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LETTER OF TRANSMISSION

To His Honour W. D. Ross,
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 Fortieth Annual Report of the Department over which I have the honour to preside.

I have the honour to be, Sir,

Your obedient servant,

Chas. McCrea,
Minister of Mines.

Department of Mines,
Toronto, 1931.

INTRODUCTORY LETTER

To The Honourable Chas. McCrea,
Minister of Mines.

Sir,—The undersigned has the honour to submit the Fortieth Annual Report of the Department of Mines, issued in six parts, as follows:—

Part 1

Introductory Letter, by Thos. W. Gibson.
Statistical Review of Ontario's Mineral Industry in 1930, by W. R. Rogers and A. C. Young.
Mines of Ontario in 1930, by D. G. Sinclair, R. H. Cleland, E. C. Keeley, D. F. Cooper, and A. R. Webster.
Mining Accidents in 1930, by D. G. Sinclair, R. H. Cleland, E. C. Keeley, D. F. Cooper, and A. R. Webster.
Classes for Prospectors, 1930-31, by E. M. Burwash.

Part 2

Geology of the Ontario-Manitoba Boundary (12th Base Line to Latitude 54), with Map No. 40*a*, by D. R. Derry and G. S. MacKenzie.
Geology of the Heron Bay Area, District of Thunder Bay, with Map No. 40*d*, by J. E. Thomson.

Part 3

German-Currie Area, District of Cochrane, with Map No. 40*b*, by H. C. Laird.
Groundhog-Kamiskotia Area, District of Cochrane, with Map No. 40*c*, by A. R. Graham.

Part 4

Goudreau and Michipicoten Gold Areas, District of Algoma, with Map No. 40*e*, by E. S. Moore.
Kowkash-Ogoki Gold Area, with Map No. 40*f*, by L. F. Kindle.
A Deposit of Titaniferous Magnetite in Angus township, District of Nipissing, by M. E. Hurst.
Chromite Deposits of the Obonga Lake Area, by M. E. Hurst.

Part 5

Natural Gas in 1930, with Map No. 40*g* (Natural Gas Pipe Lines in S.W. Ontario), by R. B. Harkness.
Petroleum in 1930, by R. B. Harkness.

Only Part 1 is bound with the Sessional Papers of the Legislature. All parts, together with accompanying geological maps as indicated above by number and letter, are available on application to the Department.

Respectfully submitted,

Thos. W. Gibson
Deputy Minister of Mines.

Department of Mines,
Toronto, 1931.

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

HON. CHAS. MCCREA *Minister of Mines* THOS. W. GIBSON, *Deputy Minister*

FORTIETH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XL, PART I, 1931

CONTENTS

Statistical Review of Ontario's Mineral Industry in 1930	1-50
List of Mines, Quarries, and Metallurgical Works	51-62
Mines of Ontario in 1930	63-126
Mining Accidents in 1930	127-135
Classes for Prospectors, 1930-31	136-138

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1931

CONTENTS

Vol. XL, Part I

PAGE

Letter of Transmission i
Introductory Letter ii

STATISTICAL REVIEW OF ONTARIO'S MINERAL INDUSTRY IN 1930

General Remarks 1
Table I—Summary of Mineral Statistics of Ontario for 1930 2
Table II—Comparative Value of Mineral Production, 1926-1930 3
Table III—Total Mineral Production of Ontario 4
Diamond-Drilling 5
Gold 6
Table IV—Total Gold Production in Ontario 6
Table V—Ontario's Gold Production, 1930 7
Table VI—Value of Total Production by Mines of the Kirkland Lake Area 9
Table VII—Value of Total Production by Mines of the Porcupine Area ... 10
Table VIII—Dividends and Bonuses Paid to December 31, 1930 12
Table IX—Yearly Dividends and Bonuses Paid by Gold Mining Companies, 1912-1930 13
Receipts of Crude Gold Bullion at Royal Mint, Ottawa, 1926-1930 14
World Output 14
Silver-Cobalt 15
Silver Production, 1929-1930 15
Table X—Operations of Ontario Silver-Cobalt Refineries in 1930 15
Table XI—Total Shipments from Silver Mines, Smelters and Refineries, 1904-1930 16
Table XII—Silver Shipments by Camps, 1904-1930 17
Table XIII—Dividends and Bonuses Paid to December 31, 1930 18
Nickel-Copper Industry 20
Table XIV—Nickel-Copper Mining and Smelting, 1926-1930 21
Table XV—Nickel-Copper Refining, 1929-1930 21
Table XVI—Precious Metals Recovered, 1926-1930 22
Heavy Chemicals 22
Copper 22
Nickel 23
Dividends 23
Table XVII—Total Dividends Paid by Nickel Companies 23
Statistical Synopsis, 1929 and 1930 ... 24
Iron Ore, Pig Iron, Steel, Ferro-Alloys, and Coke 25
Table XVIII—Iron and Steel Statistics, 1926-1930 25

PAGE

Nickel-Copper Industry—*Continued*
Iron Blast Furnaces in Operation, 1930 25
Pig Iron, Steel, and Ferro-Alloy Producers, 1930 25
Table XIX—The Coking Industry, 1929-1930 26
Non-Metallic Minerals 26
Actinolite 27
Arsenic 27
Barite 27
Beryl 27
Calcite 27
Diatomite 27
Feldspar 28
Fluorspar 29
Graphite 29
Gypsum 29
Iron Pyrites and Sulphuric Acid 29
Lignite 30
Mica 30
Mineral Waters 31
Natural Gas and Petroleum 31
Peat 32
Quartz, Quartzite, and Silica Brick ... 32
Salt 33
Talc 34
Structural Materials 34
Building Permits 34
Construction Contracts 34
Cement 35
Cement Products 36
Lime 37
Sand-Lime Brick 38
Sand and Gravel 38
Stone 39
Clay Products 41
Mining Company Incorporations 43
Mining Revenue and Expenditures 45
Mining Lands Sold and Leased 45
Summary of Business Transacted in Mining Divisions in 1930 46
Statement of Moneys Remitted by Mining Recorders, 1930 47
Mining Claims Recorded, 1907-30 47
Details of Profit Tax 48
Temiskaming Testing Laboratories 48
Provincial Assay Office 49
Draughting Office, North Bay 50

LIST OF MINES, QUARRIES AND METALLURGICAL WORKS

Metallics 51
Metallurgical Works 54
Non-Metallics 54
Structural Materials 57

MINES OF ONTARIO IN 1930

Chrome 63
Consolidated Chromium Corporation. 63

PAGE
Copper ... 64
White Lake Mines, Ltd ... 64
Copper-Zinc-Lead ... 64
Treadwell Yukon Co., Ltd ... 64
Gold ... 65
Barry-Hollinger Gold Mines, Ltd ... 65
Beardmore Gold Mines, Ltd ... 67
Bennett-Pacaud Mines, Ltd ... 67
British Canadian Mines, Ltd ... 68
Bunker Hill Extension Mines, Ltd ... 68
Canadian Champion Reef Mining Co., Ltd ... 68
Canadian Kirkland Mines, Ltd ... 68
Canusa Mining and Exploration Co., Ltd ... 69
Central Canada Mines, Ltd ... 69
Central Patricia Mines, Ltd ... 69
Coniaurum Mines, Ltd ... 70
Cooper Gold Mines, Ltd ... 71
De Santis Gold Mining Co., Ltd ... 71
Dome Mines, Ltd ... 72
Goldbank Syndicate ... 76
Harvey Kirkland Mines, Ltd ... 76
Hayden Gold Mines Co., Ltd ... 76
Hollinger Consolidated Gold Mines, Ltd ... 76
Howey Gold Mines, Ltd ... 79
Kirkland Lake Gold Mining Co., Ltd. 84
Lake Shore Mines, Ltd ... 86
McIntyre-Porcupine Mines, Ltd ... 88
March Gold, Ltd ... 93
Moss Mines, Ltd ... 93
Parkhill Gold Mines, Ltd ... 94
Porcupine United Gold Mines, Ltd ... 94
Power and Mines Corporation, Ltd ... 94
Sylvanite Gold Mines, Ltd ... 94
Tashota Gold Mines, Ltd ... 97
Teck-Hughes Gold Mines, Ltd ... 97
Telluride Gold Mines of Canada, Ltd. 98
United Mineral Lands Corporation ... 99
Vipond Consolidated Mines, Ltd ... 99
West Dome Lake Gold Mines, Ltd ... 101
Wright-Hargreaves Mines, Ltd ... 101
Graphite ... 103
Black Donald Graphite Co., Ltd ... 103
Gypsum ... 103
Gypsum, Lime and Alabastine, Canada, Ltd ... 103
Lead ... 104
Kingdon Mining, Smelting and Manufacturing Co., Ltd ... 104
Lead and Zinc ... 104
Lake Geneva Mining Co., Ltd ... 104
Lignite ... 104
Ontario Department of Mines ... 104
Nickel and Copper ... 104
Falconbridge Nickel Mines, Ltd ... 104
International Nickel Company of Canada, Ltd ... 107
Silver ... 109
Animikie Mines, Ltd ... 109
Arthur Brocklebank ... 110
Richard Bunclark ... 110
C. E. Cain and Associates ... 110
Castle-Trethewey Mines, Ltd ... 110
E. H. Clemens ... 113

PAGE
Silver—*Continued*
Cobalt Contact Mines, Ltd ... 113
D. L. Jemmett, Ltd ... 113
Henry Jemmett ... 114
Keeley Silver Mines, Ltd ... 114
Laurentian Mines, Ltd ... 116
E. Lynch ... 116
George Martin ... 116
Mining Corporation of Canada, Ltd ... 116
Hudson Bay Mining and Smelting Co ... 116
Base Metals Mining Corporation ... 116
Quemont Mining Corporation ... 116
Mincor Exploration and Development Co ... 117
Ashley Gold Mining Corporation ... 117
Cobalt Reduction Co., Ltd ... 119
Morrison Mines, Ltd ... 119
William Newton ... 120
Nipissing Mining Co., Ltd ... 120
M. J. O'Brien, Ltd ... 123
Miller Lake O'Brien Mine ... 123
O'Brien Mine ... 123
C. W. Price ... 123
C. P. Roper ... 123
Sandoe and Moyle ... 123
A. Sarabura ... 124
Smith and Laycock ... 124
Roy Sullivan ... 124
F. H. Todd ... 124
C. F. Tuer ... 124
R. N. Ward ... 124
Yorkshire Cobalt Mining Co ... 124
Talc ... 124
Canada Talc Co., Ltd ... 124
Geo. H. Gillespie Co., Ltd ... 125
Metallurgical Works ... 125
Algoma Steel Corporation, Ltd ... 125
Canadian Industries, Ltd ... 125
Deloro Smelting and Refining Co., Ltd. 126
International Nickel Co. of Canada, Ltd ... 126
Ontario Refining Co., Ltd ... 126
Steel Co. of Canada, Ltd ... 126

MINING ACCIDENTS IN 1930

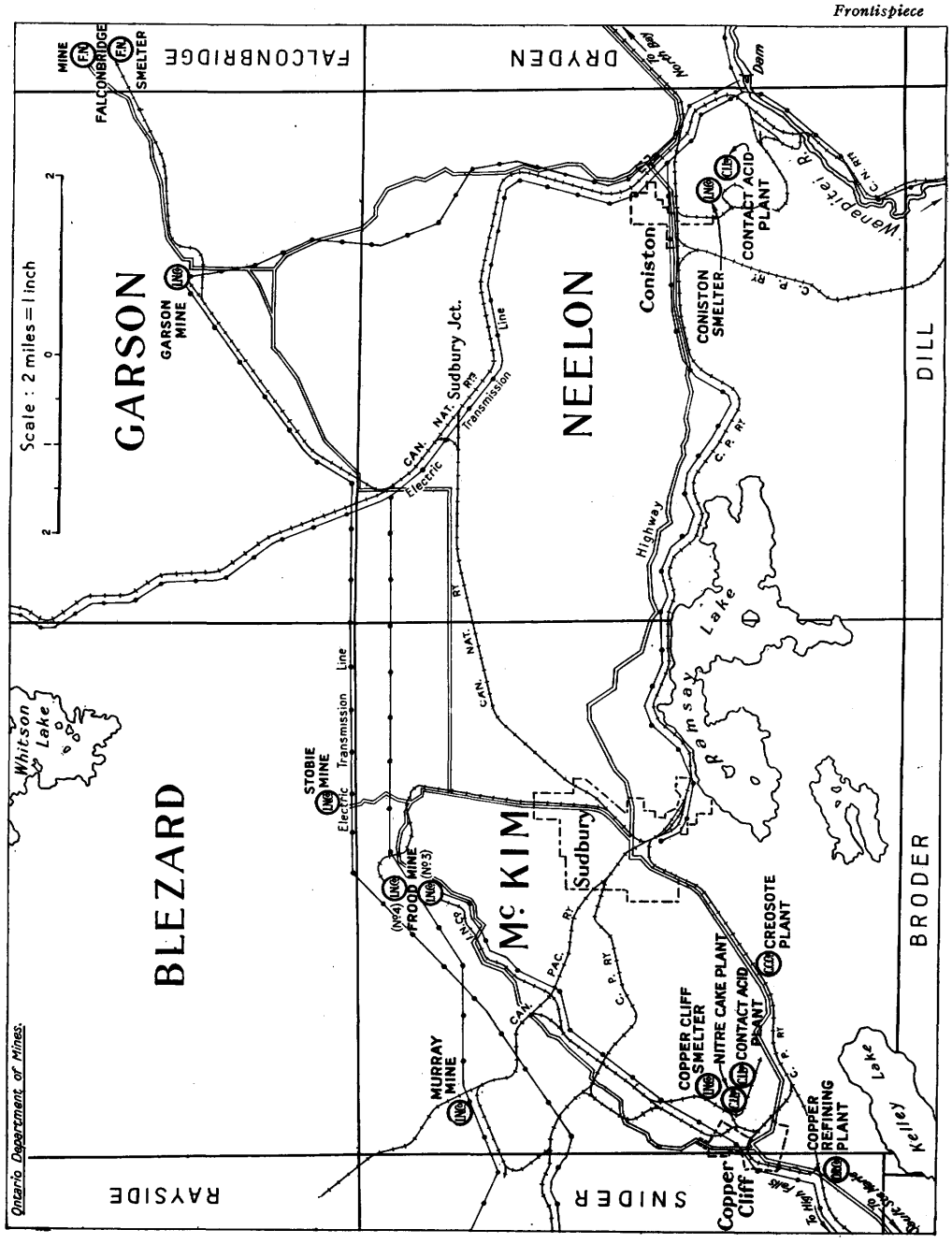
Accidents during 1930 ... 127
Fatal Accidents ... 127
Non-Fatal Accidents ... 130
Infection ... 131
Accidents from Explosives ... 131
Electric Accidents ... 131
Electric Fire ... 132
Prosecutions ... 133
Summary of Rope Tests, 1930 ... 134
Mine Rescue Stations ... 134
Timmins ... 134
Sudbury ... 134

CLASSES FOR PROSPECTORS, 1930-31

Introduction ... 136
Attendance ... 136
Acknowledgments ... 138

ILLUSTRATIQN

Key map of the Sudbury nickel-copper area, showing principal industrial developments, including location of smelters, copper refinery and certain mines, also chemical plants at Coniston and Copper Cliff ..... *frontispiece*



Key map of the Sudbury nickel-copper area, showing principal industrial developments, including location of smelters, copper refinery and certain mines, also chemical plants at Coniston and Copper Cliff.

STATISTICAL REVIEW OF ONTARIO'S MINERAL INDUSTRY IN 1930

By W. R. Rogers and A. C. Young

General Remarks

While many industries throughout the country experienced severe depression during 1930 the mining industry as a whole maintained its position remarkably well, and although the total output was lower in value than in 1929, the decrease was small, particularly as regards the metallic group. The total value of Ontario's mineral production in 1930 was $113,641,468 as against $117,960,722 in the previous year, or a decrease of only 3.6 per cent. The detailed figures, as may be observed in Tables I and II, show the entire production separated into groups, as follows: Metallics $83,356,365, Non-Metallics $8,492,263, Structural Materials $16,571,626, and Clay Products $5,221,214. Table III gives an historical record by groups.

In the metal group there was a substantial increase in value of gold, namely from $33,535,226 in 1929 to $35,886,558 in the year under review. The value of the nickel contained in matte exported increased from $5,064,497 to $7,552,102, metallic copper from $12,087,832 to $14,015,480, and platinum metals from $1,646,381 to $2,436,683. On the other hand silver decreased in value, although the quantity produced rose from 8.7 to 10.5 million ounces. Copper in matte exported was lower both in quantity and value due to the fact that the bulk of the Ontario copper was refined in the Province, while the mattes exported were higher in nickel content.

Among the non-metallics, natural gas and salt recorded small gains in value in 1930 but not in quantity output, feldspar fell off about half, and gypsum was slightly lower. On the whole the non-metallics while lower than in 1929 maintained their position very well. Structural materials with the exception of sand and gravel were all lower, reflecting the lessened activity in building and construction. Clay products showed a decrease both in quantity and value, although agricultural or drain tile, while up in quantity, was lower in value than in 1929. More complete and detailed comment follow under the several items.

During the year the Abitibi canyon power development was undertaken by Ontario Power Service Company, a subsidiary of the Abitibi Power and Paper Company and a transmission line was surveyed from that point to Sudbury. According to Dr. F. A. Gaby, Chief Engineer of the Hydro-Electric Power Commission of Ontario, the length will be 260 miles, and with a load factor of 70 to 80 per cent., the cost of hydro-electric power in the Sudbury field in large blocks will be $22 per horsepower on 132,000-volt lines. The Power Commission has contracted for 100,000 horsepower. The natural head at the canyon is 97 feet. The dam will be 260 feet in height, giving an effective head of 237 feet. The gate ventage allows for 150,000 cubic feet per second, and the total development with 4 turbines will give 275,000 horsepower. With the installation of more turbines a maximum development of 376,000 horsepower is possible. The Abitibi canyon is 68 miles north of Cochrane and 55 miles southeast of the Onakawana lignite field. It is connected by a short spur line with the T. & N.O. railway.

TABLE I.—SUMMARY OF MINERAL STATISTICS OF ONTARIO FOR 1930

Product (tons of 2,000 lb.)	Quantity	Value	Employees	Wages
METALLIC:		$		$
Gold....oz.	1,736,012	35,886,558	6,848	10,750,758
Silver.... "	10,531,243	3,998,112	959	1,269,989
Copper in matte exported (a)....lb.	11,709,866	1,170,987	(b)4,970	7,607,177
Nickel in matte exported (a).... "	41,956,123	7,552,102		
Copper metallic and in concentrates, exported.... "	115,998,612	14,015,480		
Nickel, metallic and contained in speiss and ore exported.... "	57,482,455	15,485,854	(c)1,711	2,527,310
Nickel oxide and salts.... "	5,797,257	1,417,178		
Platinum metals....oz.	68,040	2,436,683		
Bismuth....lb.	12,732	6,366		
Cobalt, metallic and in residues exported Cobalt oxide (metal content).... " Cobalt in salts and unseparated oxides	694,163	1,144,007	(d) 223	247,668
Lead, pig, and in concentrates exported "	2,193,856	116,034	232	392,987
Zinc in concentrates exported.... "	3,527,894	127,004		
Total....	....	83,356,365	14,943	22,795,889
NON-METALLIC:				
Actinolite....tons	34	437	2	1,100
Arsenic, white....lb.	2,750,887	109,932	(d)....	....
Diatomite....tons	10	140	....	....
Feldspar, crude and ground.... "	9,722	104,670	88	34,449
Fluorspar.... "	80	1,240	....	....
Graphite, crude and refined.... "	1,338	86,543	33	32,081
Gypsum.... "	94,946	776,069	92	98,818
Iron pyrites and sulphur (e).... "	7,277	73,855	....	....
Mica.... "	741	34,275	194	35,148
Mineral waters....Imp. gals.	214,200	20,754	15	5,544
Natural gas....M. cu. ft.	7,943,416	5,061,588	1,328	1,545,648
Peat....tons	628	1,602	....	....
Petroleum, crude....bbls.	117,302	235,746	125	94,952
Quartzite and quartz....tons	167,487	274,674	49	54,586
Silica brick....M.	378	19,120	20	7,574
Salt....tons	248,637	1,558,405	263	288,237
Talc and soapstone.... "	11,664	133,213	36	32,718
Total....	....	8,492,263	2,245	2,230,855
STRUCTURAL MATERIALS:				
Cement, Portland....bbls.	3,942,690	5,779,404	836	1,094,384
Hydrated lime....tons	42,726	504,178	330	352,768
Quicklime.... "	209,340	1,673,409		
Sand and gravel.... "	10,215,859	3,559,487	567	568,464
Sand-lime brick (f)....M.	41,576	424,178	129	147,827
Stone: building, trap, granite, etc....tons	5,088,121	4,630,970	1,456	1,385,458
Total....	....	16,571,626	3,318	3,548,901
CLAY PRODUCTS				
Brick, face....no.	88,634,003	1,811,569		
" common.... "	51,720,660	779,744		
" fancy and ornamental.... "	264,946	23,858		
" sewer.... "	721,750	12,490		
Tile drain.... "	22,783,261	593,980	2,107	1,868,348
" structural....	....	848,556		
Sewer pipe, copings, flue-linings, etc....	....	834,361		
Pottery from domestic clay....	....	89,381		
Haydite....	....	227,275		
Total....	....	5,221,214	2,107	1,868,348
GRAND TOTAL....	....	113,641,468	22,613	30,443,993

(a) Copper and nickel in matte valued at 10 and 18 cents per pound, respectively.
(b) Employees and wages for nickel-copper mines and smelters.
(c) Employees and wages for nickel-copper refineries.
(d) Employees and wages for silver-cobalt smelters and refineries.
(e) Tonnage given is sulphur content.
(f) No deduction made for lime consumed in manufacturing.

