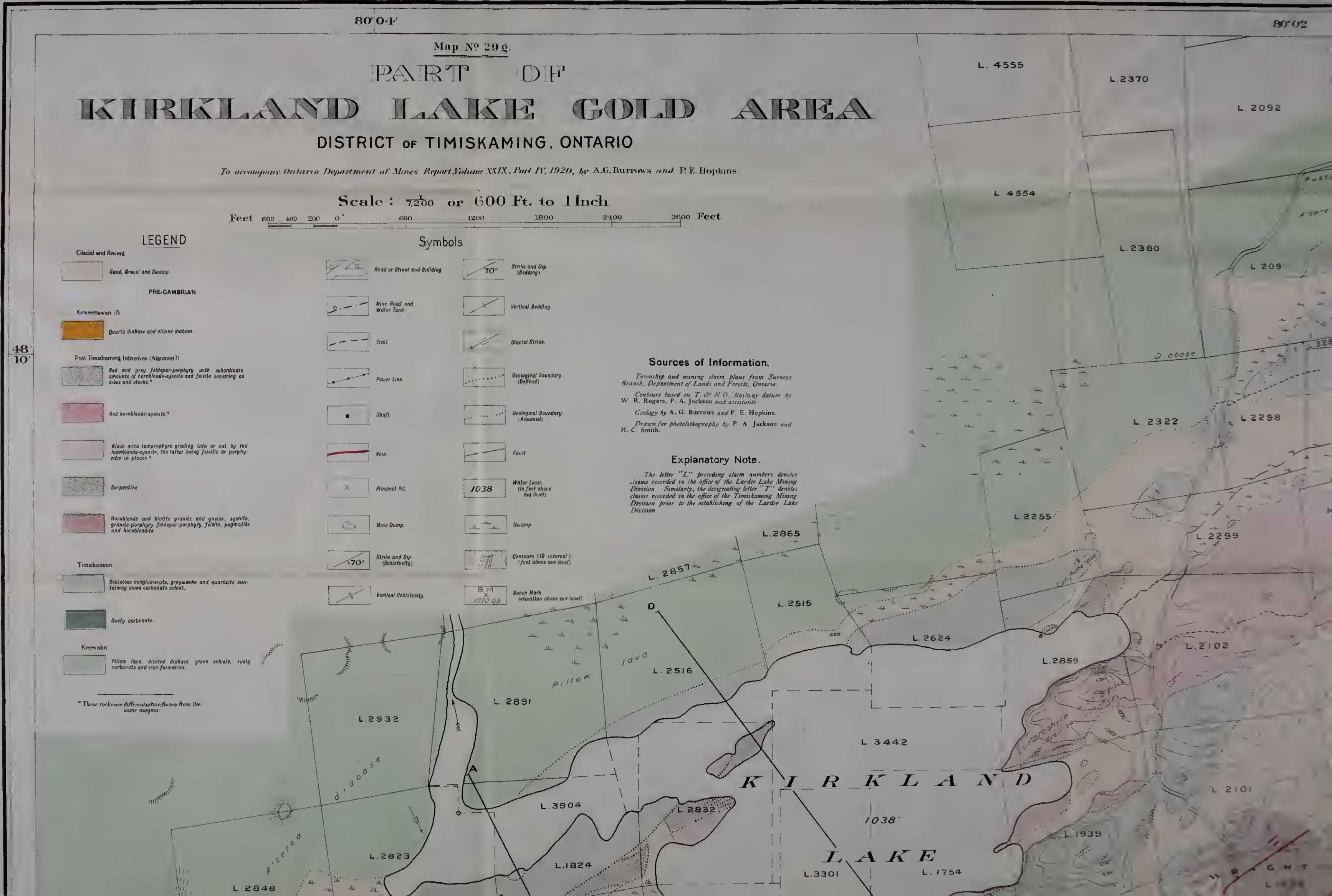
Scale: 63360 or 1 Mile = 1 Inch

Chains 80 40 0 1 2 3 4 Miles

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

Hon. H. Mills, *Minister* Willet G. Miller *Provincial Geologist*



PROVINCE OF ONTARIO

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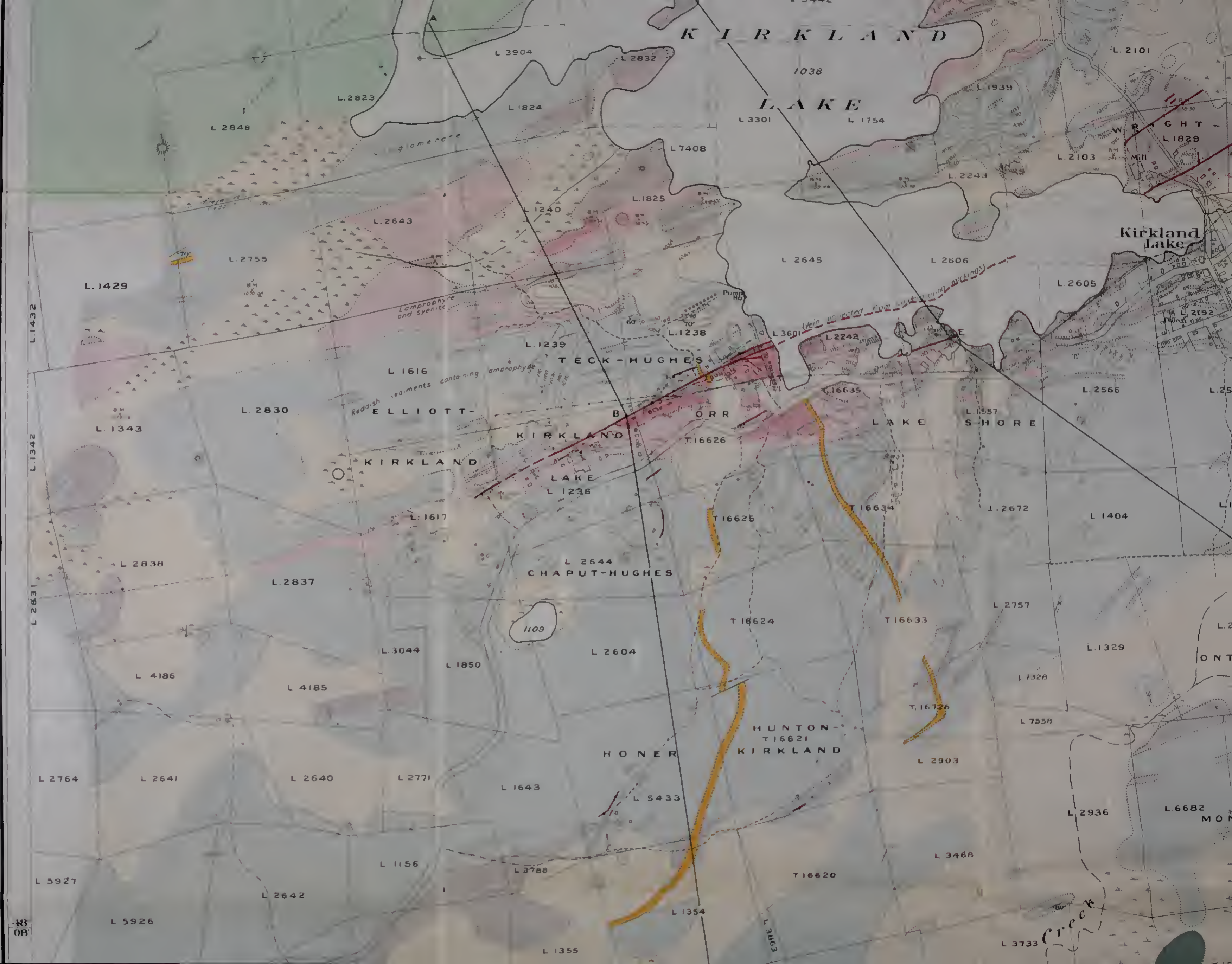
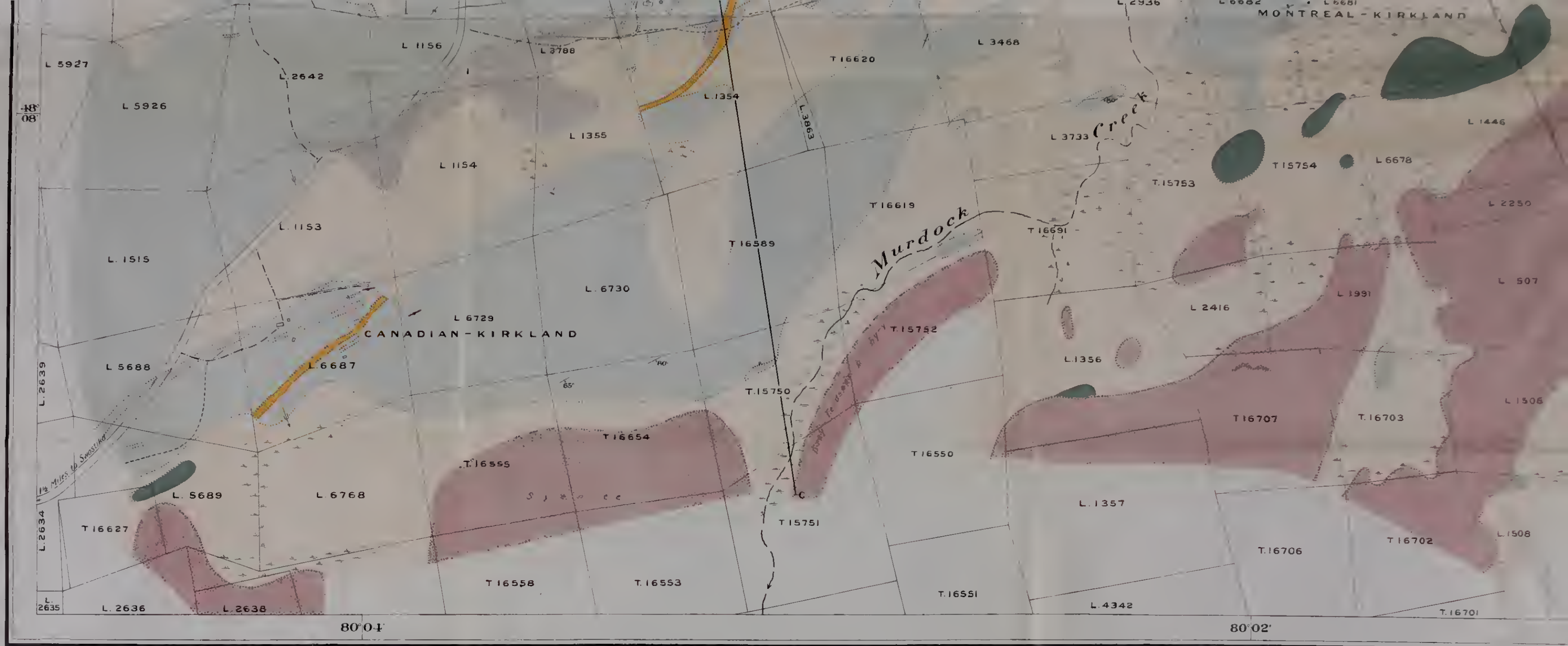
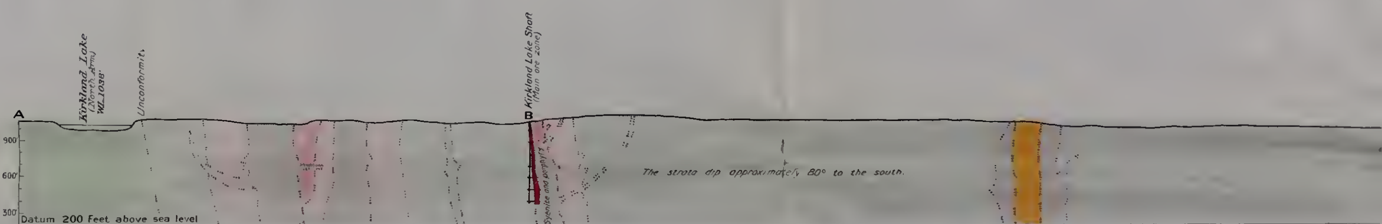