TABLE II.—COMPARATIVE VALUE OF MINERAL PRODUCTION, 1926–1930

Product	1926	1927	1928	1929	1930
METALLIC:	$	$	$	$	$
Gold	30,950,753	33,627,040	32,629,111	33,535,226	35,886,558
Silver	5,781,706	5,230,402	4,156,431	4,630,820	3,998,112
Platinum metals	1,559,527	1,270,843	1,309,923	1,646,381	2,436,683
Cobalt (*a*)	1,136,014	1,764,534	1,671,900	1,801,915	1,144,007
Nickel (*b*)	14,374,163	15,262,171	22,318,907	27,115,461	24,455,134
Copper, metallic and in matte	4,828,964	4,946,533	8,770,149	14,622,609	15,186,467
Iron ore (*c*)	.....	.....	.....	.....	.....
Pig iron (*d*)	.....	.....	.....	.....	.....
Lead (pig) and in ore	580,730	528,729	402,289	294,431	116,034
Zinc in ore and concentrates	.....	.....	3,226	297,190	127,004
Bismuth	6,440	1,003	5,067	23,413	6,366
Total	59,218,297	62,631,255	71,267,003	83,967,446	83,356,365
NON-METALLIC:					
Abrasives (*e*)	576	.....	.....	.....	.....
Actinolite	1,000	1,075	875	375	437
Arsenic white	135,549	197,668	178,149	154,887	109,932
Asbestos	3,935	.....	.....	.....	.....
Beryl	.....	.....	.....	114	.....
Diatomite	.....	.....	.....	.....	140
Feldspar, crude and ground	199,102	154,533	180,153	206,979	104,670
Fluorspar	.....	.....	.....	1,120	1,240
Graphite, crude and refined	158,994	109,613	52,373	90,522	86,543
Gypsum	496,059	500,688	553,271	832,689	776,069
Iron pyrites and sulphur	4,912	6,077	(*f*) 54,100	(*f*) 54,056	73,855
Mica	59,085	75,183	32,945	45,919	34,275
Mineral waters	27,277	12,811	27,890	13,651	20,754
Natural gas	4,415,918	4,331,780	4,535,312	4,968,137	5,061,588
Peat fuel	.....	.....	5,845	4,500	1,602
Petroleum, crude	376,822	289,391	249,981	253,678	235,746
Phosphate of lime (apatite)	.....	824	.....	.....	.....
Quartzite and quartz	339,304	266,204	308,608	316,050	274,674
Silica brick	56,411	(*h*) 28,549	86,323	80,374	19,120
Salt	1,388,672	1,510,777	1,377,629	1,420,424	1,558,405
Talc and soapstone	178,986	181,981	179,187	180,492	133,213
Total	7,842,632	7,638,605	7,822,641	8,621,427	8,492,263
STRUCTURAL MATERIALS:					
Cement, Portland	4,792,857	5,144,326	5,520,897	6,608,246	5,779,404
Lime, hydrated and quicklime	2,051,446	2,198,239	2,467,843	3,364,412	2,177,587
Sand and gravel	2,117,461	2,035,793	2,056,366	3,156,254	3,559,487
Sand-lime brick	461,376	(*i*) 721,485	(*i*) 745,719	641,159	424,178
Stone: building,trap, granite, etc.	3,258,168	4,060,709	4,024,989	4,771,616	4,630,970
Total	12,681,308	14,160,552	14,815,814	18,541,687	16,571,626
CLAY PRODUCTS					
Brick, face	2,436,848	2,287,495	2,267,268	2,467,539	1,811,569
" common	768,734	1,063,724	1,154,763	1,188,688	779,744
" fancy and ornamental	20,047	25,016	25,714	9,012	23,858
" sewer	111,620	202,920	49,547	92,316	12,490
Tile, drain	340,403	521,957	572,577	629,322	593,980
" structural, roofing and floor	756,011	808,436	1,035,119	1,047,807	848,556
Sewer pipe, copings, flue-linings,	835,206	852,187	974,157	1,167,463	834,361
Pottery	87,600	91,300	98,519	96,394	89,381
Haydite	.....	.....	.....	131,621	227,275
Total	5,356,469	5,853,035	6,177,664	6,830,162	5,221,214
GRAND TOTAL	**85,098,706**	**90,283,447**	**100,083,122**	**117,960,722**	**113,641,468**

(*a*) Cobalt oxide, metallic cobalt, and cobalt content of residues marketed.
(*b*) Nickel in matte, oxide, and metallic nickel.
(*c*) Exports and shipments to points other than Ontario blast furnaces.
(*d*) Product from Ontario ore only. (*e*) Includes garnets and quartz pebbles.
(*f*) Includes value of sulphuric acid produced. (*g*) Includes value of silica brick.
(*h*) Not included in the total of non-metallics or grand total.
(*i*) No deduction made for lime consumed in manufacturing.

Table III shows the aggregate value of metallic products from the time production began in Ontario and of other minerals since the year 1891. As regards pig iron it should be pointed out that since 1914 the statistics of annual production credit the Province only with the value of the product made from Ontario ore. This is but a small part of the total output, since the great bulk of the iron ore charged to the blast furnaces of the Province is "lake" ore from the mines of Minnesota and Wisconsin. In the production tables credit is taken only for the ore exported or shipped to points other than Ontario blast furnaces, since to include the value of the domestic ore converted into pig iron in Ontario furnaces would involve a duplication of this item. The table follows:—

TABLE III.—TOTAL MINERAL PRODUCTION OF ONTARIO

Year	Value of Mineral Production				
	Metallic	Non-Metallic	Structural	Clay	Total
	$	$	$	$	$
Before 1891....	(a) 9,520,269		(a)		9,520,269
1891.....	388,715		4,316,958		4,705,673
1892.....	864,382		4,509,757		5,374,139
1893.....	614,762		5,505,991		6,120,753
1894.....	842,750		5,244,008		6,086,758
1895.....	616,055		4,554,083		5,170,138
1896.....	963,288		4,271,715		5,235,003
1897.....	1,038,089		4,480,452		5,518,541
1898.....	1,689,002		5,546,875		7,235,877
1899.....	2,055,592		6,361,081		8,416,673
1900.....	2,565,286		6,733,338		9,298,624
1901.....	5,016,734		6,814,352		11,831,086
1902.....	6,257,499		7,134,135		13,391,634
1903.....	5,242,575		7,628,018		12,870,593
1904.....	4,906,677		6,665,970		11,572,647
1905.....	10,201,010		7,653,286		17,854,296
1906.....	13,353,080		9,035,303		22,388,383
1907.....	14,550,835	3,020,537	3,876,275	3,571,726	25,019,373
1908.....	16,754,986	2,629,749	3,396,406	2,856,476	25,637,617
1909.....	22,928,496	2,825,751	4,028,206	3,198,922	32,981,375
1910.....	28,161,678	3,141,658	4,380,000	3,630,559	39,313,895
1911.....	29,102,867	3,674,926	4,935,609	4,263,395	41,976,797
1912.....	34,799,734	4,009,643	4,701,170	4,831,056	48,341,603
1913.....	37,507,935	4,296,450	5,866,775	5,561,151	53,232,311
1914.....	33,345,291	4,339,703	4,505,368	4,105,597	46,295,959
1915.....	44,109,769	4,655,250	3,609,371	1,871,379	54,245,679
1916.....	55,002,918	4,982,140	3,734,065	1,584,699	65,303,822
1917.....	56,831,857	7,702,942	4,962,284	2,596,749	72,093,832
1918.....	66,178,059	7,815,062	4,297,401	2,018,450	80,308,972
1919.....	41,590,759	6,308,182	7,208,413	3,776,562	58,883,916
1920.....	48,281,553	8,141,796	11,921,019	4,735,154	73,079,522
1921.....	28,777,581	6,636,217	13,967,386	5,183,125	54,564,309
1922.....	40,290,157	7,591,913	13,640,166	6,944,218	68,466,454
1923.....	44,076,660	8,511,786	13,139,757	6,269,140	71,997,343
1924.....	52,130,314	7,555,283	12,398,465	5,137,865	77,221,927
1925.....	62,495,472	7,488,034	12,451,174	5,148,626	87,583,306
1926.....	59,218,297	7,842,632	12,681,308	5,356,469	85,098,706
1927.....	62,631,255	7,638,605	14,160,552	5,853,035	90,283,447
1928.....	71,267,003	7,822,641	14,815,814	6,177,664	100,083,122
1929.....	83,967,446	8,621,427	18,541,687	6,830,162	117,960,722
1930.....	83,356,365	8,492,263	16,571,626	5,221,214	113,641,468
Total.....	1,183,492,962		562,713,602		1,746,206,564

(a) Prior to 1891, when the Ontario Bureau (now Department) of Mines was established it is estimated that metals to the value of $9,520,269 were produced. No estimate has been made of the output of non-metallics up to 1891.

In the total production of metals in Ontario noted hereunder, gold moved up from third to first place in 1927:—

Metal or Product	Production to December 31, 1929	Production, 1930	Production to December 31, 1930
	$	$	$
Gold	315,234,163	35,886,558	351,120,721
Nickel, including nickel oxide and salts	292,613,059	24,455,134	317,068,193
Silver	247,983,780	3,998,112	251,981,892
Copper (*a*)	105,987,805	15,186,467	121,174,272
Pig iron from domestic ore	84,775,556	.....	84,775,556
Cobalt (*b*)	22,948,374	1,144,007	24,092,381
Platinum metals	16,056,531	2,436,683	18,493,214
Iron ore (*c*)	9,463,516	.....	9,463,516
Lead	4,324,845	116,034	4,440,879
Molybdenite	209,735	.....	209,735
Zinc, in ore and concentrates	408,692	127,004	535,696
Bismuth	130,541	6,366	136,907
Grand Total	1,100,136,597	83,356,365	1,183,492,962

(*a*) Includes small quantities of copper sulphate.
(*b*) Includes metal, oxide, salts, and cobalt contents of residues exported.
(*c*) Value of ore shipped out of the Province.

Diamond-Drilling.—As a prospecting tool the diamond-drill continues in favour with the mining companies of Ontario. The following table gives data covering operations in Ontario during the past five years:—

DIAMOND-DRILLING OPERATIONS, 1926–1930

Year	Machines Operated	Holes Drilled	Core Extracted	
			Feet	or Miles
1926	71	1,986	385,932	70.8
1927	72	1,484	359,041	68.0
1928	85	1,901	485,304	91.9
1929	144	2,325	489,156	92.6
1930	98	2,298	417,851	79.1

DIAMOND-DRILL OPERATORS IN ONTARIO IN 1930

Name	Ontario Address	No. of drills active
Badeski, F	Timmins	11
Baker, John	Buckingham, P.Q.	1
Capital Engineering Co., Ltd	New Liskeard	3
Chisholm, D. D. (Kirkland Lake Diamond Drilling Co.)	Timmins	1
Dome Mines, Ltd	South Porcupine	2
McIntyre Porcupine Mines, Ltd	Schumacher	3
Mitchell, W. J., Diamond-Drill Company, Ltd	Cobalt	7
Morissette, N	Haileybury	5
O'Brien mine	Cobalt	2
Ontario Diamond-Drilling Co., Ltd	Sudbury	4
Ryan Diamond-Drilling Co., Ltd	Timmins	6
Smith & Travers	Sudbury	17
Smith, Oscar R., Diamond Drilling Co., Ltd	Sudbury	4
Sudbury Diamond-Drilling Co., Ltd	Sudbury	26
Wright-Hargreaves Mines, Ltd	Kirkland Lake	1
Total		93

In addition to the figures quoted considerable drilling was done in other provinces by eight of the seventeen firms active in 1930. The footages reported were: Quebec, 116,457; Manitoba, 7,383; Northwest Territories, 5,556; Saskatchewan, 4,052; and Nova Scotia, 2,575; or a total of 136,023 feet.

Statistics of exports of industrial diamonds are not available. It is known, however, that a considerable portion of the imports are re-exported. The following table gives the imports into Canada for a five-year period:—

IMPORTS OF DIAMOND DUST, BORT AND BLACK DIAMONDS, 1926–1930*

Source	1926	1927	1928	1929	1930
	$	$	$	$	$
United Kingdom	19,256	56,593	136,422	141,676	70,015
United States	930,850	1,304,976	2,115,508	2,560,323	1,334,769
British South Africa	.....	1,713	6,238	1,424	4,888
Australia	1,460	.....	.....	.....	.....
Belgium	4,324	1,351	5,403	11,091	29,912
Brazil	.....	.....	.....	445	.....
France	1,835	5,513	2,599	3,489	1,287
Netherlands	5,416	25,976	15,079	8,837	.....
Total Imports	963,141	1,396,122	2,281,249	2,727,285	1,440,871

*Data supplied by the Dominion Bureau of Statistics.

Gold

In the following table the value of the total gold output of the Province, exclusive of premium, is given, also that from Porcupine and Kirkland Lake:—

TABLE IV.—TOTAL GOLD PRODUCTION IN ONTARIO

Year	Total Production $	Porcupine		Kirkland Lake	
		$	Per cent.	$	Per cent.
1866-1891	(a) 190,258	.....	.....	.....	.....
1892-1909	(b) 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	86,316	1.9
1914	5,544,979	5,206,006	93.8	114,154	2.0
1915	8,501,391	7,462,111	88.6	551,069	6.5
1916	10,339,259	9,391,408	90.8	702,761	6.8
1917	8,698,735	8,229,744	94.5	404,346	4.6
1918	8,502,480	7,767,907	91.4	632,007	7.4
1919	10,451,709	9,941,803	95.1	486,809	4.7
1920	11,686,043	10,597,572	90.7	1,033,478	8.8
1921	14,692,357	13,103,526	89.5	1,524,851	10.4
1922	20,579,569	18,374,658	89.3	2,159,581	10.5
1923	20,136,287	17,313,115	85.9	2,719,939	13.5
1924	25,669,303	22,135,534	86.2	3,446,632	13.4
1925	30,206,432	24,733,120	81.8	5,385,256	17.8
1926	30,950,753	23,680,670	76.5	7,174,083	23.2
1927	33,627,040	23,851,857	70.9	9,674,114	28.7
1928	32,629,111	20,246,319	62.0	12,233,524	37.5
1929	33,535,226	19,281,286	57.6	14,046,596	41.8
1930	35,886,558	17,758,842	49.9	17,172,770	47.9
Total to end of 1930	351,120,721	265,151,195	75.5	79,548,286	22.7

(a) Estimated. (b) Maximum yearly output was $424,568 in 1899.

Gold from all sources in Ontario in 1930 totalled 1,736,012 fine ounces or an increase of 7 per cent. over the 1929 production. Of this total 1,712,153 ounces were recovered by the gold mines, 22,867 ounces from the refining of nickel-copper mattes, and 992 ounces were contained in ores and concentrates shipped out of the Province for treatment.

TABLE V.—ONTARIO'S GOLD PRODUCTION, 1930

Source	Ore milled, tons	Bullion shipped				Total Value of Bullion[1]
		Gold content		Silver content		
		Fine ounces	Value	Fine ounces	Value	
PORCUPINE			$		$	$
Ankerite (clean-up)	.....	41.86	865	36	13	878
Coniaurum	122,972	35,663.68	737,233	4,517	1,708	738,941
Dome (includes clean-up)	67,600	37,415.90	773,455	3,959	1,488	774,943
Hollinger	1,625,868	494,531.89	10,222,881	102,542	38,069	10,260,950
March	53,953	14,794.24	305,824	1,173	438	306,262
McIntyre	565,510	226,266.40	4,677,341	56,047	19,237	4,696,578
Porcupine United (Rochester)	7,815	2,745.41	56,753	421	160	56,913
Vipond	114,667	43,882.96	907,141	6,469	2,273	909,414
West Dome Lake	1,413	756.56	15,639	53	23	15,662
Miscellaneous[2]	.....	2,985.24	61,710	619	230	61,940
Total	2,559,798	859,084.14	17,758,842	175,836	63,639	17,822,481
KIRKLAND LAKE						
Argonaut (clean-up)	13	89.00	1,840	135	51	1,891
Barry-Hollinger	31,725	10,516.22	217,389	1,229	446	217,835
Kirkland Lake Gold	52,106	25,763.72	532,583	3,526	1,268	533,851
Lake Shore	550,501	377,830.89	7,810,457	69,629	26,322	7,836,779
Sylvanite	81,213	38,303.45	791,803	7,181	2,656	794,459
Teck-Hughes	338,555	260,774.69	5,390,690	20,243	7,581	5,398,271
Wright-Hargreaves	220,430	117,454 90	2,428,008	13,090	4,880	2,432,888
Total	1,274,543	830,732.87	17,172,770	115,033	43,204	17,215,974
NORTHWESTERN ONTARIO						
Botham (Bad Vermilion L.)	25	15.75	326	.....	.....	326
Grace (Michipicoten)	750	28.19	583	13	5	588
Howey (Red Lake)	110,438	22,146.58	457,810	8,785	3,047	460,857
Minto (Michipicoten)	1,074	123.64	2,556	6	3	2,559
St. Anthony (Sturgeon L.)	8	22.00	455	7	3	458
Total	112,295	22,336.16	461,730	8,811	3,058	464,788
TOTAL for Gold Mines	3,946,636	1,712,153.17	35,393,342	299,680	109,901	35,503,243
Nickel-Copper Refineries	.....	22,867.00	472,703			
In copper ores shipped to Noranda (Potter-Doal)	.....	56.53	1,168			
In Treadwell-Yukon exports	.....	935.80	19,345			
GRAND TOTAL (all sources)	.....	1,736,012.50	35,886,558			

[1]The premium received in addition to values quoted amounted to $20,911.63 from Porcupine and $15,790.69 from Kirkland Lake.

Small quantities of copper are recovered in the treatment of residues and slags produced by the auriferous quartz mines. In 1930 Vipond material contained 375 pounds, Argonaut 491, Barry-Hollinger 88, and Botham 89 pounds.

[2]High grading.

As may be seen in the preceding table giving the tonnages of ore milled, and output of mines, the Kirkland Lake area, represented by six mines, has made important strides in production and closely approached that of Porcupine represented by eight operating mines. Average grades of ore treated in these camps works out as $6.96 per ton at Porcupine and $13.50 at Kirkland Lake.

The milling rates per day of the several gold mines in order of tonnage for the month of December were: Hollinger 4,612 tons, Lake Shore 2,172, McIntyre 1,511, Dome 1,114, Teck-Hughes 923, Wright-Hargreaves 700, Howey 464, Coniaurum 355, Vipond 293, Sylvanite 247, March 190, Kirkland Lake Gold 122, and Barry Hollinger 85 tons. The new 1,500-ton Dome mill started operating in November but had not reached full capacity at the close of the year. Mill capacities are being increased at some of the properties. The Hollinger is equipped to treat a much greater tonnage. The new flotation section of the McIntyre mill was operating, and when the new mill is completed during 1931 capacity will be 2,000 tons daily. The Lake Shore mill enlargement was completed, and could be stepped up somewhat from the December figures without any increase of plant, while the Teck-Hughes was expected to have its enlarged mill in operation by the first of May, 1931, increasing capacity to 1,250 tons daily.