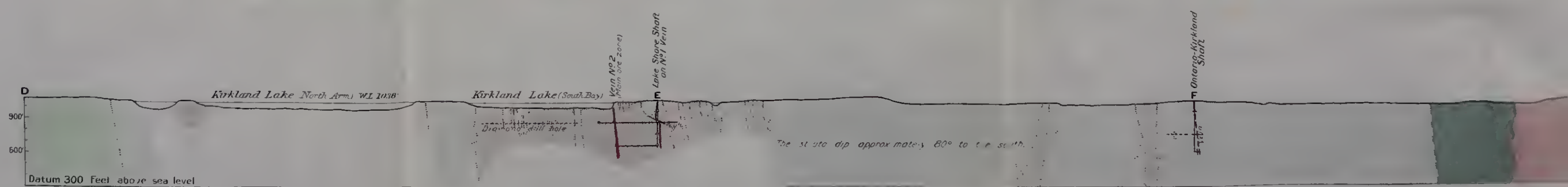
KIRKLAND LAKE
1038
Kirkland Lake
L. 3904
L. 2832
L. 2823
L. 1824
L. 2848
L. 3301
L. 1754
L. 1939
L. 2101
L. 1829
L. 2103
L. 2243
L 7408
Mill
conglomerate
L. 1825
L. 1240
L. 2643
L. 2755
L. 2645
L. 2606
L. 2605
L. 1429
L. 1432
Lamprophyre and syenite
Pump Ho.
L. 1238
L. 3601
L. 2242
L. 2192
Church
L. 1239
TECK-HUGHES
L 1616
Reddish segments containing lamprophyre
L. 16635
L. 2566
L. 2830
ELLIOTT-
B
ORR
L. 1557
LAKE SHORE
L. 1343
L. 1342
KIRKLAND
T. 16626
KIRKLAND
LAKE
L 1238
T 16634
L. 2672
L 1404
L: 1617
T 16625
L 2838
L 2644
CHAPUT-HUGHES
L. 2837
L. 2831
L 2757
1109
T 16624
T 16633
L. 1329
L. 3044
L 1850
L 2604
L 1328
L 4186
L 4185
T. 16726
L 7558
HUNTON-
T 16621
KIRKLAND
HONER
L 2903
L 2764
L 2641
L 2640
L 2771
L 1643
L 5433
L. 2936
L 6682
L 3468
L 1156
L 3788
T 16620
L 5927
L 2642
L 1354
L 3863
Creek
L 5926
L 3733
L 1355
48
08

KIRKLAND
LAKE
1038
L.3301
L.1754
L.1939
L.2101
L.2103
L.2243
L.2645
L.2606
L.2605
Kirkland Lake
Mill
School
Church
WRIGHT-HARGREAVES
L.1829
L.1830
L.2100
Power Sub-Station
L.1823
L.2374
L.1822
L.1821
L.2504
L.1831
L.1635
L.2192
GULL
L.3104
LAKE
1049'
Pump
L.1661
L.2454
BLACK
L.2728
L.1535
L.1536
L.1438
L.2553
L.2566
L.3601
L.2242
Vein projected from underground workings
T.16635
L.1557
LAKE SHORE
L.2029
L.2030
L.1477
L.1475
L.1534
L.1439
L.1437
L.1403
L.1404
L.2672
T.16634
TOWNSHIP BOUNDARY
TECK
LEBEL
L.1873
L.1478
L.1476
L.5941
L.2679
L.2678
L.2757
T.16633
L.1329
L.1328
ONTARIO-KIRKLAND
T.16726
HUNTON-
T.16621
KIRKLAND
L.7558
L.2903
L.1479
L.1872
L.6680
L.6679
L.6682
L.6681
L.2936
MONTREAL-KIRKLAND
L.2345
L.3468
T.16620
L.1480
L.1519
L.1446
L.3733
Creek
L.3863
48°
08'