In Northwestern Ontario five properties produced a total of $464,788, of which the Howey accounted for $460,857. Considerable activity was apparent during 1930. A small gold mill was completed on the Cooper gold mine, Michipicoten area, by John Knox, Jr., and contract let for a 75-ton mill on the property of the Parkhill Gold Mining Company. The Goudreau mine was dewatered and exploratory work undertaken. In Moss township, west of Port Arthur, development was carried on by a company now known as Moss Gold Mines, Ltd. Recent financing has provided funds for further development, and a 100-ton mill is contemplated.

In the Boston Creek area the Telluride Gold Mines in Skead township started up its new mill and produced a gold-copper concentrate early in 1931.

A promising discovery of gold, known as the Ashley find, was made on October 6, in Bannockburn township about one mile east of the northwest corner. Diamond-drilling was undertaken at once by the Mining Corporation of Canada, one of the principal owners. By the end of the year two drills were operating which to the present have indicated a well defined ore body which offers encouragement to the owners. This discovery was followed by active staking of claims in the townships of Bannockburn, Argyle, Hincks, and Montrose.

The following figures summarize labour statistics as reported to the Ontario Department of Mines and Dominion Bureau of Statistics for the gold-mining industry:—

AVERAGE YEARLY WAGE, ONTARIO GOLD MINING, 1930

Loality	No. of Wage earners	Wages paid	Average Wage per annum
		$	$
Porcupine	4,186	6,447,018	1,540
Kirkland Lake	2,464	3,987,012	1,618
Northwestern Ontario	198	325,728	1,645
Operating but non-producing	195	204,290	1,047
Total	7,043	10,964,048	1,557

TABLE VI.—VALUE OF TOTAL PRODUCTION (GOLD AND SILVER) BY MINES OF THE KIRKLAND LAKE AREA

Year	Lake Shore	Teck-Hughes	Wright-Hargreaves	Tough-Oakes Burnside	Kirkland Lake	Sylvanite	Argonaut (a)	Barry-Hollinger	Canadian Associated Goldfields	Lucky Cross	Gold Hill	Ontario-Kirkland	Swastika	Total Value (b)
	$	$	$	$	$	$	$	$	$	$	$	$	$	$
1913	.....	.....	1,127	66,632	.....	.....	.....	.....	.....	14,006	.....	.....	7,172	88,937
1914	.....	.....	.....	117,644	.....	.....	5,204	.....	.....	.....	.....	.....	.....	122,848
1915	.....	.....	.....	555,539	.....	.....	.....	.....	.....	.....	.....	.....	.....	555,539
1916	.....	.....	.....	711,625	.....	.....	.....	.....	.....	.....	.....	.....	.....	711,625
1917	.....	66,722	.....	342,831	.....	.....	.....	.....	.....	.....	.....	.....	.....	409,553
1918	416,414	80,570	.....	139,683	.....	.....	.....	(c) 10,114	.....	.....	.....	.....	.....	646,781
1919	263,354	169,590	.....	.....	56,263	.....	2,631	.....	.....	.....	.....	.....	.....	491,838
1920	503,735	247,757	.....	.....	286,901	.....	26,863	.....	.....	.....	.....	.....	.....	1,065,256
1921	495,276	322,919	468,751	.....	242,417	.....	513	.....	.....	.....	.....	.....	.....	1,529,875
1922	471,341	596,495	762,753	107,481	224,396	.....	.....	.....	.....	.....	.....	10,082	.....	2,172,458
1923	547,600	1,117,963	754,979	12,174	223,102	.....	72,512	.....	.....	.....	.....	.....	.....	2,728,331
1924	1,098,572	1,023,025	1,088,725	47,547	46,512	.....	152,072	.....	.....	.....	.....	.....	.....	3,456,453
1925	1,958,720	996,943	1,913,401	263,064	.....	.....	214,183	56,978	.....	.....	.....	.....	.....	5,403,289
1926	2,775,000	1,601,209	2,150,844	309,709	126,999	.....	143,387	86,263	.....	.....	.....	.....	.....	7,193,411
1927	3,375,053	2,781,962	2,151,916	153,215	473,673	429,424	127,448	175,692	34,595	.....	(d) 865	.....	.....	9,703,843
1928	4,073,965	4,948,896	1,838,510	82,316	414,596	738,146	32,430	111,767	17,700	.....	12,784	.....	.....	12,271,110
1929	6,090,189	5,048,420	1,734,728	.....	352,789	689,465	9,959	151,758	.....	.....	.....	.....	.....	e14,089,233
1930	7,836,779	5,398,271	2,432,888	.....	533,851	794,459	1,891	217,835	.....	.....	.....	.....	.....	17,215,974
Total	29,905,998	24,400,742	15,298,622	2,909,460	2,981,499	2,651,494	789,093	810,407	52,295	14,006	13,649	10,082	7,172	79,856,444

(a) Exclusive of copper values. (b) Exchange premiums received in addition to the above valuations were as follows: 1920, $110,424; 1921, $121,425; 1922, $19,590; 1923, $37,812; 1924, $24,028; 1925, $231 discount; 1926, $595 discount; 1928, $2,810.55; 1929, $70,283; and 1930, $15,791. (c) Patricia mine, afterwards called Barry-Hollinger. (d) Samples shipped in 1923 and 1926 not heretofore reported. (e) Contains $11,925 miscellaneous (estimate of high-grade).

TABLE VII.—VALUE OF TOTAL PRODUCTION (GOLD AND SILVER) BY MINES OF THE PORCUPINE AREA

Year	Hollinger	Dome	McIntyre	Vipond	Porcupine Crown and Northcrown	West Dome Lake	Ankerite	Coniaurum	Night Hawk Peninsular	Schumacher (a)	March	Paymaster	Rea and Newray
	$	$	$	$	$	$	$	$	$	$	$	$	$
1910....	31,194	4,355	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1911....	6,000	4,277	.....	5,160	.....	.....	.....	.....	.....	.....	.....	.....	.....
1912....	909,181	737,499	77,657	16,259	.....	.....	.....	.....	.....	.....	.....	.....	.....
1913....	2,488,022	1,242,625	236,299	.....	Porcupine Crown 326,803	.....	.....	.....	.....	.....	.....	.....	Rea 18,858
1914....	2,719,355	1,05),238	549,166	73,628	685,135	.....	.....	.....	.....	.....	.....	.....	125,255
1915....	4,206,015	1,530,287	750,812	246,053	602,436	102,880	.....	.....	.....	48,236	.....	.....	.....
1916....	5,073,401	2,153,820	1,218,073	176,686	578,322	16,814	.....	.....	.....	225,301	.....	.....	.....
1917....	4,261,938	1,480,174	1,710,204	209,738	377,904	44,434	.....	.....	.....	198,605	.....	.....	Newray 1,447
1918....	5,752,371	82,127	1,578,444	82,868	124,474	103,745	.....	.....	.....	92,842	.....	.....	1,516
1919....	6,722,266	1,290,301	1,978,014	.....	.....	23,910	.....	.....	.....	.....	.....	.....	.....
1920....	6,219,665	2,020,568	2,223,083	.....	71,529	47,169	.....	.....	.....	.....	.....	.....	.....
1921....	9,051,276	2,290,264	1,827,761	.....	N'crown 97,301 / 7,943	.....	.....	.....	.....	.....	.....	.....	.....
1922....	12,274,114	4,178,936	2,021,811	.....	.....	.....	.....	.....	.....	.....	.....	2,800	.....
1923....	10,446,412	4,374,144	2,550,129	23,876	.....	.....	.....	.....	.....	.....	.....	.....	.....
1924....	13,433,063	4,307,624	3,604,874	596,803	.....	60,642	.....	.....	268,518	.....	.....	.....	.....
1925....	15,749,109	4,365,923	3,721,499	565,379	.....	287,758	.....	.....	196,947	.....	.....	.....	.....
1926....	14,829,655	3,940,053	3,862,074	631,636	.....	220,758	140,588	.....	111,154	.....	11,055	63,551	.....
1927....	14,539,538	4,031,575	3,965,210	667,724	.....	(b)35,252	359,005	.....	166	.....	19,839	135,025	.....
1928....	10,706,235	3,915,051	4,201,808	694,426	.....	.....	289,960	220,534	.....	.....	133,879	183,271	.....
1929....	9,455,290	3,590,537	4,295,491	820,667	.....	155,797	71,684	635,485	.....	.....	256,303	.....	.....
1930....	10,260,950	774,943	4,696,578	909,414	.....	15,662	878	738,941	.....	.....	306,262	.....	.....
Total...	159,135,050	47,374,321	45,068,987	5,720,317	2,871,847	1,114,821	862,115	1,594,960	566,885	564,984	727,338	384,647	147,076

(a) Purchased by the Hollinger in 1922. (b) Total value of bullion in 1927 was $87,919. Figures shown in above table allow for a deduction of $52,667 due to an erroneous return made in 1925.

TABLE VII.—VALUE OF TOTAL PRODUCTION (GOLD AND SILVER) BY MINES OF THE PORCUPINE AREA—*Continued*

Year	Porcupine United	David-son	Preston and Clifton	Scottish Ontario	Porcupine Pet	Porphyry Hill	Gold Reef	Tommy Burns	De Santis	Hughes	Miscel-laneous	Total Value (*c*)
	$	$	$	$	$	$	$	$	$	$	$	$
1910												35,549
1911												15,437
1912												1,740,596
1913			Preston			4,200						4,316,807
1914			Preston 15,212		5,000							5,231,989
1915					5,551	2,036	1,547					7,495,853
1916												9,442,417
1917							588	289				8,285,321
1918		15,579										7,833,966
1919		27,089										10,041,580
1920		11,246										10,690,561
1921												13,177,244
1922			Clifton 1,664									18,479,325
1923			Clifton 8,331								(*d*) 2,756	17,405,648
1924			Clifton 5,270									22,266,894
1925												24,886,615
1926									146	30		23,810,700
1927				5,893							(*e*) 217,350	23,976,577
1928				6,795							(*f*) 140	20,352,099
1929	44,285										(*g*) 47,701	19,373,240
1930	56,913										(*g*) 61,940	17,822,481
Total	101,198	53,914	30,477	12,688	10,551	6,236	2,135	289	146	30	329,877	266,680,899

(*c*) A record of total exchange premiums received in addition to the above amounts shows the following: 1920, $1,265,664; 1921, $1,238,211; 1922, $189,022; 1923, $207,742; 1924, $172,721; 1925, $2,607 discount; 1926, nil; 1928, $2,810.55; 1929, $87,173; and 1930, $20,912. (*d*) Huddlestone and Cline. (*e*) Includes "highgrade" recovered from W. P. Wilson. (*f*) Blue Quartz. (*g*) Highgrade.

TABLE VIII.—DIVIDENDS AND BONUSES PAID BY GOLD MINING COMPANIES TO DECEMBER 31, 1930

Name of Company	Date of Incorporation	Authorized Capital, $ or shares	Capital Stock Issued, $ or shares	Par value per share	Dividends and Bonuses paid to end of 1929, Amount	Dividends and Bonuses paid during 1930, Amount	Rate per cent., or per share, 1930	Total of Dividends and Bonuses paid to Dec. 31, 1930	Date when last Dividend or Bonus was paid
				$	$	$		$	
Dome Mines, Ltd. (a)	Sept. 30, 1923	1,000,000	1,000,000	No par	13,359,174.75	953,334.00	$1.00	14,312,508.75	Oct. 20, 1930
Hollinger Cons. Gold Mines, Ltd. (b)	May 25, 1916	25,000,000	24,600,000	5.00	51,342,400.00	3,444,000.00	14%	54,786,400.00	Dec. 31, 1930
Lake Shore Gold Mines, Ltd	Feb. 25, 1914	2,000,000	2,000,000	1.00	8,220,000.00	3,000,000.00	150%	11,220,000.00	Dec. 16, 1930
McIntyre-Porcupine Mines, Ltd	Mar. 16, 1911	4,000,000	3,990,000	5.00	8,399,408.00	798,000.00	20%	9,197,408.00	Dec. 1, 1930
Porcupine Crown Mines, Ltd	May 25, 1913	2,000,000	2,000,000	1.00	840,000.00	.....	.....	840,000.00	July 15, 1917
Rea Consolidated Gold Mines, Ltd	April 5, 1911	1,000,000	200,000	5.00	12,000.00	.....	.....	12,000.00	1915
Schumacher Gold Mines, Ltd. (c)	Jan. 6, 1914	2,000,000	1,850,000	1.00	.....	.....	.....	.....	.....
Sylvanite Gold Mines, Ltd	June 13, 1913	3,300,000	3,299,500	1.00	.....	65,590.00	2%	65,590.00	Dec. 20, 1930
Teck-Hughes Gold Mines, Ltd., The	Mar. 1, 1923	5,000,000	4,767,144	1.00	6,914,858.80	2,872,286.40	60%	9,787,145.20	Nov. 1, 1930
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
Vipond Consolidated Mines, Ltd	July 17, 1922	2,500,000	2,250,000	1.00	67,500.00	.....	.....	67,500.00	April 5, 1927
Wright-Hargreaves Mines, Ltd. (d)	June 16, 1916	5,550,000	5,550,000	No par	4,331,250.00	.....	.....	4,331,250.00	Nov. 1, 1928
Total	.....	.....	.....	.....	93,885,216.55	11,133,210.40	.....	105,018,426.95	.....

(a) On April 22, 1922, the capital of Dome Mines Co., Ltd., was reduced from $5,000,000 to $4,500,000 and $476,667 distributed to shareholders in addition to dividends paid to September 30, 1923, when the new company, Dome Mines, Limited, issued 1,000,000 N.P.V. shares at $7.00 per share. Of these 46,666 shares are transferred to a Trustee and held in trust for the company.

(b) Hollinger Consolidated Gold Mines, Limited, is an amalgamation of the Acme Gold Mines, Ltd.; Millerton Gold Mines, Ltd.; and Hollinger Gold Mines, Ltd. Dividends include $160,000 paid in 1915 by Acme, also $4,170,000 paid by Hollinger to May 25, 1916, the date of consolidation.

(c) The Schumacher mine was sold to the Hollinger in 1922 and a total of $1,591,000 or 86 per cent. of the assets distributed to shareholders, the final payment being made July 30, 1923.

(d) The authorized and issued capital was changed in May, 1927, from 2,750,000 shares of $1.00 par value to 5,550,000 shares of "no par" value.

TABLE IX.—YEARLY DIVIDENDS AND BONUSES PAID BY ONTARIO GOLD MINING COMPANIES, 1912–1930

Year	Porcupine						Kirkland Lake					Total
	*Hollinger Consolidated	Porcupine Crown	Dome Mines†	Rea	McIntyre	Vipond	Tough-Oakes	Lake Shore	Teck-Hughes	Wright-Hargreaves	Sylvanite	
	$	$	$	$	$	$	$	$	$	$	$	$
1912	270,000											$270,000.00
1913	1,170,000											1,170,000.00
1914	1,170,000	240,000										1,410,000.00
1915	1,560,000	240,000	400,000.00	12,000			132,875					2,344,875.00
1916	3,286,000	240,000	800,000.00				265,750					4,591,750.00
1917	738,000	120,000	300,000.00		541,542.45							1,699,542.45
1918	1,230,000				543,042.45			100,000				1,873,042.45
1919	1,722,000				364,028.30			100,000				2,186,028.30
1920	2,214,000		416,886.00		546,042.45			80,000				3,256,928.45
1921	3,198,000		478,947.75		546,042.45			120,000				4,342,990.20
1922	3,198,000		715,000.00		546,042.45			80,000		412,500		4,951,542.95
1923	3,198,000		1,430,001.00		548,542.45			160,000		206,250		5,542,793.45
1924	3,198,000		1,906,668.00		774,125.00			380,000		206,250		6,465,043.00
1925	4,378,800		1,906,668.00		798,000.00			600,000		550,000		8,233,468.00
1926	5,805,600		1,906,668.00		798,000.00			1,000,000	474,714.40	893,750		10,878,732.40
1927	6,396,000		1,191,667.50		798,000.00	67,500		1,400,000	713,571.60	1,237,500		11,804,239.10
1928	5,412,000		953,334.00		798,000.00			2,000,000	2,860,286.40	825,000		12,848,620.40
1929	3,198,000		953,334.00		798,000.00			2,200,000	2,866,286.40			10,015,620.40
1930	3,444,000		953,334.00		798,000.00			3,000,000	2,872,286.40		65,590	11,133,210.40
Total	54,786,400	840,000	14,312,508.75	12,000	9,197,408.00	67,500	398,625	11,220,000	9,787,145.20	4,331,250	65,590	105,018,426.95

*Includes $160,000 paid by the Acme in 1915, before amalgamation with the Hollinger. †Does not include repayment of capital of $476,667 in 1922.

RECEIPTS OF CRUDE GOLD BULLION FROM ONTARIO MINES AT THE ROYAL MINT, OTTAWA, 1926–1930

Year	Crude ounces	Precious Metals			Buying rate in Canada for New York Funds*
		Gold, fine oz.	Silver, fine oz.	Total Value	
				$	
1926	1,610,195	1,256,570	224,106	26,112,717	100.0125
1927	1,721,111	1,338,192	229,657	27,793,399	100.0109
1928	1,537,295	1,217,622	199,470	25,285,865	100.0817
1929	412,058	328,556	54,068	6,821,876	100.747
1930	908,209	713,527	86,419	4,760,111	100.147

*The average rate of premium in New York funds is based on the day to day record of current quotations.

World Output.—The following statement of output by the leading gold-producing countries, for 1915 (year of maximum world production), for 1919 (first post-war year), also for 1922 and subsequent years, has been abstracted chiefly from annual reports of the Director of the United States Mint. It will be noted that Canada now holds second place among the gold-producing countries of the world, having overtaken the United States (exclusive of the Philippine Islands) in 1930. The Province of Ontario, as deduced from the table, now produces 82 per cent. of Canada's gold.

OUTPUT BY LEADING GOLD-PRODUCING COUNTRIES AND STATES

(Millions of Dollars)

Source	1915	1919	1922	1923	1924	1925	1926	1927	1928	1929	1930
World	470.0	365.9	319.4	367.8	393.4	393.3	400.0	401.7	408.4	403.0	416.8
Transvaal	188.0	172.2	145.1	189.1	197.9	198.4	205.8	209.3	214.0	215.2	221.5
Canada	19.0	15.9	26.1	25.5	31.5	35.9	36.3	38.3	39.1	39.9	43.6
United States	101.0	60.3	47.3	50.2	50.6	48.0	46.3	43.8	44.3	42.5	43.4
Ontario	**8.5**	**10.5**	**20.7**	**20.1**	**25.7**	**30.2**	**30.9**	**33.7**	**32.6**	**33.5**	**35.9**
Russia(U.S.S.R.)	26.3	11.0	3.0	5.2	19.8	21.9	20.5	21.9	24.8	17.3	17.9
Mexico	6.6	15.2	15.5	16.2	16.5	16.3	16.0	15.0	14.5	13.5	13.9
Oceania†	49.0	26.1	18.8	18.1	16.5	14.0	13.5	14.2	13.1	12.1	12.1
Rhodesia	18.9	12.3	13.5	13.4	13.0	12.0	12.3	12.0	11.9	11.6	11.3
California	21.4	17.4	14.7	13.4	13.2	13.1	11.9	11.7	10.6	8.5	9.1
Australia	40.3	21.5	15.9	14.9	14.2	11.7	10.9	11.6	10.6	8.3	9.2
West Australia	25.0	15.2	11.1	10.4	10.0	9.1	9.0	8.4	8.1	7.8	8.6
India	11.5	10.5	9.0	7.9	8.2	8.1	7.9	7.9	7.8	7.5	6.8

†Includes Australia and New Zealand.