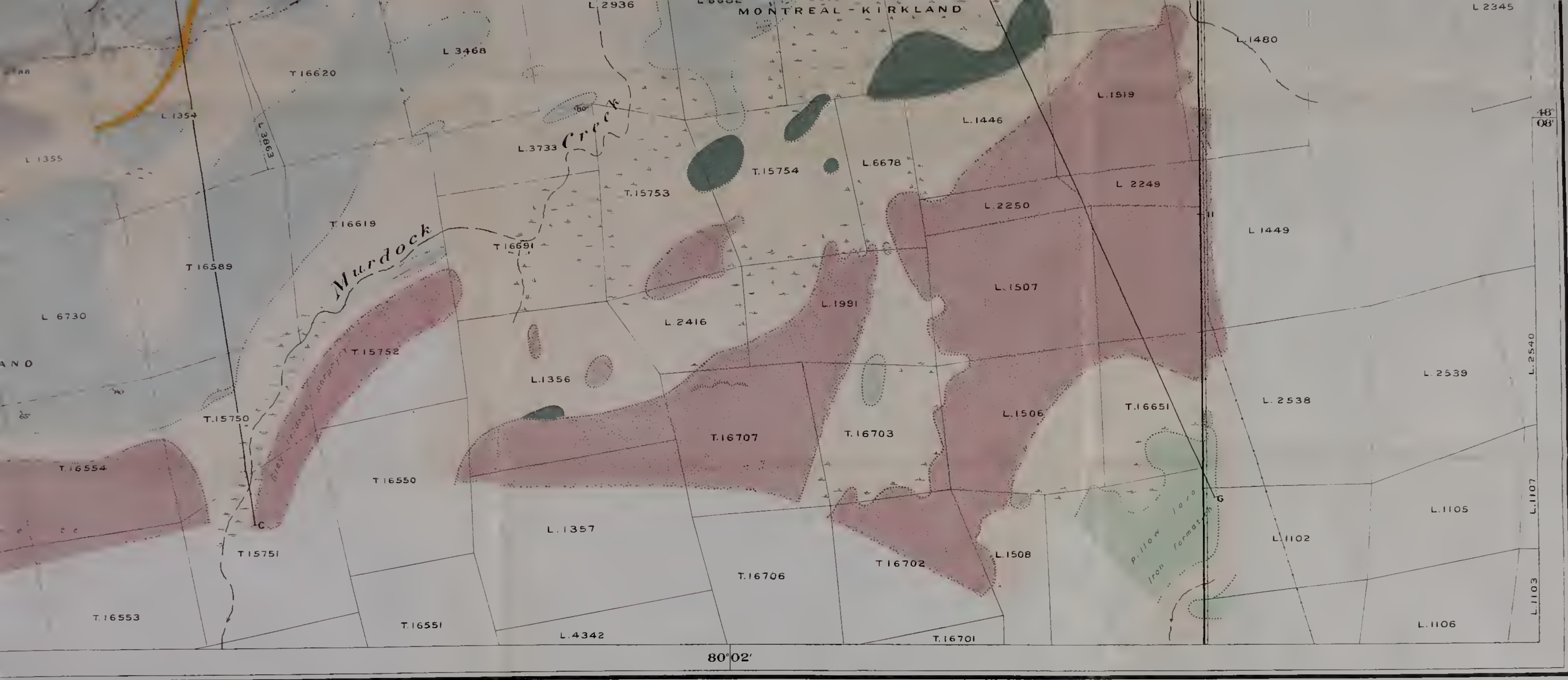


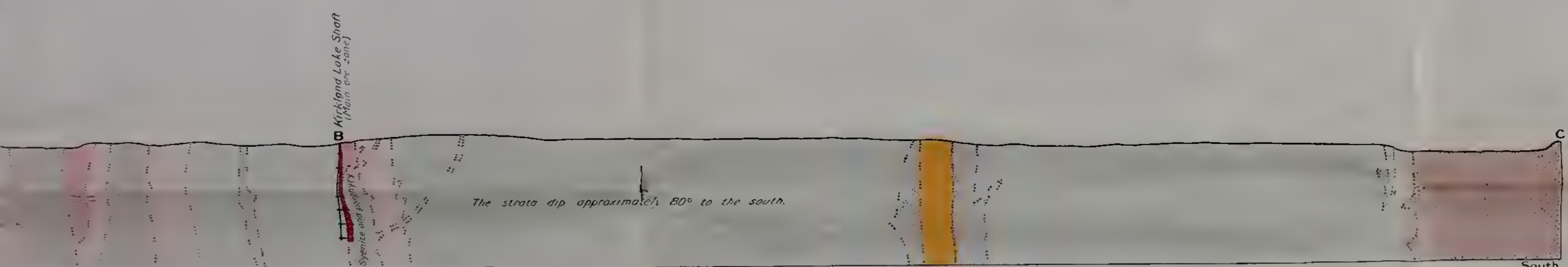




VERTICAL SECTION A-B-C ACROSS THE GENERAL STRIKE OF THE VEINS. Horizontal and Vertical Scale: 1 Inch = 600 Feet.

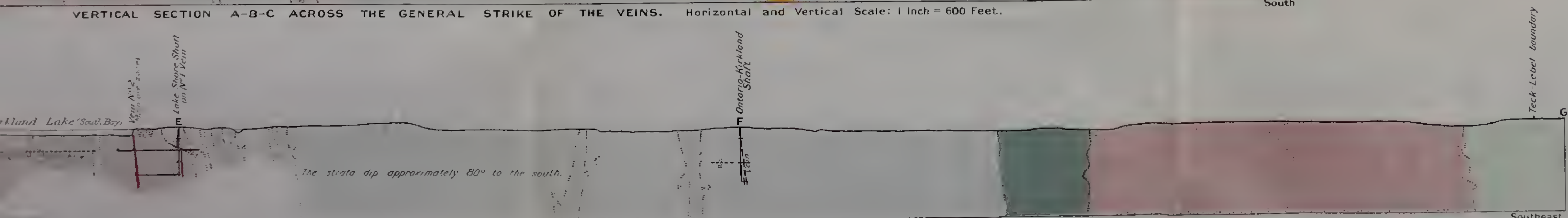



VERTICAL SECTION D-E-F-G ACROSS THE GENERAL STRIKE OF THE VEINS. Horizontal and Vertical Scale: 1 Inch = 600 Feet.




VERTICAL SECTION A-B-C ACROSS THE GENERAL STRIKE OF THE VEINS. Horizontal and Vertical Scale: 1 Inch = 600 Feet.




VERTICAL SECTION O-E-F-G ACROSS THE GENERAL STRIKE OF THE VEINS. Horizontal and Vertical Scale: 1 Inch = 600 Feet.

## COLOURED MAPS

**ONTARIO DEPARTMENT OF MINES. VOL. XXIX, 1920**

PART I.

No. 29 *b*.—Windy Lake Nickel Area, District of Sudbury, Scale: 40 chains or ½ mile to the inch.

PART II.

No. 29 *f*.—Explorations along the Abitibi, Mattagami and Missinaibi Rivers, Districts of Timiskaming and Algoma, Scale: 7.89 miles to the inch.

PART III.

No. 29 *a*.—West Shiningtree Gold Area, District of Sudbury, Scale: 40 chains to the inch.

No. 29 *d*.—Argonant Gold Mine, District of Timiskaming, Scale: 400 feet to the inch.

No. 29 *e*.—Ben Nevis Gold Area, District of Timiskaming, Scale: 1 mile to the inch.

PART IV.

No. 29 *g*.—Part of the Kirkland Lake Gold Area, District of Timiskaming, Scale: 600 feet to the inch.