Maximum World production.....470.0 million dollars in 1915.
Maximum U.S. production.....101.0 " " "
Maximum Transvaal production.....221.5 " " 1930

Silver-Cobalt

The output and shipments of silver in 1929 and 1930 are shown below. It should be pointed out that the figures given are based as nearly as possible on actual sales of bullion and silver contained in concentrates and residues exported, with the gross values as reported by the producers before deducting treatment and shipping charges. The figures for any one year do not agree with those in Tables XI and XII but average up over a period of years:—

SILVER PRODUCTION, 1929–1930

Source	1929		1930	
	Fine Ounces	Value	Fine Ounces	Value
		$		$
Sales of bullion by the reduction companies, smelters, and mines	7,166,459	3,823,599	8,436,688	3,217,242
Contained in silver-cobalt concentrates and residues exported	804,081	416,381	673,197	243,005
Estimated as recovered from copper-lead-zinc concentrates exported	52,787	27,972	51,267	19,560
Estimated recoveries by Noranda smelter from Ontario copper ores	1,030	546	3,257	1,243
In crude gold bullion	257,745	134,697	299,680	109,901
Recovered by nickel-copper refineries	429,541	224,272	1,067,154	407,161
Total	8,711,643	4,630,820	10,531,243	3,998,112

Shipments of silver mines by camps during 1930 were as follows:—

	Silver, fine oz.	Cobalt*	
		Quantity	Value
		lb.	$
Cobalt	5,329,335	436,942	182,179
Gowganda	2,141,234	107,264	15,067
South Lorrain	1,754,989	391,466	185,003
Total	9,225,558	935,672	382,249

*Figures represent the quantities paid for by the smelters, and values received by the mines.

TABLE X.—OPERATIONS OF ONTARIO SILVER-COBALT REFINERIES IN 1930

Products marketed	Sales	
	Quantity	Value
		$
Silver bullion, fine oz.	6,615,045	2,511,000
Arsenic, white, lb.	2,501,946	95,004
Arsenic, other forms, "	248,734	14,924
Cobalt products, including metals and metallic content of all oxides, mixed oxides and salts, "	404,473	991,766
Nickel oxide, and salts (metal content), "	104,659	27,205
Base bullion (*a*), "	75,301	45,304
Speiss residues (*b*), "	2,099	1,041
Total		3,686,244

(*a*) Contains silver, lead, bismuth and antimony.
(*b*) Speiss residues contain silver, cobalt, nickel and arsenic.

TABLE XI.—TOTAL SHIPMENTS FROM SILVER MINES, SMELTERS AND REFINERIES, 1904–1930

Year	Bismuth		Copper(a)		Lead(a)		Nickel(b)		Cobalt(c)		Arsenic		Silver		Total Value
	Tons	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	3,764,113
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(d)	.....	.....	.....	.....	.....	.....	90	28,978	351	590,406	2,030	116,624	25,162,841	12,765,461	13,501,469
1915	.....	.....	.....	.....	.....	.....	35	28,353	206	383,261	2,490	148,379	24,746,534	12,135,816	12,695,809
1916	.....	.....	.....	.....	.....	.....	79	59,380	400	805,014	2,160	200,103	19,915,090	12,643,175	13,707,672
1917	.....	.....	53	28,840	.....	.....	155	125,071	337	1,138,190	2,592	608,483	19,401,893	16,121,013	18,021,597
1918	.....	.....	72	35,712	3	453	186	156,893	380	1,640,310	2,545	566,332	17,661,694	17,341,790	19,741,490
1919	.....	.....	110	40,976	12	1,296	276	188,418	298	1,019,479	2,834	485,360	11,214,317	12,738,994	14,474,523
1920	.....	.....	50	17,494	5	792	127	93,233	283	1,605,365	1,883	431,527	10,846,321	10,654,471	12,802,882
1921	.....	.....	103	34,504	3	270	10	7,665	126	616,235	1,491	233,763	8,261,931	5,564,594	6,457,031
1922	.....	.....	93	26,346	16	1,891	61	34,987	(f)776	1,333,676	2,059	299,940	10,711,127	7,658,802	9,355,642
1923(e)	9	48,139	56	16,214	26	3,738	42	19,321	380	1,803,872	2,579	582,794	10,377,846	6,677,367	9,151,445
1924	6	16,079	55	14,290	45	7,295	130	26,862	476	1,662,526	1,915	323,186	10,361,945	7,009,984	9,060,222
1925	10	18,578	77	17,007	31	1,888	290	116,347	558	2,328,517	1,078	113,325	9,614,881	6,700,129	9,295,791
1926	3	6,440	35	5,394	11	1,463	83	30,051	332	1,136,014	2,025	135,549	8,981,557	5,541,009	6,855,920
1927	1	1,003	20	2,940	3	312	100	52,829	440	1,764,534	2,481	197,668	8,883,829	4,970,194	6,989,480
1928	7	5,067	38	15,764	27	2,169	111	57,039	477	1,671,900	2,049	178,149	6,688,454	3,882,570	5,812,658
1929	13	23,413	13	3,098	3	267	115	63,167	464	1,801,915	1,871	154,887	7,970,540	4,239,980	6,286,727
1930	6	6,366	23	5,070	22	1,748	53	27,455	347	1,143,631	1,375	109,928	9,109,885	3,460,247	4,754,445
Total	54	125,085	798	263,649	207	23,582	5,642	1,158,236	14,287	23,916,374	64,974	5,336,977	405,408,499	248,390,692	279,214,595

(a) Copper and lead are recovered from certain silver ores and concentrates shipped to United States refineries.
(b) Nickel metal and metallic contents of all nickel compounds.
(c) Cobalt metal and metallic contents of all cobalt compounds, also cobalt contained in ores and speiss residues exported.
(d) Prior to 1914 an estimate based on assays was made of the nickel, cobalt and arsenic in the ores. Since that date recoveries have been reported.
(e) Recoveries of bismuth from base bullion were not reported prior to 1923. (f) Includes 460 tons of speiss residues worth $153,116.

The following table shows statistics based on the metal contents of shipments of ore and concentrates and should not be confused with the figures in the main table on page 2 and Table XI immediately preceding. Silver shown as shipped in Table XII has been compiled for each mining area and is mainly the silver contents of ore or concentrates shipped to the reduction works at Cobalt or to the silver smelters. Of necessity there is a lag and it does not follow that all the ores, etc., shipped have received treatment during the year by smelters, although in the yearly aggregate, and more particularly over a period of years, these figures will agree closely with those for silver bullion sold, as given in the table on page 2 and also in Table XI.

Since the discovery of silver at Cobalt in 1903 the silver contents of shipments from this camp and outlying silver areas, as reported by the operators, have been as follows:—

TABLE XII.—SILVER SHIPMENTS BY CAMPS, 1904-1930

Year	Average price, cents per ounce (New York)	Silver Content in Troy Ounces					
		Total Ounces	Cobalt	Casey Township	South Lorrain	Gowganda	Montreal River and Maple Mountain
1904	57.221	206,875	206,875	.....	.....	.....	.....
1905	60.352	2,451,356	2,451,356	.....	.....	.....	.....
1906	66.791	5,401,766	5,401,766	.....	.....	.....	.....
1907	65.237	10,023,311	10,023,311	.....	.....	.....	.....
1908	52.864	19,437,875	19,424,251	500	13,124	.....	.....
1909	51.502	25,897,825	25,658,683	26,185	194,955	.....	18,002
1910	53.486	30,645,181	29,849,981	92,544	221,133	471,688	9,835
1911	53.340	31,507,791	29,989,893	114,789	933,912	468,687	510
1912	60.835	30,243,859	28,605,940	253,824	834,119	549,976	.....
1913	57.791	29,681,975	28,105,505	825,108	248,992	502,370	.....
1914	54.811	25,162,841	24,155,699	499,643	108,199	399,300	.....
1915	49.684	24,746,534	24,280,366	223,939	.....	242,229	.....
1916	65.661	19,915,090	19,008,517	445,900	77,280	383,393	.....
1917	81.417	19,401,893	18,327,258	.....	10,000	1,064,635	.....
1918	96.772	17,661,694	16,807,407	143,901	72,188	638,198	.....
1919	111.122	11,214,317	10,314,689	171,278	4,586	723,764	.....
1920	100.900	10,846,321	10,402,249	.....	8,253	433,352	(a) 2,467
1921	62.654	8,261,931	7,673,535	1,011	328,886	258,292	117
1922	67.528	10,711,127	9,239,147	1,028	1,284,307	170,651	(b) 15,994
1923	64.873	10,377,846	7,259,858	.....	2,955,646	160,761	1,581
1924	66.781	9,935,902	6,704,787	.....	2,633,058	598,057	.....
1925	69.065	10,707,235	6,252,115	.....	3,099,964	1,355,156	.....
1926	62.107	10,543,473	6,262,249	.....	3,044,584	1,236,640	.....
1927	56.370	8,543,513	4,482,543	.....	2,319,356	1,741,614	.....
1928	58.176	6,745,401	3,934,020	.....	1,133,952	1,677,429	.....
1929	52.993	7,781,429	4,823,529	.....	876,006	2,081,894	.....
1930	38.154	9,225,610	5,329,335	.....	1,754,989	2,141,234	(c) 52
Total	.....	407,279,971	364,974,864	2,799,740	22,157,489	17,299,320	48,558

(a) Includes 885 ounces from Silver Islet, Lake Superior.
(b) Silver Islet, Lake Superior.
(c) Nickel Hill Syndicate in the Sudbury area shipped a silver-cobalt ore.

TABLE XIII.—DIVIDENDS AND BONUSES PAID BY SILVER MINING COMPANIES TO DECEMBER 31, 1930

Name of Company	Date of Incorporation	Authorized Capital	Capital Stock Issued	Par value per Share	Dividends and Bonuses paid to end of 1929	Dividends and Bonuses paid during 1930	Total Dividends and Bonuses paid to 31st Dec., 1930	Date when last Dividend was paid
		$	$	$	$	$	$	
Aladdin Cobalt Company, Limited	Aug. 23, 1912	500,000	500,000	5.00	75,000.00	.....	75,000.00	Apr. 30, 1917
Beaver Consolidated Mines, Ltd.	Mar. 1, 1907	2,000,000	2,000,000	1.00	710,000.00	.....	710,000.00	May 31, 1920
Buffalo Mines, Ltd., The (*a*)	April 27, 1906	500,000	500,000	.50	2,787,000.00	.....	2,787,000.00	May 28, 1924
Casey Cobalt Silver Mining Co., Ltd.	Dec. 19, 1906	100,000	100,000	1.00	203,249.33	.....	203,249.33	April 22, 1914
Castle-Trethewey Mines, Ltd. (*b*)	Jan. 20, 1922	2,000,000	2,000,000	1.00	18,027.00	.....	18,027.00	April 15, 1925
Cobalt Central Mines Co., Ltd.	Dec. 13, 1905	5,000,000	5,000,000	1.00	192,845.00	.....	192,845.00	Aug. 25, 1909
Cobalt Comet Mines, Ltd. (*c*)	April 16, 1913	1,000,000	1,000,000	1.00	230,000 00	.....	230,000.00	April 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	11,440,000.00	.....	11,440,000.00	May 1, 1924
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. (*d*)	July 16, 1909	3,500,000	3,200,050	5.00	778,909.42	.....	778,909.42	Aug. 31, 1913
Keeley Silver Mines, Ltd.	June 22, 1922	2,000,000	2,000,000	1.00	2,240,000.00	.....	2,240,000.00	Mar. 15, 1928
Kerr Lake Mining Company, Ltd. (*e*)	Aug. 9, 1905	40,000	40,000	100.00	10,521,000.00	.....	10,521,000.00	Oct. 13, 1927
La Rose Mines, Ltd.	May 31, 1908	1,500,000	1,500,000	1.00	6,600,546.84	.....	6,600,546.84	Mar. 24, 1923
Lorrain Trout Lake Mines, Ltd.	Mar. 20, 1923	1,500,000	1,500,000	1.00	150,000.00	.....	150,000.00	July 15, 1925
McKinley-Darragh-Savage Mines of Cobalt, Ltd.	April 27, 1906	2,500,000	2,247,692	1.00	5,955,391.86	.....	5,955,391.86	Oct. 1, 1920
Mining Corporation of Canda, Ltd.	Nov. 23, 1916	8,300,250	8,300,250	5.00	7,573,937.47	.....	7,573,937.47	Dec. 19, 1929
City of Cobalt Mining Co., Ltd. (*f*)	Jan. 7, 1909	1,500,000	1,500,000	1.00	145,000.00	.....	145,000.00	April 15, 1920

Cobalt Lake Mining Co., Ltd. (*f*)	Dec. 22, 1906	3,000,000	3,000,000	1.00	465,000.00	.....	465,000.00	May 29, 1914
Cobalt Townsite Mining Co., Ltd. (*f*)	May 8, 1906	100,000	45,011	1.00	1,042,259.61	.....	1,042,259.61	Nov. 11, 1914
Nipissing Mining Co., Ltd. (*g*)	Dec. 16, 1904	250,000	250,000	100.00	30,678,297.25	370,000.00	31,048,297.25	Dec. 31, 1930
Penn-Canadian Mines, Ltd. (*h*)	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 Mines, Ltd.	Sept. 11, 1909	2,000,000	1,685,500	1.00	252,825.00	.....	252,825.00	Mar. 17, 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
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	2,159,156.25	.....	2,159,156.25	Jan. 31, 1920
Temiskaming and Hudson Bay Mining Co., Ltd.	July 10, 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 June 1, 1911	2,000,000	1,000,000	1.00	1,211,998.50	.....	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(*i*)	.....	.....	.....	.....	97,101,281.16	370,000.00	97,471,281.16	.....

(*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, but returning to shareholders amounts equal to the reduction in capital, leaving 300,000 shares issued of 50 cents each. The mine was sold to the Mining Corporation of Canada, and operated by it in 1920 and subsequently.

(*b*) 200,000 preferred shares, par $1.00, redeemed April, 1925, and capital reduced from $2,200,000 to $2,000,000.

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

(*d*) Name of company changed from Temiskaming and Hudson Bay in 1909.

(*e*) In addition a return of capital amounting to $600,000 was made on July 3, 1919, to stockholders of the Kerr Lake Mines, Ltd.

(*f*) Mining Corporation of Canda, Limited, now owns and operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines.

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

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

(*i*) Does not include dividends by private companies such as M. J. O'Brien, Ltd.

Nickel-Copper Industry

During the period the International Nickel Company of Canada, Limited, at Sudbury brought practically to completion the huge plant extension undertaken in 1928. In addition, other establishments such as the Ontario Refining Company and the Canadian Industries, Limited, completed their plants as indicated below. The discovery by diamond-drilling in 1927 of the rich ores in the Frood mine below 2,000 feet in depth greatly influenced the development policy of the International company. Since this rich deposit was partly owned by the Mond Nickel Company and it appeared that economies could be effected by working the deposit as a unit, a plan of amalgamation of the two companies was proposed late in 1928 by Lord Melchett on behalf of the Mond company. Upon this amalgamation being effected at the close of that year extensive plans of development were made. These included an increase in the capacity of the Mond plant at Coniston from 2,700 tons per month to 6,300 tons, and at Sudbury the construction of a concentrator of 8,000 tons capacity per day, bins of 6,000 tons capacity, roasters, 5 reverberatory furnaces and 8 converters. The maximum capacity of the enlarged plants will be 140 million pounds of nickel and 200 to 240 million pounds of copper per annum.

Owing to the completion of the construction work, and also to the general business depression throughout the world and its resulting effect on the market for nickel and copper, some reductions in staff were made and output was curtailed during the year, 1930. On June 1 production from the Creighton mine was reduced from 100,000 tons of ore per month to 50,000 tons and again on November 1 this output was dropped to 35,000 tons. On June 1 the Garson output was reduced from 30,000 tons to 20,000 tons per month. The Frood mine which had in the meantime been developed to a capacity of 110,000 tons of ore per month was reduced on November 1 to 75,000 tons. The Levack mine was idle during the year except for development work and surface construction. A new head frame and rock house was erected at this mine to replace that destroyed by fire in December, 1929. Despite these curtailments the month of October established a record for matte produced by the International Nickel Company. On November 1 one reverberatory out of five active units was closed.

The Falconbridge Nickel Company blew in its 250-ton smelter on February 1, 1930, and closed down temporarily November 1 in order to allow the refinery in Norway to absorb the supplies of matte accumulated. The smelter resumed operations in February, 1931, on a 300-ton daily basis, some alterations having been made during the shut-down.

The refinery of this company in Southern Norway, about 300 miles from Oslo, was practically rebuilt and started again in April, 1930. It produces 8 and 2½ metric tons of nickel and copper, respectively, per day. No precious metals have as yet been recovered from the slimes which are accumulating. Products are marketed mostly in England, France and Italy. Of the matte treated in the refinery, 70 per cent. comes from Ontario, and the balance from Norway on a customs basis. The company is known as the Falconbridge Nikkelverk, and the address is Kristiansand South, Norway.

Copper Refining.—The Ontario Refining Company, owned jointly by the International Nickel Company, American Metal Company, Consolidated Mining and Smelting Company, and Ventures, Limited, has constructed a copper refinery at Copper Cliff, at present the largest of its kind in the British Empire and capable of producing 10,000 tons of electrolytic copper per month. The first refined copper was produced on July 14. Output to the end of 1930 was 25,377

tons. In connection with the copper refinery, a gold and silver division to recover these metals is nearing completion. Provision is also made for the preliminary treatment of the rich platinum metal residues recovered at Port Colborne and at Sudbury. These are finally treated and refined at Acton, near London, England, in a plant owned by the company.

The table following gives the record of mining and smelting operations for the last five years:—

TABLE XIV.—NICKEL-COPPER MINING AND SMELTING, 1926–1930

Schedule	1926	1927	1928	1929	1930
Ore raised.....tons	1,322,050	1,305,917	1,457,910	1,991,910	2,115,139
Ore smelted..... "	1,309,782	1,350,214	1,476,704	2,033,457	2,357,154
Bessemer matte produced..... "	78,643	81,848	91,313	132,030	166,703
Nickel content..... "	39,038	39,623	43,393	58,095	61,112
Copper content..... "	24,159	25,969	29,704	46,315	70,800
Matte exported*..... "	34,908	33,541	39,310	28,402	34,550
Nickel content..... "	16,988	15,762	18,856	14,068	20,978
Copper content..... "	11,596	11,682	13,221	8,449	5,855
Matte refined in Canada..... "	33,489	39,253	67,866	109,818	139,635
Men employed.....No.	3,132	3,418	3,845	4,546	5,246
Wages paid.....$	4,359,066	4,919,445	6,005,697	7,069,995	7,992,294

*All matte was exported prior to 1918 when refining in Canada began at Port Colborne, Ontario. The British America Nickel Corporation commenced refining operations at Deschênes, Quebec, in 1920, and closed down finally in July, 1924.

Refineries.—During the year the International Nickel Company of Canada at Port Colborne recovered electrolytic and refined nickel; nickel oxide; converter copper; platinum, palladium and other metals of the platinum group in the form of residues; also the precious metals, gold and silver. The record for 1929 and 1930 is shown in the following table:—

TABLE XV.—NICKEL-COPPER REFINING, 1929–1930

Schedule	1929		1930	
	Quantity	Value	Quantity	Value
		$		$
Matte, treated.....tons	109,818	.....	139,635	.....
Nickel oxide, marketed.....lb.	14,400,198	3,347,983	5,452,826	1,389,973
Metallic nickel, recovered..... "	70,704,762	18,639,814	57,478,651	15,485,381
Blister copper, recovered*..... "	74,265,747	11,880,306	119,006,163	12,748,178
Gold, recovered†.....ounces	4,420	91,370	22,862	472,600
Silver, recovered†..... "	349,632	181,861	1,067,092	407,138
Platinum metals, recovered†.... "	29,615	1,646,381	68,040	2,436,683
Employees.....No.	1,302	.....	1,259	.....
Wages paid.....$	.....	2,098,550	.....	1,994,866

*In 1930 a portion of the blister copper from Port Colborne was shipped for refining to Copper Cliff, where 59,838,505 pounds of electrolytic copper was recovered. This copper was valued at 12.982 cents per pound. The value of the blister as shown in the table is the company valuation.

†Includes recoveries by the Mond division at Clydach in Wales and at Acton, England. The gold and silver content of Strathy township ore shipped in 1930 is excluded.

TABLE XVI.—PRECIOUS METALS RECOVERED, 1926–1930

	1926	1927	1928	1929	1930†	
	Ounces	Ounces	Ounces	Ounces	Ounces	Value,
						$
Gold	4,447*	4,866*	3,850	7,802	22,867	472,703
Silver	151,429	188,180	222,924	429,541	1,067,154	407,161
Platinum metals:						
Platinum	9,471	11,217	10,452	12,474	34,000	1,542,172
Palladium	9,790	11,247	11,389	12,231	29,907	687,861
Rhodium, Ruthenium, Osmium and Iridium	234	298	1,689	4,910	4,133	206,650
Total ounces	19,495	22,762	23,539	29,615	68,040	.....
Value $	1,559,527	1,270,843	1,309,923	1,646,381	.....	2,436,683

*Includes small recoveries of the rhodium group by the Mond Nickel Company.
†In 1930, 5 oz. gold, 62 silver, 4 platinum, and 14 palladium were included in ore exported from Strathy township.

The average price obtained for platinum in 1930 was $45.36 and for palladium $23.00 per fine ounce. Prices of the rarer platinum metals fluctuate so widely that average prices are difficult to secure.

Heavy Chemicals—In the first separation of nickel and copper sulphides into copper "tops" and nickel "bottoms," large quantities of nitre cake are necessary, and to provide for this the Canadian Industries, Limited, has established an acid plant comprising three units, each of 50 tons capacity, or a total of 150 tons per day; a nitre cake plant which started in July where the sodium sulphate from Saskatchewan is treated with sulphuric acid for the production of nitre cake; and also a storage plant for the sodium sulphate. Thus Copper Cliff has become an important centre for the manufacture of heavy chemicals. Canadian Industries also operates the original acid plant at Coniston, which was built in 1925 by the Mond Nickel Company.

Copper.—The details of copper production in 1929 and 1930 follow:—

Source of copper	1929		1930	
	Quantity	Value	Quantity	Value
	lb.	$	lb.	$
Metal content of Port Colborne converter copper*	70,835,430	11,880,306	114,934,859	13,878,421
In nickel-copper matte exported	16,898,515	2,534,777	11,709,866	1,170,987
In Cobalt ores exported to U.S. and Noranda†	52,118	9,437	47,041	5,070
In Ontario copper ore treated at Noranda smelter	104,955	19,004	18,371	2,386
In lead-zinc-copper concentrate exported	989,041	179,085	994,229	129,071
In miscellaneous ores	.....	.....	4,112	532
Total	88,880,059	14,622,609	127,708,478	15,186,467

*In 1930 the converter or blister copper made at Port Colborne was partly exported and partly refined in Ontario. The portion refined in Ontario was valuated at the average price for electrolytic copper on the New York market, namely, 12.982 cents per pound. The total value is therefore slightly greater than the company figures.
†Figures are estimated recoveries, not metals paid for.

Nickel.—Total nickel produced in Ontario, that is, the metal content of all nickel-bearing substances in 1929 and 1930, was as follows:—

Nickel in various forms	1929		1930	
	Quantity	Value	Quantity	Value
	lb.	$	lb.	$
Metallic	25,260,177	6,821,814	57,478,651	15,485,381
Electrolytic	45,444,585	11,818,000		
In nickel-copper matte exported	28,136,095	5,064,496	41,956,123	7,552,102
In oxide (Port Colborne)	11,204,577	3,347,983	4,225,620	1,389,973
In speiss residues, oxides, salts (Deloro)	230,478	63,167	104,659	27,205
In other ores	.....	.....	3,804	473
Total	110,275,912	27,115,460	103,768,857	24,455,134

Dividends.—Payments in 1930, and total dividends paid to the end of 1930 are given in the table which follows. For convenience of comparison Mond figures have been converted to dollars on the basis of £1 = $4.8665.

TABLE XVII.—TOTAL DIVIDENDS PAID BY NICKEL COMPANIES

Company		Period (inclusive)	Total to end of 1929	Paid in 1930
Canadian Copper Company		1894–1901	$1,975,000	.....
*International Nickel Company	Preferred	1906–1928	12,299,273	.....
	Common	1909–1928	68,811,694	.....
†International Nickel Company of Canada, Limited	Preferred	1929–1930	1,712,097	$1,934,068.76
	Common	1929–1930	12,375,704	14,148,941.55
Total		.....	$94,174,668	$16,083,010.31
‡Mond Nickel Company	Deferred	1906–1914	£264,043	.....
	Preferred	1904–1929	2,556,359	.....
	Ordinary	1905–1929	2,581,984	.....
Total		.....	£5,402,386 or $26,291,126	.....
Grand Total		.....	$120,465,794	$16,083,010.31

*Successors to the Canadian Copper Company. The International Nickel Company paid dividends on the common stock from 1909 to 1919, inclusive, and again from 1925 to 1928, inclusive. Common stock outstanding was $41,834,600, and preferred stock $8,912,600, or a total of $50,747,200 at the beginning of 1928. On December 19, 1928, the authorized capital stock of $62,000,000 of the New Jersey company was reduced by changing the par value of the shares from $25 to $1 each, and at the same time the name of the company was changed to "Nickel Holdings Corporation." On December 31, 1928, the authorized capital was further reduced to $993,425 fully issued or subscribed for stock consisting of $843,700 preferred stock and $149,725 common stock, par value in each case.

†Dividends paid by the International Nickel Company of Canada, Limited, on the common stock in 1929 were 90c. per share, and $1.00 per share in 1930. Common stock was increased to 15,000,000 shares of no par value on July 25, 1930; and as a result shares issued were increased from 13,758,208 to 14,584,025. Seven per cent. preferred stock (cumulative) now stands at $27,627,825.

‡Upon completion of the exchange of stock under the amalgamation of the Mond and International companies, effective, December 31, 1928, stock issued or issuable was as follows: $27,627,825 of 7 per cent. cumulative preferred, and 13,758,208 common shares without par value. Dividends paid on February 16, 1929, by the Mond company cover the 8 months period ending December 31, 1928.

STATISTICAL SYNOPSIS OF THE NICKEL-COPPER INDUSTRY IN ONTARIO DURING 1929 AND 1930

Year	Number of Producing Companies	Number of Plants	Capital Invested (*c*)	Dividends Paid	Salaried Employees		Wage-earners		Selling Value of Products (*d*)	
					No.		No.	Wages	Kind	
			$	$		$		$		$
1929	1	4 mines	16,550,736	.....	32	115,775	2,973	4,694,920	Matte (exported)	7,599,274
		2 smelters	25,993,232	16,055,578	80	281,774	1,573	2,375,075	Metallic nickel	18,639,814
		1 refinery (*a*)	18,091,557	.....	86	255,923	1,302	2,098,550	Nickel oxide	3,347,983
									Converter copper	11,880,306
									Gold	161,282
		Construction	.....	.....	.....	.....	2,649	3,306,061	Silver	227,625
									Platinum metals	1,646,381
		Total	60,635,525	16,055,578	198	653,472	8,497	12,474,606	.....	43,502,665
1930	2	5 mines	94,354,807	16,083,010	43	178,211	3,428	5,210,574	Matte (exported)	8,723,089
		3 smelters			75	296,268	1,818	2,781,720	Metallic nickel	15,485,381
		2 refineries (*b*)			130	374,983	1,435	2,142,193	Nickel oxide	1,389,973
									Converter copper	12,748,178
									Gold	472,599
									Silver	407,138
		Construction	.....	.....	.....	.....	1,245	1,781,655	Platinum metals	2,436,683
		Total	94,354,807	16,083,010	248	849,462	7,926	11,916,142	.....	41,663,041

(*a*) Port Colborne plant.

(*b*) Port Colborne plant, and Ontario Refining Company at Copper Cliff.

(*c*) The capital invested is exclusive of value of mineral lands. In the Report for 1929, Vol. XXXIX, Part 1, the capital shown includes the company's book value for mineral lands, or a total of $74,077,808 for the lands.

(*d*) Figures for 1930 do not include the output of the Ontario Refining Company.

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

No Ontario ore has been smelted since 1925, as will be noted in the following table of iron and steel statistics for the past five years:—

Pig Iron.—As shown in the table below foreign ore charged amounted to 935,005 long tons, from which 534,542 long tons of pig iron were produced, including 285,596 of basic, 189,073 foundry and 59,873 of malleable. The average selling prices of these grades were $19.75 per long ton for basic and $23.80 for foundry and malleable.

TABLE XVIII.—IRON AND STEEL STATISTICS, 1926-1930

Unit	1926	1927	1928	1929	1930
Ontario ore smelted.....long tons	.....	.....	.....	.....	.....
Foreign ore smelted..... " "	846,566	910,688	1,242,937	1,331,498	935,005
Limestone for flux.....short tons	218,996	217,748	324,550	342,776	234,309
Coke..... " "	503,871	487,825	736,746	767,420	542,094
Pig iron produced.....long tons	487,265	460,148	734,779	769,359	534,542
Value of pig iron produced.....$	9,805,300	9,663,108	11,544,668	17,408,514	11,465,435
Steel made.....long tons	485,849	566,466	790,548	899,807	639,128
Value of steel made.....$	16,710,365	18,695,950	22,370,425	32,393,052	22,369,480

IRON BLAST FURNACES IN OPERATION, 1930

Name of Company	Furnaces			Location
	No. of stacks	Daily capacity long tons	Days operated	
Algoma Steel Corporation, Ltd.	4	1,600	365	Sault Ste. Marie
Steel Company of Canada, Ltd.	2	825	365	Hamilton
Canadian Furance Company, Ltd.	1	350	222	Port Colborne

PIG IRON, STEEL, AND FERRO-ALLOY PRODUCERS, 1930

Company	Location
Abrasive Company of Canada, Ltd. (*c*)	Hamilton
Algoma Steel Corporation, Ltd. (*a*), (*b*)	Sault Ste. Marie
Canadian Electric Castings Co., Ltd. (*b*)	Orillia
Canadian Furnace Co., Ltd., (*a*)	Port Colborne
Dominion Foundries and Steel, Ltd. (*b*)	Hamilton
Electro-Metallurgical Co. of Canada, Ltd. (*c*)	Welland
Exolon Co., Ltd., (*c*)	Thorold
Lionite Abrasives, Ltd. (*c*)	Stamford
London Rolling Mills Co., Ltd. (*b*)	London
Steel Company of Canada, Ltd., (*a*), (*b*)	Hamilton
Superior Alloys, Ltd. (*c*)	Sault Ste. Marie
Union Carbide Co. of Canada, Ltd. (*c*)	Welland
Welland Steel Castings, Ltd. (*b*)	Welland
Wm. Kennedy & Sons, Ltd. (*b*)	Owen Sound

(*a*) Pig iron; (*b*) steel; (*c*) ferro-alloys.

Steel.—Total production of steel was 639,128 long tons which were estimated at $35 per ton. Two broad classes, ingots and direct steel castings cover the output. Under ingots 606,197 tons were reported as basic open hearth and 17,226 tons as electric, or a total of 623,423 long tons. Of the direct steel castings 1,023 were given as bessemer and 12,399 as electric or a total of 15,705 long tons. Seven plants were active during the period.

Ferro-Alloys.—These products which include ferro-silicon, ferro-manganese, refined silicon and silico-spiegel were made in Ontario by five establishments. The total output in 1930 was 60,956 long tons.

Coke.—The Algoma Steel Corporation at Sault Ste. Marie, and the Steel Company of Canada at Hamilton, produce coke in conjunction with their blast furnace operations, while the Hamilton By-Products Coke Ovens, Ltd., also at Hamilton, produces coke for domestic purposes, having commenced in January, 1924. The figures of production below do not include the output from municipal gas plants. The materials used and products consumed and sold by the coke plants in Ontario during 1929 and 1930 are shown in the following table:—

TABLE XIX.—THE COKING INDUSTRY IN ONTARIO, 1929-1930*

		1929		1930	
	Unit	Quanity	Value	Quantity	Value
MATERIALS USED			$		$
Bituminous coal, foreign	tons	1,843,737	7,621,308	1,619,109	6,983,606
Coke for gas making	"	11,118	27,795	1,824	10,944
Oil for gas making	Imp. gals.	94,904	11,270	1,824,890	159,413
Lime	tons	1,512	14,274	1,381	13,624
Water		.....	15,156	.....	22,753
Sulphuric acid, 66° Be	lb.	33,535,020	219,879	30,247,190	202,897
Oxide		.....	.....	4	245
All other materials		.....	26,391	.....	30,013
Total		.....	7,936,073	.....	7,423,495
PRODUCTS MADE					
Coke	tons	1,292,150	9,296,015	1,146,581	8,001,115
Coke breeze	"	88,810	160,165	117,081	202,128
Gas sold and used	M. cu. ft.	14,444,375	2,957,791	12,731,867	2,704,454
Tar	Imp. gals.	13,014,003	894,754	12,236,529	802,967
Ammonium sulphate	lb.	39,761,539	699,926	35,667,853	581,012
Light oils	Imp. gals.	4,593,383	657,930	3,550,094	773,980
All other products		.....	1,295	.....	.....
Total		.....	14,667,876	.....	10,361,202

*Supplied by Dominion Bureau of Statistics.

NON-METALLIC MINERALS

During 1930 the value of the output of non-metallic minerals totalled $8,492,263 as against $8,621,427 in 1929, or a decrease of 1.49 per cent. The principal items with values, in order of importance, were as follows: Natural gas, $5,061,588; salt, $1,558,405; gypsum, $776,069; quartz and quartzite, $274,674; petroleum, $235,746; talc, $133,213; arsenic, $109,932; and feldspar, $104,670. Actinolite, beryl, fluorspar, graphite, iron pyrites and sulphuric acid (i.e. sulphur content), mica, mineral water, peat, and silica brick were represented, but were each under $100,000 in value, as may be seen in Table I in the list of non-metallics.

Actinolite

This mineral, which is a variety of asbestos, has been mined in Hastings county in a small way since 1883. It is mainly exported to the United States in ground form mixed with mica, where it is used as an ingredient in the manufacture of roofing material. In 1930 the output was 34 tons valued at $437 as against 30 tons worth $375 in 1929.

Arsenic

Arsenic in the native state is a metallic mineral, but since it is produced in Ontario in the oxide form, called in the trade "white arsenic," it has been rectomary to include it under the non-metallics. The whole production is recovered in the smelting of the silver-cobalt arsenides of Northern Ontario by the Deloro Smelting and Refining Company. Including the arsenic produced as insecticides and also contained in speiss residues exported to the United States for treatment, the production in 1930 was 2,750,887 pounds valued at $109,932 as against 3,742,913 pounds worth $145,887 in the previous year.

Barite

This mineral has not appeared in the production table since the year 1923. Several deposits are known to exist; and one in the Porcupine gold area, owned by Canada Nighthawk Mines, Limited, is equipped with milling facilities. The main difficulty, however, for domestic producers is the limited home market and the high duty to be met on entry into the United States.

Beryl

This mineral occurs in fine green crystals on lot 23, concession XV, Lyndoch township, in the county of Renfrew. No production apart from hand specimens was reported from this property for a number of years, but in 1927 some 4,456 pounds of beryl were shipped to Germany, the c.i.f. value of which at Hamburg was $175. This production was not reported until the year 1929. Exploratory work on this and other deposits in Lyndoch is under way during 1931 by the Madawaska Syndicate.

Calcite

There are several large deposits of pure white calcium carbonate in Ontario. This mineral in a finely ground condition may displace the imported whiting in some industries. A plant having a yearly capacity of 12,000 tons has recently been built in Montreal to produce whiting from native crude minerals. The market for imported whiting which enters into a variety of industries such as the manufacture of linoleum, oil cloth, putty, cold water paints, crayons and scouring media, is quite large. The imports to Canada during the fiscal year ending March 31, 1930, totalled 17,898 tons valued at $207,394, while the imports of whiting substitute has been estimated at around 7,000 tons during the same period. The difference between ground calcite and imported whiting is entirely of a physical nature, since their chemical composition is identical. The grain of ground calcite is angular or crystalline in structure, while that of true whiting is amorphous with much higher absorptive capacity for oil and water.

Diatomite

A trial shipment of crude diatomite (10 tons) was made in 1930 by R. Morrow of Muskoka Falls to Geo. Bailey, Toronto (now of Brampton), maker of insulating materials such as brick, and plates for electric stoves. The

shipment, taken from a lake bottom in Draper township, was valued at $140 which covered only mining and transportation charges. Two other diatomite properties in Muskoka are being developed, namely at Martin's Siding and 5 miles west of Novar. Construction work and machinery installation on the first mentioned, Diatomite Products, Limited, is well advanced, and the company plans to produce 20 tons of finished product daily. Dominion Diatomite, Limited, is the name of the company near Novar, and their calcining plant was expected to be ready for operation about November, 1931.

Diatomite is a hydrous type of silica in the form of countless microscopic siliceous remains of aquatic plants called algae, and may be of either fresh water or marine origin. In addition to its use as an insulator, diatomite is employed as a filtering material, as a filler, as a fine abrasive polish, and for many other uses.

Feldspar

Production of crude feldspar dropped from 21,737 tons in 1929 to 9,722 tons in 1930. This decrease was due to a falling off in exports to the United States, and is accounted for in part by the imposition of a tariff of $1.00 per long ton on crude spar going into that country, effective June 30, 1930. The valuation for 1930, namely $102,871, includes $34,666 which was the calculated value added to the spar ground in Ontario. Canadian consumption of ground spar is approximately 10,000 tons per year. The grinding plant at Kingston, Ontario, is operated by the Frontenac Floor and Wall Tile Company to supply its own needs, and also to market a surplus. With the addition of a new grinding mill at Buckingham, Quebec, Canadian requirements can be met without importing ground spar from the United States. A further protection for the Canadian industry was the placing of a protective duty of 15 per cent. ad valorem in July, 1930, on imports of ground feldspar.

The following note, abstracted from a report of the Department of Commerce at Washington, D.C., describes the feldspar industry of the United States and may be of interest to Ontario producers:—

The crude feldspar sold or used by producers in the United States in 1930 amounted to about 171,788 long tons valued at $1,066,636, or $6.21 a long ton; or 192,402 short tons valued at $5.54 a short ton. These figures show a decrease of 13 per cent. in quantity and 16 per cent. in total value in comparison with 1929. The production of crude feldspar by States in 1929 and 1930 is shown in the following table:—

CRUDE FELDSPAR SOLD OR USED BY PRODUCERS IN UNITED STATES IN 1929 AND 1930

State	1929		1930	
	Short tons	Value	Short tons	Value
		$		$
California	14,302	84,567	7,301	54,941
Maine	22,391	142,042	25,467	161,631
New Hampshire	34,680	231,810	18,499	132,342
New York	14,220	103,531	6,223	37,790
North Carolina	115,665	598,938	115,542	593,552
Other States	20,164	115,752	19,370	86,380
Total	221,422	1,276,640	192,402	1,066,636

In 1930 there were 34 commercial mills operating in 12 states, namely: California, Colorado, Illinois, Maine, New Hampshire, New Jersey, New York, North Carolina, Ohio, South Dakota, Tennessee and Virginia. These mills reported 181,541 short tons of ground feldspar sold in 1930 valued at $2,450,915 or $13.50 a ton, compared with 230,582 tons valued at $3,296,252 or $14.30 a ton in 1929, a decrease of 21 per cent. in quantity and 26 per cent. in total value.

Fluorspar

The output of fluorspar from Ontario deposits have been practically negligible during the past decade. A few tons, however, have been recovered from the old ore dumps on lot 3, concession 1, of Madoc township. During 1930 the production was 80 tons worth $1,240.

Graphite

The only producer of this mineral in Ontario in 1930 was the Black Donald Graphite Company, Limited, of Calabogie from its property on lots 16, 17 and 18, concession III of Brougham township, Renfrew county. During the year the sales totalled 1,338 tons valued at $86,543 as against 1,288 tons worth $90,522 in 1929. Crude ore mined was 3,970 tons and ore milled totalled 4,060 tons from which 1,338 tons of refined were sold in flake, dust and amorphous grades.

Gypsum

Gypsum, Lime and Alabastine, Canada, Limited, formerly known as the Canada Gypsum & Alabastine, Limited, was the only producer of gypsum in Ontario in 1930. The crude mined totalled 102,789 tons of which 78,182 tons were calcined, from the two plants at Lythmore and Caledonia. The material marketed during the past five years is shown in the table below:—

GYPSUM SALES, 1926–1930

Grade	1926	1927	1928	1929	1930
Crushed.....tons	37,769	29,832	20,675	23,533	25,130
Fine ground..... "	1,110	621	1,134	497	1,190
Calcined sold..... "	3,098	856	4,133	5,269	3,515
Calcined used in products..... "	48,010	52,689	59,869	71,048	65,111
Total sold or used.....tons	89,987	83,998	85,811	100,347	94,946
Total value.....$	496,059	500,688	553,271	832,689	776,069
Number of workers.....	188	231	248	257	*92
Wages paid.....$	245,663	274,790	289,292	311,609	98,818

*Exclusive of wage earners employed in the manufacturing division of the plant.

This company which produces wall board, insulex and other building materials has developed the industry greatly and now has a considerable export trade.

Iron Pyrites and Sulphuric Acid

Only 140.61 tons of pyrites worth $1,645 were shipped in 1930 from Ontario. The property known as the Caldwell mine, near Flower Station on the K. & P. branch of the C. P. Ry. has been shipping small quantities of pyrites for a number of years. In addition, sulphuric acid is produced by Canadian Industries, Ltd., at Copper Cliff and Coniston from sulphur fumes. The sulphur content of this acid along with that of the iron pyrites amounted in 1930 to 7,277 tons worth $73,855 as against 4,579 tons valued at $51,516 in 1929. The key map which appears as a frontispiece to this Report shows the Sudbury area as a new centre of the heavy chemical industry.

A recent development which offers encouragement to pyrite producers is the invention by Horace Freeman of Shawinigan Falls, Quebec, of a new type

of pyrites burner which, in 1930, came into commercial use at the Three Rivers, Quebec, plant of the Canada Power and Paper Company. The flash-roasting furnace, with a capacity of 20 tons of pyrites per day, supplies the total acid requirements of the sulphite wood pulp mill. By this method a cool moist gas is produced containing 11 to 12 per cent. sulphur dioxide, and free from dust and traces of sulphur trioxide. The waste heat from pyrite burning is passed through tubular boilers and the steam generated is used for plant heating. In addition the iron oxide residue constitutes an important by-product.

Lignite

In June, 1929, the first of a long series of drill holes was completed at Onakawana (formerly known as Blacksmith Rapids, Abitibi River), after having penetrated a lignite seam, 14 feet in thickness. This work was done by contract for the Provincial Government under the supervision of officers of the Ontario Department of Mines. Since then 96 holes have been drilled in the vicinity of Onakawana, and it has been found to date that the lignite underlies about 5 square miles, and that its average thickness is 23 feet. The maximum thickness so far found in any one drill hole is 68 feet. One deep test hole was also drilled in this field which passed through 1,027 feet of sediments (Pleistocene, Cretaceous and Devonian) before reaching the pre-Cambrian.

Although no sign of oil or gas was encountered much geological information was obtained in respect to structure, thickness and character of the sedimentary formations. An interesting development is the discovery of high grade fire clays and ball clays overlying the lignite seam, or occurring as partings within it. Two shafts have been sunk in the lignite field, and a total of about 400 feet of drifting has been done in the seams. This is still in progress. The purpose of the mining is to obtain lignite for tests and to examine the seams in a more detailed way than can be done by drilling.

Many tests have been made, and still more are expected to be carried out. The lignite more closely resembles that of Southern Saskatchewan than any other on this continent, but differs from it in its more immature appearance and higher moisture content. The analyses on both the air dried and dry basis of the two lignites are, however, very similar. Analysis of a sample of Onakawana lignite is as follows —

	As received	Air dried	Dry
Moisture	45.2	20.2	.....
Ash	4.8	7.0	8.8
Volatile matter	22.4	32.6	40.9
Fixed carbon	27.6	40.2	50.3
	100.0	100.0	100.0
Sulphur	0.2	0.3	0.4
Calorific value (B.t.u. per lb.)	5,640	8,210	10,290

The Temiskaming and Northern Ontario railway was extended during the year to the crossing of the Moose River, and passes through the lignite field.

Mica

The business depression so prevalent throughout the world may be given as the reason for a decline of more than 4½ million pounds in the quantity of mica produced by Ontario mines. The most serious decrease was observed in

the item scrap mica. Much if not all of this grade finds a market in the United States, and during the period the buying was not at all active.

By grades the shipments during 1929 and 1930 were as follows:—

Grade	1929		1930	
	Quantity	Value	Quantity	Value
	lb.	$	lb.	$
Rough cobbed	.....	.....	2,130	85
Thumb-trimmed	85,470	10,620	1,375	1,168
Splitting	.....	.....	60,180	24,788
Scrap	5,896,640	35,299	1,417,662	8,234
	5,982,110	45,919	1,481,347	34,275

The prices for the various sizes and grades as reported by the producers, covered the following:—

Size	Cents, per lb.	Size	Cents, per lb.
Scrap	0.5 to 0.6	2- by 3-inches	.35 to .38
Crude mica	.4	2- by 4- "	.55 to .60
1- by 1-inch	.10	3- by 5- "	1.00 to 1.25
1- by 2-inches	.....	4- by 6- "	2.00
1- by 3- "	.30	5- by 8- "	2.50 to 3.00
2- by 2- "	.....		

Mineral Waters

The production in Ontario while not extensive is sufficient to supply all domestic consumption. The output from five or six springs during the past decade has ranged from 183,000 to 309,000 Imperial gallons. During 1930 five wells, all in eastern Ontario, produced 214,200 Imperial gallons worth $20,574 at the shipping post. The record for the past ten years is as follows:—

Sales	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Imp. gals.	308,647	209,072	227,030	201,670	183,012	208,400	293,200	253,630	309,700	214,200
Value, $	14,438	10,528	14,047	13,133	25,452	27,277	12,811	27,890	13,651	20,754

In addition to the above there are springs near Wilberforce in Haliburton county close to the uraninite deposits which are radio-active and which possiblv may have therapeutic value. Another mineral water is calcium chloride which has been found in saline waters near Concord in York county, Burlington in Halton county, and elswhere. These waters have had some use for medicinal purposes. It has also been tried as a dust allayer on the highways, but the calcium chloride to water ratio was found to be too low and it could not compete with the calcium chloride as now used in crystal form. Sanitaria at St. Catharines and Preston have long been using the mineral springs at those points. This latter production has not been included with the figures of output.

Natural Gas and Petroleum

The Natural Gas Commissioner of Ontario, R. B. Harkness, has supplied the following notes:—

The consumption of Natural Gas decreased from 8,583,187 M. cu. ft. in 1929 to 7,943,416 M. cu. ft. in 1930, a difference of about 640,000 M. cu. ft. The industrial depression of the year 1930 made itself felt in the use of natural gas in industries, which probably accounts for the major portion of the decrease. The mild autumn and winter of 1930 are also accountable in part. The prosperous year of 1929 had the effect of stimulating the search for natural gas, and in the year 1930 many more wells than usual were drilled, and probably 300,000 acres of new leases were taken, principally in the eastern fields. The old Haldimand-Norfolk field, which was considered to be approaching exhaustion, has been revived by this drilling activity, and is now able to supply as much gas as it did ten years ago. Whether the promised drilling activity of the season 1931 will prove as successful as in 1930 remains to be seen.

The production of Petroleum for the year 1930 has shown a normal decline, as has each recent year. The price of oil being so low, there has been nothing to stimulate the oil men in the search for further supplies, and, unless the price of oil is materially increased, our old Ontario fields will gradually pass into history.

CRUDE PETROLEUM PRODUCTION,* 1926–1930

	1926	1927	1928	1929	1930
	Barrels	Barrels	Barrels	Barrels	Barrels
Petrolia and Enniskillen township	53,485	50,172	60,547	56,284	55,130
Oil Springs	38,349	37,281	35,653	30,789	29,160
Moore township	2,438	2,015	2,148	1,230	1,576
Sarnia township	1,890	1,589	1,221	749	1,149
Plympton township	1,047	1,240	371	315	296
Bothwell	25,382	25,224	24,255	23,236	21,176
Dover West township	959	602	773	715	457
Raleigh township	676	276	.....	.....	.....
Onondaga township	361	210	87	243	231
Mosa township	7,868	7,456	7,268	6,850	7,166
Thamesville	2,376	4,139	1,006	427	447
Dunwich township (Dutton and Iona)	139	.....	.....	148	365
Tilbury East township	.....	60	736	139	149
Total quantity	136,971	139,606	134,065	121,125	117,302
Value	$376,822	$289,390	$249,981	$253,678	$235,746
Average price per barrel (35 gals.)	$2.73	$2.11	$1.86	$2.09	$2.00

*Information furnished by the Imperial Oil Refineries, Limited, of Sarnia, and others.

Refining of oil and the manufacture of oil refinery products were carried on during 1930 by four companies in Ontario, as follows:—

Company	Head Office	Plant
British American Oil Company, Ltd	1312 Royal Bank Bldg., Toronto	Toronto
Canadian Oil Refineries, Ltd	1312 Royal Bank Bldg., Toronto	Petrolia
Imperial Oil Refineries, Ltd	445 South Christina St., Sarnia	Sarnia
McColl Bros., Ltd	114 Don Esplanade, Toronto	Toronto

Imported crude refined in 1930 was 343,372,124 gallons, and Canadian crude only 3,944,969 gallons or 112,713 barrels.

Peat

The output of 628 tons worth $1,602 f.o.b. plant, as reported in Table I, was from stock pile at the Alfred peat plant near Ottawa. No operations were carried on other than shipping.

Quartz, Quartzite, and Silica Brick

The output of quartz in 1930 was 167,487 tons worth $274,674 as compared with 187,973 tons valued at $316,050 in the previous year. The decrease in

output had its effect on the number of wage-earners employed. In the year under review 49 men received $54,586 in wages as against 94 men and $78,489 in wages during 1929.

The largest producer was the Dominion Mines and Quarries, Ltd., which operated the Killarney quarry. The International Nickel Company of Canada and Falconbridge Nickel Mines both consumed quartz as a flux, while Wright & Co. of Sault Ste. Marie again shipped quartz to the Algoma Steel Corporation for the manufacture of silica brick. The production of silica brick which are used in the iron and steel industry was reported as 378,479 worth $19,120 in 1930, as against 1,566,199 in 1929 valued at $80,374.

Salt

The production of salt and brine in Ontario, totalling 248,637 tons of all grades valued at $1,558,405, was the highest in value since the year 1923. As compared with the previous year the record shows an increase in value for a decrease in tonnage. The number of plants decreased from 7 to 6. During March the Kincardine Salt Company's plant at Kincardine was taken over by the Canadian Industries, Ltd. Salt plants were operated in 1930 at Sandwich, Sarnia, Goderich, Kincardine and Courtright. The entire output is from salt wells in the form of brine, no salt being mined in Ontario.

OPERATING SALT COMPANIES, 1930

Name of Owner, Firm or Company	Location of Wells or Works	P.O. Address of Manager, etc.
Brunner, Mond Canada, Limited	Amherstburg*	Amhertsburg
†Canadian Salt Company, Limited, The	Sandwich*	Sandwich.
Dominion Salt Company, Limited, The	Sarnia	Sarnia.
Goderich Salt Company, Limited	Goderich	Goderich.
‡Kincardine Salt Company, Limited	Kincardine	Kincardine.
Western Canada Flour Mills Company, Limited	Goderich	Goderich.
Western Salt Company, Limited	Courtright	Courtright.

*Chemical works using salt brine as raw material.
†Now, the heavy chemical division of the Canadian Industries, Ltd.
‡Sold to Canadian Industries, Ltd., in March, 1930.

Quantity production of salt by grades for the past five years, also the total value, exclusive of packages or containers, are shown in the table which follows:—

SALT STATISTICS, 1926–1930

Schedule	1926	1927	1928	1929	1930
Land.....tons	3,965	4,599	3,621	1,919	245
Coarse..... "	31,192	25,216	26,730	22,632	21,160
Fine..... "	47,202	47,185	51,055	49,869	55,373
Table and Dairy..... "	50,461	53,477	56,214	54,138	49,467
Pressed blocks..... "	6,505	7,709	7,083	5,560	7,655
Brine (salt equivalent)..... "	113,020	115,995	135,138	168,327	114,737
Total sold or used..... "	252,345	254,180	279,841	302,445	248,637
Value of products old or used.....$	1,388,672	1,510,777	1,377,629	1,420,424	1,558,405
Employees.....No.	*466	290	299	263	263
Wages.....$	614,790	322,549	337,214	303,618	288,237

*Employees of Sandwich salt and chemical works are included.

Talc

This industry has not changed greatly during the five years up to and including 1930. The two operating companies at Madoc are the Geo. H. Gillespie & Co., and Canada Talc, Ltd. In 1930 the output was lower than usual, due to general business depression. The product in the ground state ranges in price from $9.00 to $18.00 per ton, depending on grade, and is marketed in Canada and the United States. No soapstone was mined during the period, the deposit at Eagle Lake in Kenora district not being in operation.

Following are statistics of talc and soapstone for the past five years:—

TALC AND SOAPSTONE STATISTICS, 1926–1930

Schedule	1926	1927	1928	1929	1930
Soapstone shipped.....tons	110	135	.....	.....	.....
Ground talc shipped..... "	14,772	15,003	14,925	15,463	11,664
Total value of shipments.....$	178,986	181,981	179,187	180,492	133,213
Employees, mine and mill.....No.	50	61	45	42	36
Wages paid.....$	47,083	51,834	44,858	40,055	32,718

STRUCTURAL MATERIALS

Building Permits.—In 61 Canadian cities building permits in 1930 were valued at $166,379,325. Of this total thirty Ontario cities accounted for $69,042,946 or 41.5 per cent., as noted in the following table abstracted from *Annual Review of Building Permits in Canada in 1930*, issued by the Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa.

BUILDING PERMITS IN ONTARIO, 1920–1930

Year	30 Ontario Cities, Value	Prices Index No. (*a*)	Toronto Metropolitan Area, (*b*) Value	Wages Index No. (*c*)
	$		$	
1920.....	58,636,365	144.0 (*d*)	30,049,413	180.9
1921.....	59,315,845	122.8	31,979,346	170.5
1922.....	81,396,259	108.7	36,405,625	162.5
1923.....	74,673,080	111.9	39,530,877	166.4
1924.....	57,330,141	106.6	29,636,428	169.1
1925.....	59,888,867	102.9	32,408,636	170.4
1926.....	65,373,757	100.0	31,588,124	172.1
1927.....	79,883,344	96.1	37,316,511	179.3
1928.....	104,777,566	98.1	59,817,568	185.6
1929.....	95,055,827	99.0	57,522,927	197.5
1930.....	69,042,946	90.9	38,371,587	203.2

(*a*) Applies to average index numbers for Canadian wholesale prices of building materials on the basis of 1926=100, as compiled by Dominion Bureau of Statistics. In 1913 the index was 67.0, dropping to a low of 60.5 in 1915.

(*b*) Includes York and East York municipalities.

(*c*) Average index numbers of wages in Canadian building trades as compiled by the Federal Department of Labour on the basis of 1913=100. (*d*) Peak year.

Construction Contracts.—The value of Canadian construction contracts awarded for 1930 reported by *McLean Building Review* was $456,999,600 as compared with $576,651,800 in 1929. Ontario contracts in 1930 amounted to

$175,459,600 or 38.3 per cent. of the total. Prices of materials were considerably below the peak of 1920, and a greater drop was recorded in 1930 than in any year since 1922.

VALUE OF ONTARIO CONSTRUCTION CONTRACTS, 1926–1930

Classification	1926	1927	1928	1929	1930
	$	$	$	$	$
Residential	52,084,100	57,580,800	64,628,600	59,211,000	44,427,000
Business	38,808,200	81,328,100	58,700,200	82,949,000	52,636,400
Industrial	21,126,900	11,922,500	25,109,800	28,247,200	12,787,400
Engineering	29,910,200	45,327,600	39,913,100	45,365,900	65,608,800
Total	141,929,400	196,159,000	188,351,700	215,773,100	175,459,600

Cement

During 1930 the plants in operation were those of the Canada Cement Company, Limited, located at Belleville, Port Colborne, and Lakefield; and that of the St. Marys Cement Company, Limited, at St. Marys. Production for the last pre-war year and subsequently is given in the following table:—

PORTLAND CEMENT STATISTICS, 1913–1930

Year	No. of Operating Plants	Sales		
		Barrels (350 lbs.)	Total Value	Average Price per bbl.
			$	$
1913	13	3,802,321	4,105,455	1.08
1914	11	2,665,650	2,931,190	1.10
1915	7	2,302,242	2,534,537	1.10
1916	7	2,143,949	2,242,433	1.15
1917	6	2,063,231	2,934,271	1.43
1918	4	1,226,244	1,910,839	1.56
1919	5	2,022,575	3,659,720	1.81
1920	5	2,035,594	3,377,814	2.15
1921	5	2,723,072	6,425,266	2.37
1922	4	3,104,386	6,235,370	2.01
1923	4	3,296,428	5,855,590	1.77
1924	4	3,564,499	5,668,671	1.59
1925	4	3,462,358	5,253,911	1.52
1926	3	3,398,860	4,792,857	1.41
1927	4	3,751,786	5,144,326	1.34
1928	4	3,911,795	5,520,897	1.41
1929	4	4,624,712	6,608,246	1.43
1930	4	3,942,690	5,779,404	1.47

Stocks on hand December 31, 1929 and 1930, were 345,968 and 956,794 barrels, respectively. The following information has been abstracted from the annual report of the Canada Cement Company, Limited, for the fiscal year ending November 30, 1930:—

Your company has felt the effect of the world-wide business depression of the past year, and sales, both domestic and export, have fallen below those for 1929. The decreased consumption was most marked in the smaller class of buildings and the dealer trade. Increased efficiencies and economies in production and distribution have enabled us to compensate to a considerable extent for the reduction in volume. This year another self-discharging boat, built specially for service on the Great Lakes, was purchased and put into operation to carry bulk cement from our plant at Belleville to storage and packing plants completed during the past year at Toronto and Windsor. This arrangement also is working out very satisfactorily.

Cement Products.—In recent years the industry of cement products manufacture in Ontario has assumed considerable importance. Since 1924 no data have been included in the tables of mineral production, as the raw materials entering into the manufacture of these products have all been accounted for. Cement products being so closely allied to the building industry, statistics are included so that complete information covering all structural materials is available under one cover. The following table gives the record of materials used and products made by cement products manufacturers during the past two years. Monolithic construction is not included:—

PRODUCTION OF CEMENT PRODUCTS IN ONTARIO,* 1929–1930

	1929		1930	
	Quantity	Cost at Works	Quantity	Cost at Works
MATERIALS USED		$		$
Portland cement ..... bbls.	275,049	472,957	150,447	333,524
Quicklime ..... bu.	7,619	3,595	3,946	2,203
Sand ..... cu. yds.	59,012	110,180	37,818	57,767
Gravel ..... "	116,509	107,641	50,820	83,365
Crushed stone ..... "	12,740	47,232	8,730	20,460
Cinders ..... tons	.....	43,715	.....	31,058
Boxes, crates, lumber, etc.	.....	21,326	.....	7,938
Other materials	.....	161,940	.....	71,841
Total	.....	968,586	.....	608,156
PRODUCTS MADE				
Cement brick ..... M.	649	178,247	1,130	105,203
Hollow building blocks, etc.	.....	560,022	.....	440,506
Drain pipe	.....	51,878	.....	32,287
Sewer and culvert pipe	.....	957,325	.....	706,693
Artificial stone	.....	497,539	.....	260,541
Cement posts, poles, etc.	.....	4,975	.....	95
Cinder blocks (cincrete) ..... M.	2,209	305,893	1,504	242,333
Other products	.....	234,560	.....	133,360
Total	.....	2,790,439	.....	1,921,018

*Supplied by Dominion Bureau of Statistics, Ottawa.

The cement products industry is comprised of a number of small operations principally, although a few of them are fairly extensive requiring substantial plants. Many of them, however, are organized for temporary operations to fill a local demand that has arisen. As a result the number of plants fluctuates from year to year as may be seen in the accompanying table:—

PRINCIPAL STATISTICS OF CEMENT PRODUCTS INDUSTRY,* 1926–1930

	1926	1927	1928	1929	1930
Plants ..... No.	133	109	105	106	88
Wage-earners (average) ..... "	474	481	590	767	533
Salaries and wages ..... $	439,487	468,371	617,503	897,481	658,381
Cost of fuel and electricity ..... $	33,391	29,257	39,669	49,974	44,697
Capital invested ..... $	2,168,758	1,888,102	2,501,018	3,031,747	3,148,950
Value products at works ..... $	1,583,437	1,685,050	2,441,717	2,664,372	1,921,018

*Supplied by Dominion Bureau of Statistics, Ottawa.

Lime

The lime burning industry in Ontario is practically standardized and the proportions of hydrated to quicklime produced each year does not fluctuate widely. In 1926 the ratio of hydrated to quicklime was 1: 4.8, in 1930 the corresponding ratio was 1: 4.9 while for the intervening years it was as low as 1: 4.4 in 1927 and as high as 1: 5.6 in 1929. During the past few years, while lime-producing establishments have decreased in number, larger and better equipped plants have been developed.

During 1930 some twenty-two establishments were active, employing 330 men to whom $352,768 was paid in wages. Six of these plants are equipped for the production of hydrated lime. Of the 22 plants active, 7 were operated by Gypsum, Lime and Alabastine, Canada, Ltd. Total lime sales were 252,066 tons, valued at $2,177,587. Figures of production for the past five years are given in the table which follows:—

LIME STATISTICS, 1926–1930

Year	Lime Marketed or Used						Fuel Costs	Employees	Wages
	Hydrated			Quicklime					
	Tons	Value		Tons	Value				
		Total	Per Ton		Total	Per Ton			
		$	$		$	$	$		$
1926..	39,217	457,978	11.68	189,079	1,593,468	8.43	396,128	414	397,988
1927..	44,749	540,687	12.08	198,383	1,657,552	8.35	386,284	451	458,001
1928..	49,085	597,367	12.17	228,101	1,870,476	8.20	388,152	414	390,611
1929..	55,916	740,127	13.24	314,246	2,624,285	8.35	513,741	577	398,266
1930..	42,726	504,178	11.80	209,340	1,673,409	7.99	343,237	330	352,768

The disposition of the quicklime and hydrated lime sold in 1930, as reported by the producing companies was as follows:—

Industrial Consumption	Quicklime		Hydrate	
	Tons	Value, $	Tons	Value, $
Building Trades: finishing	5,446	44,625	30,554	381,877
masons	17,825	150,971	10,201	101,736
Sand-Lime Brick	10,074	76,896	.....	.....
Agriculture	.....	.....	20	210
Chemical and Metallurgical Industries: Smelters	2,116	12,897	5	52
Iron and steel	4,395	35,160	245	2,573
Gold milling	13,004	103,956	.....	.....
Pulp and paper	456	3,648	50	525
Glass	2,956	24,710	.....	.....
Sugar	9,621	73,371	.....	.....
Tanneries	1,795	14,345	.....	.....
*Other chemicals	141,605	1,132,233	183	1,921
Dealers	.....	.....	1,207	12,674
Others	47	597	261	2,610
Total	209,340	1,673,409	42,726	504,178

*Uses for lime under this heading include the manufacture of alkali, acetate of lime, and calcium carbide, the last mentioned being used largely for making cyanamide.

Sand-Lime Brick

In sympathy with other building and construction materials the output of sand-lime brick fell off in 1930, and was lower both in quantity and value than in any year since 1921. The average price per thousand declined from $11.50 in 1929 to $10.20 in 1930. As the industry is mainly centered in and around Toronto and is dependent on the building activity, the figures of output strikingly reflect the depression in the building industry during 1930.

SAND-LIME BRICK PRODUCERS, 1930

Name of Company	Address
Canada Sand-Lime Pressed Brick Co., Ltd.	28 Symes Rd., Toronto
Harbour Brick Co., Ltd.	Fleet St., at Bathurst, Toronto
Hinde Bros.	134 Northlands Ave., Toronto
*River Sand Brick Co., Ltd.	30 Sandwich St., East Windsor
Toronto Brick Co., Ltd.	897 Bay St., Toronto
York Sandstone Brick Co., Ltd.	447 Victoria Park Ave., Toronto

*Reported for first time in 1930.

The following table shows statistics for the past five years, also the comparative average values of common clay brick:—

SAND-LIME BRICK STATISTICS, 1926–1930

Year	No. of operating plants	No. of wage-earners	Wages	Sales				Average value per M. of common clay brick
				M.	Total selling value	Average value per M.	Value with lime cost deducted	
			$		$	$	$	$
1926	8	178	171,747	46,869	555,847	11.86	461,376	15.18
1927	7	199	224,535	61,380	721,485	11.75	600,750	15.83
1928	7	183	205,497	61,506	745,719	12.12	624,228	15.83
1929	6	190	228,576	55,750	641,159	11.50	540,299	15.84
1930	6	129	147,827	41,576	424,178	10.20	318,037	15.08

Sand and Gravel

Among the structural materials, sand and gravel ranks third in value of production, following Portland cement and stone. During 1930 the production was 10,215,857 tons valued at $3,559,487 or an average value of 34.8 cents per ton. The figures for 1929 were 8,045,213 tons worth $3,156,254. The industry may be divided in two groups, land operations and dredging. In the former, in addition to several large companies which operated mechanically equipped pits, there is a large group of smaller operators who market sand and gravel from privately owned pits, and deliver the material by trucks to the larger centres. There are included also in the figures of production the material consumed in the construction of colonization roads and provincial highways. Ballast as produced by the railway companies from company owned pits along the right-of-way was not included in the total. During the year the railways in Ontario reported an output of 1,756,161 tons which were valued at $169,504.

Dredging in 1930 was carried on by 23 companies in the waters of Lakes Ontario, Erie, and Superior; and in the Ottawa, St. Lawrence, St. Marys, St. Clair, and Thames rivers. Twenty-seven vessels carried on operations under license in 23 Crown water areas. The output and source of the sand and gravel produced in 1929 and 1930 is shown below:—

OUTPUT OF SAND AND GRAVEL, 1929-1930

Source	1929		1930	
	Tons	Value	Tons	Value
		$		$
Private pit operators	2,080,280	1,138,458	2,210,881	1,118,281
Dredged from Great Lakes and Rivers	2,323,136	1,290,630	3,014,518	1,116,488
Department of Northern Development	1,500,814	111,171	1,764,645	130,714
Department of Highways	621,000	160,000	1,131,300	565,650
Miscellaneous counties and townships	1,519,983	455,995	2,094,515	628,354
Total	8,045,213	3,156,254	10,215,859	3,559,487

The distribution of the output of sand and gravel is shown in two classes: screened or washed, and ordinary bank or pit run. It will be observed in the following table that the major portion of the materials going to the building trade was practically all prepared by screening or washing. The table follows:—

DISTRIBUTION OF SAND AND GRAVEL MARKETED IN 1930

Class		Screened or washed	Bank	Value
				$
Sand: Moulding	tons	.....	32,165	22,652
Building	"	754,779	105,139	414,673
Other	"	.....	10,807	8,982
Sand and Gravel: Concrete and Roads	"	3,723,826	5,190,861	2,862,954
Crushed gravel	"	386,942	11,340	250,226
Total		4,865,547	5,350,312	3,559,487

Stone

The production of stone, including limestone, sandstone, trap and granite, during 1930 was 5,088,121 tons as against 5,224,194 tons during the previous year. The number of employees was 1,456 during the period, while wages paid amounted to $1,385,458.

Quantities and values by grades, and also the various uses of stone during 1930 are shown in the following table. It will be noticed that, curbstone, lining for open-hearth furnaces, glass manufacture, and whiting are blank, indicating that none of the operators marketed limestone for these purposes. One firm produced marble as 'terazzo', which was used in the production of artificial stone. This production has been included with stucco dash. On the other hand while cement and lime are shown blank it should be pointed out that the stone consumed by these industries is not included as such but rather in its more advanced condition.

STONE STATISTICS BY GRADES AND USES, 1930

Uses	Limestone		Granite		Trap		Sandstone		Total	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
		$		$		$		$		$
Building and Ornamental	33,572	285,039	1,202	17,072	.....	.....	6,581	32,664	41,355	334,775
Flagstone	130	461	.....	.....	.....	.....	.....	.....	130	461
Curbstone	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Paving blocks	.....	.....	2,849	23,606	.....	.....	.....	.....	2,849	23,606
Lining open-hearth furnaces	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chemical—										
Cement plants	.....	(a)	.....	.....	.....	.....	.....	.....	.....	.....
Flux in iron and steel plants	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Flux in smelters	278,757	207,541	.....	.....	.....	.....	.....	.....	278,757	207,541
Glass factories	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Manufacture of lime	.....	(b)	.....	.....	.....	.....	.....	.....	.....	.....
Pulp and paper mills	40,038	37,386	.....	.....	.....	.....	.....	.....	40,038	37,386
Sugar refineries	23,337	16,336	.....	.....	.....	.....	.....	.....	23,337	16,336
Other chemical uses	3,436	2,405	.....	.....	.....	.....	.....	.....	3,436	2,405
Whiting	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Asphalt-filler	11,240	49,851	.....	.....	.....	.....	.....	.....	11,240	49,851
Dusting coal mines	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Agricultural purposes	13,903	43,329	.....	.....	.....	.....	.....	.....	13,903	43,329
Poultry grit	1,940	11,294	.....	.....	.....	.....	.....	.....	1,940	11,294
Stucco dash and terazzo flooring	3,551	22,596	.....	.....	.....	.....	.....	.....	3,551	22,596
Rubble and riprap	112,869	75,832	.....	.....	.....	.....	.....	.....	112,869	75,832
Crushed stone. Concrete aggregate	770,070	663,869	.....	.....	.....	.....	.....	.....	770,070	663,869
Crushed stone. Road metal	1,878,968	1,533,542	1,100	1,100	138,494	184,191	.....	.....	2,018,562	1,718,833
Crushed stone. Railroad ballast	1,053,605	772,715	712,479	650,141	.....	.....	.....	.....	1,766,084	1,422,856
Total	4,225,416	3,722,196	717,630	691,919	138,494	184,191	6,581	32,664	5,088,121	4,630,970
Producers ..... No.	68	.....	11	.....	4	.....	7	.....	90	.....
Wage-earners ..... "	1,223	.....	180	.....	43	.....	10	.....	1,456	.....
Wages paid ..... $	.....	1,125,328	.....	211,551	.....	40,579	.....	8,000	.....	1,385,458

(a) Value included with cement.
(b) Stone used for lime accounted for in statistics for lime.

The following table shows the valuation of the several kinds of stone used or marketed during the past five years:—

VALUE OF STONE PRODUCTION, 1926–1930

Year	Limestone	Sandstone	Trap	Granite	Total
	$	$	$	$	$
1926	2,908,520	41,892	212,613	95,143	3,258,168
1927	3,716,419	50,192	205,480	88,618	4,060,709
1928	3,440,858	53,903	456,351	73,877	4,024,989
1929	3,759,357	69,898	367,590	574,771	4,771,616
1930*	3,722,196	32,664	184,191	691,919	4,630,970

*The figures of production are exclusive of the materials produced by municipalities, such as counties and townships, in the construction of roads. During 1930 the output from this source was 342,985 tons of limestone worth $222,882. These figures will be carried forward to the year 1931, having been received too late for inclusion in the main table.

Clay Products

As was expected the production value in 1930 of the Clay Products industry was down considerably in all classes. Regarding quantity production, every class showed decreases but the decline was less in evidence in the stiff-mud face brick than in any other class. The average prices on the other hand showed only slight variation with the exception of stiff-mud common which dropped 91 cents per thousand and fancy or ornamental which rose $9.81 per thousand. Sewer brick was also off in price, being $2.75 per thousand lower, while drain tile averaged $1.83 per thousand less than 1929 prices. The average prices of brick per thousand for 1930 for the whole of Ontario were as follows:— soft-mud face $20.60, common $15.20; stiff-mud (wire cut) face $20.67, common $15.18; dry-press face $19.78, common $13.80; fancy and embossed $90.00; sewer $17.30; drain tile $26.07, and structural tile $9.29 per ton. The production value for all kinds of clay products in 1930 was $5,521,214 or a decrease of 23.5 per cent. below the figures for 1929.

Canada produces a wide list of clays which may be classified according to the purposes for which they are adapted. The "pottery" clays include "china" clay or kaolin, and "ball" clay used in the manufacture of porcelain; "stoneware" clay for making vitrified ware; and "earthenware" clay for making the more porous earthenware such as flower pots, etc.; "refractory" clays used in the manufacture of fire brick; "sewer pipe" clays which produce heavy wares capable of taking a salt glaze; and "brick and tile" clays and shales for the manufacture of building brick, structural tile, and drain tile. Ontario can supply the major portion of the above classification, e.g., china clay or kaolin occurs on the Mattagami river in Northern Ontario, but has not yet been developed in an economic way. On the other hand, fire clay in good grade and supply, which is amenable to the manufacture of fire brick, is found close to the T. & N.O. railway on the James Bay slope. Up to the present no deposit of ball clay has been discovered, and the needs of industry are imported from Saskatchewan or the United States. Stoneware or "Rockingham" ware, is already manufactured in the Province, while the porous variety of flower pots is supplied to horticulturists in large quantity. For the more widely consumed manufactures, such as sewer pipe and similar ware, building bricks in great variety of colours and grades, building tile, drain tile, etc., there is an abundant supply of raw materials available in Ontario.

The following table shows in detail the quantities and values of the several kinds of clay products made and sold in Ontario:—

HEAVY CLAY PRODUCTS MARKETED, 1930

Kind	Number or Quantity	Value, $
Brick—Soft-mud process {Face	9,798,071	201,860
Brick—Soft-mud process {Common	24,674,387	375,088
Stiff-mud (wire cut) process {Face	57,000,754	1,178,026
Stiff-mud (wire cut) process {Common	22,800,298	346,126
Dry-press {Face	21,835,179	431,683
Dry-press {Common	4,245,955	58,530
Fancy or ornamental brick (including special shapes, embossed and enamelled brick)	264,946	23,858
Sewer	721,750	12,490
Tile, structural: Hollow blocks (including fireproofing and load-bearing tile)...tons	85,155	791,474
Roofing tile...no.	3,056	356
Floor tile (quarries)...sq. feet	.....	56,726
Tile, drain...no.	22,783,261	593,980
Sewer pipe (including copings, flue linings, etc.)	.....	834,361
Pottery (flower pots) from domestic clay	6,420,000	89,381
Haydite	.....	227,275
Total value	.....	5,221,214

The value of clay products marketed for the last pre-war year (1913), for 1922, and for the past five years is given below:—

VALUE OF CLAY PRODUCTS SOLD OR USED, 1913, 1922, AND 1926–1930

Year	Brick		Pottery	Drain Tile	Sewer Pipe	Haydite	Total
	Common	Pressed, Fancy, Building Tile, etc.					
	$	$	$	$	$	$	$
1913	3,283,894	1,162,860	52,875	292,767	600,297	.....	5,392,693
1922	2,614,120	2,899,205	88,889	368,180	973,824	.....	6,944,218
1926	768,734	3,324,526	87,600	340,403	835,206	.....	5,356,469
1927	1,063,724	3,323,867	91,300	521,957	852,187	.....	5,853,035
1928	1,154,763	3,377,648	*98,519	572,577	974,157	.....	6,177,664
1929	1,281,004	3,524,358	96,394	629,322	1,167,463	131,621	6,830,162
1930	792,234	2,683,983	89,381	593,980	834,361	227,275	5,221,214

*Includes $400 worth of other products.

Production of "Haydite," a patented building material, began in Ontario in the spring of 1929. The process involves the burning of shale or clay to clinker in an inclined metal cylinder resembling a rotary cement kiln. At 2000° F. incipient fusion takes place, and gases formed cause expansion of the clay or shale into a light weight, thoroughly vitrified, cellular product. After cooling, the clinker is crushed and screened to various sizes. The product may be used as aggregate for any type of monolithic concrete construction, or it may be moulded or cast into blocks mixed with cement mortar as a binder. The resultant product is much lighter than hollow concrete blocks, will hold nails, and possesses many other advantages in interior construction, such as being soundproof and fireproof. If used for outside walls in house construction, a stucco finish may be applied directly.

Mining Company Incorporations

A summary of mining companies incorporated and licensed in Ontario for the last pre-war year and subsequently is given hereunder:—

ONTARIO MINING COMPANIES INCORPORATED AND LICENSED, 1913–1930

Year	Incorporated			Extra-Provincial Companies Licensed	
	No.	Nominal Capital	"No Par" Shares	No.	Capital for use in Ontario
		$			$
1913	119	78,000,000	.....	12	21,735,000
1914	80	39,030,000	.....	13	5,445,000
1915	59	42,005,000	.....	2	10,200,000
1916	83	109,079,500	.....	8	7,011,650
1917	100	117,183,000	.....	7	7,202,000
1918	59	49,800,000	.....	7	15,000,000
1919	149	223,600,000	.....	10	9,554,197
1920	119	146,094,000	.....	12	9,435,000
1921	67	105,715,000	.....	6	1,030,500
1922	91	181,040,000	.....	6	830,000
1923	88	179,295,500	.....	6	1,775,000
1924	85	156,485,000	.....	2	200,000
1925	70	107,400,000	9,010,000	3	162,510
1926	145	165,655,750	22,386,500	6	4,850,000
1927	199	344,145,000	40,034,000	10	3,260,000
1928	211	495,575,000	30,778,400	17	7,208,500
1929	97	142,390,000	32,557,200	13	1,540,000
1930	37	23,234,600	16,808,909	6	5,525,000

MINING COMPANIES WITH SPECIFIED CAPITAL INCORPORATED IN ONTARIO IN 1930

Name of Company	Head Office	Date of Incorporation	Capital
			$
*Bain Coal Company, Ltd.	Toronto	Apr. 23	35,000
Benny Mines, Ltd.	Toronto	June 25	2,000,000
Central Oil Company, Ltd.	Kitchener	Oct. 30	250,000
Cheltonia-Swastika Mines, Ltd.	Toronto	Sept. 12	5,000,000
Crow River Gold Mines, Ltd.	Toronto	Aug. 18	100,000
Eby-Burt Mines, Ltd., The	Kirkland Lake	Mar. 3	2,000,000
*Eldorado Quarries, Ltd., The	Toronto	Apr. 25	50,000
Federal Petroleum Royalties, Ltd.	Toronto	Aug. 23	2,000,000
Gas & Oil Developers, Ltd.	Toronto	Oct. 25	1,500,000
Haliburton Exploration, Ltd.	Lindsay	Dec. 11	150,000
Homestead Oil & Gas, Ltd.	Toronto	Oct. 6	500,000
Hydro-Carbons, Ltd.	Toronto	Sept. 23	3,000,000
Lorraine Quartzites, Ltd.	Toronto	Nov. 6	40,000
Miller Bay Gold Mines, Ltd.	Toronto	Oct. 20	2,500,000
*Mineral Resources Finance Co., Ltd.	Toronto	Feb. 13	200,000
*Park Mining Co., Ltd.	Sault Ste. Marie	Apr. 1	29,600
Paymaster Consolidated Mines, Ltd.	Toronto	Feb. 15	40,000
Select Mineral Properties, Ltd.	Hamilton	Sept. 11	300,000
Sudbury Patricia Mines, Ltd.	Toronto	Jan. 15	3,000,000
Superior Explorations, Ltd.	Toronto	July 12	40,000
Tillsonburg Oil & Gas Co., Ltd.	Tillsonburg	Nov. 3	500,000
Total (21 companies)			23,234,600

*"No par" shares issued in addition. See list of "No par" companies.

Of the 37 companies incorporated in 1929, 21 had specified capital and 20 were companies having shares without nominal or par value, while 4 companies had shares of both kinds. The corresponding figures for 1929 were 97, 71, 26 and 5.

MINING COMPANIES INCORPORATED IN ONTARIO IN 1930 HAVING SHARES WITHOUT NOMINAL OR PAR VALUE

Name of Company	Head Office	Date of Incorporation	No. of Shares
Abitibi Coal Field, Ltd	Toronto	Apr. 9	500,000
Allied Metal Products, Ltd	Toronto	May 1	10,000
Atlas Exploration Co., Ltd., The	Toronto	Jan. 20	5,000,000
Canadian Gowganda Succession Mines, Ltd	Toronto	May 8	40,000
*Bain Coal Co., Ltd	Toronto	Apr. 23	5,000
D. L. Jemmett, Ltd	Cobalt	July 22	40,000
Dominion Pavers & Supplies, Ltd	Windsor	May 1	10,000
Dominion Royalty Corporation, Ltd	Toronto	July 18	6,000,000
*Eldorado Quarries, Ltd., The	Toronto	Apr. 25	25,000
*Mineral Resources Finance Co., Ltd	Toronto	Feb. 13	9
Kremzar Gold Mines, Ltd	Sault Ste. Marie	Mar. 8	1,000,000
Mines Selection, Ltd	Toronto	Mar. 27	500
Minto Gold Mines, Ltd	Village of WaWa	July 25	8,000
Northern Ontario Lands Corporation, Ltd., The	Sault Ste. Marie	Apr. 23	60,000
*Park Mining Co., Ltd	Sault Ste. Marie	Apr. 1	10,400
Proprietary Mines, Ltd	Toronto	Mar. 14	1,000,000
Red Lake Tiger Gold Mines, Ltd	Toronto	Mar. 18	40,000
Research Service, Ltd	Toronto	Jan. 29	20,000
Superior Zinc Corporation of Canada, Ltd	Toronto	Dec. 3	40,000
Wilkie Mines, Ltd	Matheson	Jan. 14	3,000,000
Total (20 companies)			16,808,909

*Also see list with specified capital. Four companies having both capital and "No par" shares are included in both lists.

Under the provisions of the Ontario Companies Act, companies of extra-provincial incorporation are required to take out a license in Ontario and stipulate the amount of capital used in connection with mining enterprises where the land is situate within the Province. If land only is held in the Province and business not carried on a license in mortmain is sufficient.

EXTRA-PROVINCIAL AND MORTMAIN MINING COMPANIES LICENSED IN 1930 BY ORDER-IN-COUNCIL

Note.—Where incorporation is outside of Canada, the State, or Province is noted.

Name of Company	Incorporation	Date of License (O.C.)	Capital for use in Ontario
			$
Dominion Steel & Coal Corporation, Ltd	Nova Scotia	June 25	250,000
North Star Oil, Ltd	Canada*	July 17	100,000
Ontario Refining Co., Ltd	Canada*	Mar. 10	5,000,000
Interprovincial Exploration Co., Ltd	Canada**	Apr. 10	50,000
Lewis-Fleming Mines, Ltd	Canada**	Feb. 26	25,000
Northern Iron Ore Mines, Ltd	Canada**	July 9	100,000
Total (6 companies)			5,525,000

*Incorporation under The Companies Act, Revised Statutes of Canada, 1906, Par. 1 of Chapter 79.

**License issued pursuant to the provisions of The Mortmain and Charitable Uses Act, Province of Ontario.

Mining Revenue and Expenditures

The revenue of the Department of Mines for the fiscal year ending October 31, 1930, was $1,017,030.67 as compared with $882,026.05 in the previous year. Expenditures of the Department were $488,746.46 ordinary and $1,535.07 capital or a total of $490,281.53. Details of revenue follow:—

ORDINARY:

MAIN OFFICE

Sand and Gravel—			
Royalties	$ 278,156.62		
Licenses	865.55		
		$ 284,022.15	
Casual Fees		920.42	
Boring Permits		5,334.15	
Sale of Record Books—Unwrought Metal Sales Act		47.00	
Gas Leases		7,400.00	
Refunds		1,146.57	
			$ 298,870.31

BRANCHES

Inspection—Cable Testing Fees			3,193.90
Assessment—Taxes			
Acreage	$ 30,740.62		
Profit	502,525.38		
Gas	15,311.30		
			548,577.30
Chemical and Assay—Fees			1,140.15
Mine Rentals—			
Mining Leases	$ 4,707.93		
Licenses of Occupation	2,855.63		
Miners—			
Licenses	57,596.82		
Permits	2,040.00		
Fees—Recording	36,962.65		
Miscellaneous	2,410.55		
Maps—Sales	1,185.83		
			107,759.41
Natural Gas Commissioner—Permits			1,240.42
Temiskaming Testing Laboratories—Fees			23,111.63
Sulphur Fumes Arbitrator—Damages collected			4,894.86
			$ 988,787.98
CAPITAL:			
Mining Recorders—Mining Land Sales			28,242.69
Total Revenue			$1,017,030.67

MINING LANDS SOLD AND LEASED FROM NOV. 1, 1929, TO OCT. 31, 1930*

District	Sales			Leases			Total Sales and Leases		
	No.	Acres	Amount	No.	Acres	Amount	No.	Acres	Amount
			$			$			$
Timiskaming	107	3,991.17	11,779.12	80	3,706.35	674.77	187	7,697.52	12,453.89
Cochrane	51	2,087.13	5,783.40	....	.....	.....	51	2,087.13	5,783.40
Sudbury	76	3,589.02	10,545.46	18	834.25	83.43	94	4,423.27	10,628.89
Patricia	37	1,356.47	3,241.70	....	.....	.....	37	1,356.47	3,241.70
Algoma	44	1,816.53	5,289.69	....	.....	.....	44	1,816.53	5,289.69
Thunder Bay	24	1,066.04	2,674.98	....	.....	.....	24	1,066.04	2,674.98
Kenora	9	347.72	1,012.88	....	.....	.....	9	347.72	1,012.88
Rainy River	8	375.96	942.40	....	.....	.....	8	375.96	942.40
Elsewhere	6	381.55	763.68	2	69.10	6.91	8	450.65	770.59
Total	362	15,011.59	42,033.31	100	4,609.70	765.11	462	19,621.29	42,798.42

*These figures do not agree with corresponding items of the revenue statement preceding which records collections of moneys actually received during the fiscal year.

SUMMARY OF BUSINESS TRANSACTED IN THE SEVERAL MINING DIVISIONS DURING THE CALENDAR YEAR, 1930

Schedule	Fort Frances	Sudbury	Porcupine	Larder Lake	Sault Ste. Marie	Port Arthur	Kowkash	Timiskaming and Coleman	Gowganda	Montreal River	Kenora	Red Lake	Total
1. Letters received	568	3,444	3,189	3,826	1,207	3,448	429	1,818	420	694	1,157	2,273	22,473
2. Letters written	542	3,408	2,524	3,872	706	2,707	436	1,478	423	560	1,051	1,990	19,697
3. Miners' Licenses issued	15	283	82	129	117	116	31	150	.....	146	109	80	1,258
4. Miners' Licenses renewed	66	1,048	719	696	388	579	165	720	79	95	152	188	4,895
5. Mining claims recorded†	75	807	135	424	318	338	12	202	244	661	194	305	3,715
6. Mining claims cancelled	49	3,198	652	817	412	1,530	193	81	49	280	387	1,239	8,887
7. Agreements, Transfers, etc., recorded	29	851	285	296	162	216	94	101	61	176	49	185	2,505
8. Receipts for Miners' Licenses, Permits, Recording Fees, etc.....$	1,197.75	15,495.45	6,400.10	8,483.25	5,424.50	6,988.00	1,332.00	6,663.50	3,902.00	6,916.50	3,122.35	5,404.25	71,329.65
9. Receipts as Purchase Money or Rental.....$	386.80	5,738.27	2,381.00	7,212.12	5,612.39	1,667.50	1,110.03	3,356.88	55.60	664.05	497.80	460.17	29,142.61
10. Total remitted to Department.....$	1,584.55	21,233.72	8,784.23	15,695.37	11,036.89	8,655.50	2,442.03	10,020.38	3,957.60	7,580.55	3,620.15	5,864.42	100,475.39
11. Claims of which surveyors' plans were filed	3	0	2	36	24	38	.....	7	.....	16	.....	25	151
12. Disputes entered	0	.....	.....	7	.....	0	.....	1	.....	.....	.....	.....	8
13. Disputed cases decided by Recorders	.....	0	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	3
14. Appeals to Mining Court	.....	0	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1
15. Extensions of time granted	110	882	381	809	118	343	44	72	25	124	229	840	3,977
16. Certificates of Record granted	5	33	23	61	38	14	8	31	2	7	5	16	243
17. Certificates of Performance of Work granted	5	36	32	69	47	20	8	38	2	7	12	6	282
18. Claims for which papers were forwarded to the Department for issue of title	3	53	24	61	46	17	8	32	2	7	5	6	264
19. Forest Reserve Permits issued	.....	33	9	4	12	11	6	38	129	.....	.....	.....	242
20. Substitute Miners' Licenses issued	1	5	8	3	.....	0	1	3	.....	1	.....	3	25
21. Abstracts issued	210	1,933	896	765	226	336	49	78	76	356	306	895	6,126
22. Blue prints sold	58	511	406	561	114	201	51	254	118	451	65	91	2,881

†There were 171 claims recorded at Toronto, making a total of 3,886 for the entire Province as compared with 8,207 in 1929.

STATEMENT OF MONEYS REMITTED BY MINING RECORDERS FOR THE FISCAL YEAR ENDING OCTOBER 31, 1930

Mining Division	Name of Recorder	Address	Purchase Price	Forest Reserve Permits	Miners' Licenses	Recording Fees	Maps	Miscellaneous Fees	Total
			$	$	$	$	$	$	$
Fort Frances	Alexander, J. A.	Fort Frances	293.00	.....	429.00	724.00	49.00	89.50	1,584.50
Sudbury	McArthur, T. A.	Sudbury	6,337.64	350.00	6,512.00	9,434.00	209.95	651.35	23,494.94
Montreal River	Coghill, J. M.	Elk Lake	391.00	.....	868.00	2,379.00	76.25	49.90	3,764.15
Gowganda	do	do	55.60	940.00	360.00	398.00	21.00	24.05	1,798.65
Porcupine	Dixon, R.	South Porcupine	2,361.88	30.00	4,054.00	1,961.00	114.50	319.85	8,841.23
Larder Lake	Ginn, H. G.	Swastika	7,990.85	.....	3,963.00	4,077.00	152.25	398.55	16,581.65
Timiskaming	McAuley, N. J.	Haileybury	4,128.04	290.00	4,350.00	2,225.00	63.50	105.75	11,162.29
Red Lake	Holland, H. E.	Goldpines	302.82	.....	1,553.00	3,896.25	62.25	343.65	6,157.97
Port Arthur	McGregor, C. F.	Port Arthur	1,586.50	110.00	3,800.00	3,772.75	54.25	109.75	9,433.25
Sault Ste. Marie	Miller, W. N.	Sault Ste. Marie	3,872.89	130.00	2,422.00	2,379.25	46.25	127.25	8,977.64
Kowkash	O'Rourke, M. F.	Tashota	1,110.03	50.00	1,007.00	1,446.00	13.50	54.70	3,681.23
Kenora	Smith, J. D. C.	Kenora	1,012.80	.....	1,366.00	2,285.00	49.75	136.25	4,849.80
Total	.....	.....	29,443.05	1,900.00	30,684.00	34,977.25	912.45	2,410.55	100,327.30

MINING CLAIMS RECORDED IN THE SEVERAL MINING DIVISIONS, 1907, AND 1911-1930

Mining Division	1907	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Timiskaming	7,860	922	516	1,326	215	222	156	269	184	244	329	159	328	971	735	634	438	875	499	346	202
Coleman*	291	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Sudbury	456	2,309	776	483	237	233	464	262	168	673	267	319	701	436	559	546	1,367	3,351	6,424	2,164	807
Sault Ste. Marie	291	119	137	127	23	92	44	135	199	90	90	216	541	498	284	451	395	735	702	487	318
Port Arthur	317	183	180	182	353	641	172	180	66	171	108	120	296	222	300	494	1,278	982	1,269	691	338
Kenora	.....	89	91	.....	25	23	45	32	48	31	25	53	168	150	77	229	935	140	520	348	194
Parry Sound†	102	15	5	.....	2	.....	10	25	12	39	33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Larder Lake	3,813	1,252	541	1,575	718	915	783	160	423	1,015	712	918	2,344	1,736	1,219	890	1,532	3,141	1,781	891	424
Montreal River	866	98	126	63	28	2	56	294	293	134	81	143	174	400	471	471	290	126	156	48	661
Gowganda	.....	258	194	68	23	14	51	113	52	145	215	101	55	33	444	220	96	24	40	34	244
Porcupine	.....	3,756	538	496	240	262	401	236	48	136	192	273	760	1,424	556	620	1,297	3,127	611	650	135
Kowkash	.....	.....	.....	.....	.....	.....	160	135	2	9	31	3	148	206	438	150	28	250	368	319	12
Red Lake	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,827	2,018	1,100	973	305
Fort Frances	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	70	75
At Toronto	.....	.....	.....	.....	49	92	128	95	39	231	87	145	171	116	139	226	203	795	1,576	1,186	171
Total	13,996	9,001	3,104	4,320	1,913	2,519	2,470	1,936	1,534	2,918	2,160	2,459	5,686	6,092	5,222	4,751	13,496	15,564	15,046	8,207	3,886

*Joined with Timiskaming since 1911. †Office at Parry Sound closed in 1921, and records are now kept at the Department of Mines, Toronto.

The following statement, prepared by the Accounts Branch of the Department, gives details of the Profit Tax collected under the supervision of G. R. Mickle, Mine Assessor, for the fiscal year ending October 31, 1930:—

DETAILS OF PROFIT TAX

GOLD:—		
Dome Mines, Ltd	$ 14,580.67	
Hollinger Consolidated Gold Mines, Ltd	23,370.66	
Lake Shore Mines, Ltd	83,375.06	
McIntyre Porcupine Mines, Ltd	13,985.59	
Teck-Hughes Gold Mines, Ltd	69,645.80	
Wright-Hargreaves Mines, Ltd	3,288.40	
Vipond Consolidated Mines, Ltd	2,871.08	
		$ 210,117.26
SILVER:—		
Coniagas Mines, Ltd	$ 556.00	
Nipissing Mining Co., Ltd	2,488.16	
O'Brien, M. J., Ltd	8,527.33	
		11,571.49
NICKEL-COPPER:—		
International Nickel Company of Canada, Ltd	$ 256,776.84	
Mond Nickel Co., Ltd	24,012.33	
		280,789.17
MICA:—		
Loughborough Mining Co., Ltd		47.46
Total		$ 502,525.38

Under the Mining Tax Act, a graduated tax is levied on the net profits of mining companies in excess of $10,000 per annum. The basic rate is 3 per cent. on profits up to $1,000,000. On profits over $1,000,000 and up to $5,000,000 the tax is 5 per cent., and on profits in excess of the latter amount the rate is 6 per cent. A portion of this money is returned to organized municipalities for municipal government purposes.

Temiskaming Testing Laboratories

This plant, which is located at Cobalt and is equipped for sampling and assaying, has been operated by the Ontario Department of Mines since July, 1921, under the management of A. A. Cole, Mining Engineer of the T. & N. O. Railway Commission, and George Dickson, Superintendent.

The following is a comparative financial report for the years 1922 to 1930, inclusive:—

COMPARATIVE FINANCIAL STATEMENT OF THE TEMISKAMING TESTING LABORATORIES, 1922–1930

Year	Cash Receipts	Earnings	Expenditures	Operating Profit	Operating Loss
	$	$	$	$	$
1922	18,096.19	17,749.51	19,173.19	.....	1,424.68
1923	18,699.22	20,117.81	19,781.25	336.56	.....
1924	26,032.20	25,417.61	23,206.66	2,200.95	.....
1925	19,922.37	20,041.08	20,043.31	.....	2.23
1926	20,302.51	21,119.98	20,658.19	461.79	.....
1927	19,387.66	19,400.55	20,012.09	.....	611.54
1928	14,875.58	14,369.66	18,181.68	.....	3,812.02
1929	19,604.70	21,690.60	18,088.41	3,602.19	.....
1930	25,070.27	24,316.82	24,153.03	163.79	.....

Following is a brief summary of operations for the year 1930:—

Assaying.—Gold, 1,296 samples; silver, 1,833; copper, 413; silver bullion, 298; cobalt, 1,055; nickel, 104; zinc, 52; lead, 31; silica, 12; arsenic, 15; iron, 31; platinum, 12; sulphur, 5; tin, 4; and one each of chromium and vanadium.

Silver Ore Milled and Sampled.—Weight, 517.77 tons, silver content, 1,218,660 ounces.

Base Bullion Melted.—125 bars containing 102,671 gross ounces of silver.

Gold Ore Purchased.—One lot for which $34.09 was paid.

Gold Ore Milled and Sampled.—Two lots or 4.42 tons.

Cobalt Ore Milled and Sampled.—999 tons.

Provincial Assay Office

As an aid in the development of the mineral resources of Ontario an Assay Office was established at Belleville in July, 1898, by the Bureau (now Department) of Mines. For convenience the office was moved to 5 Queen's Park, Toronto, in November, 1911, and again in the spring of 1927 to the new East Block of the Parliament Buildings.

The Provincial Assayer, W. K. McNeill, reports as follows for 1930:—

FREE ASSAYS UNDER THE PROVISIONS OF THE MINING ACT OF ONTARIO

Mining Division	Number of Samples received for Free Assay during 1930†													
	Gold	Silver	Copper	Lead	Zinc	Platinum	Tin	Nickel	Iron	Sulphur	Mercury	Cobalt	Tungsten	Total
Eastern Ontario*	6	5	2	....	1	....	4	3	1	....	1	....	1	24
Fort Frances*	21	1	1	....	....	....	....	....	....	....	....	....	....	23
Gowganda	3	....	....	....	....	....	....	....	....	....	....	....	....	3
Kenora	11	....	....	....	....	....	....	....	....	....	....	....	....	11
Patricia portion	2	....	....	....	....	....	....	....	....	....	....	....	....	2
Kowkash	6	....	1	....	....	....	....	....	....	....	....	....	....	7
Larder Lake	53	10	4	1	2	1	3	....	1	....	....	....	....	75
Mississagi Reserve*	13	4	5	1	1	....	....	....	....	....	....	....	....	24
Montreal River	5	....	....	....	....	....	....	....	....	....	....	1	....	6
Parry Sound*	1	1	6	....	1	....	....	....	....	....	....	....	....	9
Porcupine	3	....	....	....	....	....	....	1	....	1	1	....	....	6
Port Arthur	21	5	2	....	....	....	....	3	....	....	....	1	....	32
Red Lake	19	....	1	....	....	....	....	....	....	....	....	....	....	20
Sault Ste. Marie	30	15	14	5	4	....	3	3	2	....	....	....	....	76
Sudbury	19	9	15	2	....	1	1	6	....	1	1	2	....	57
Timagami Reserve*	2	....	1	....	....	1	2	....	1	....	....	....	....	7
Timiskaming	19	7	13	1	....	....	....	....	....	....	....	5	....	45
Total†	234	57	65	10	9	3	13	16	5	2	3	9	1	427

*All mining claim records for these Divisions are kept at the office of the Deputy Minister of Mines, Toronto.

†Total free assays numbered 1,316 in 1928, 649 in 1929, and 427 in 1930.

The Assay Office has been in operation during the entire year and the usual variety of work has been done with the assistance of T. E. Rothwell and W. F. Green, Chemists and Assayers, also Robert Stewart, Reginald Eyre and William Ley, Laboratory Assistants.

The schedule of charges, effective Jan. 1, 1930, for the Provincial Assay Office and Chemical Laboratory, may be obtained on application. Minerals and rocks not requiring chemical analysis are identified free of charge. Tests for radio-activity are free.

The following is a statement of the samples submitted by the general public for which the regulation fee was charged, and also those submitted by geologists and officers of the Department of Mines:—

CUSTOMS ASSAYING AND GENERAL WORK, 1929

Assay and No. of Samples		Assay and No. of Samples	
Gold	393	Carbon	13
Silver	67	Radium	29
Copper	84	Chromium	3
Lead	7	Ash	15
Zinc	3	Arsenic	2
Nickel	37	Manganese	13
Iron	12	Silica	5
Platinum	25	Water	14
Tin	4	Cement	2
Sulphur	2	Mercury	6
Lime	7	Diatomite	5
Phosphorus	12	Potash	2
Cobalt	5	Soda	2
Titanium	2	Moisture	13
Coal	116	Volatile matter	13
Miscellaneous—these included 1 each of cerium, potassium, oil, sand, vanadium, insoluble, chlorine, alumina, and calcium			8
Identification—samples were received by mail and reports issued. A large number were brought directly to the Laboratory; of these no record was kept			257
Rocks—samples were submitted by geologists of the Department for complete analysis.			9
Total			1,188

DIRECTIONS AND TERMS

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 whence they were taken.

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 ensure prompt return of certificate, as no examination is commenced until the regulation fee is paid.

Crushed samples representing large quantities, or samples less than one pound weight, may be sent by mail as third-class matter. Write your name and address plainly on each parcel. Send instructions, with money in payment of fees, 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.

Samples should be addressed as follows:—

PROVINCIAL ASSAY OFFICE,
East Block, Parliament Bldgs.,
TORONTO, ONT.

Draughting Office, North Bay

In order to cope with the demand from prospectors and others for blueprints showing mining claims in good standing in the several Mining Divisions of the Province, apart from the Divisions served direct from Toronto, the Department of Mines established a Draughting Office at North Bay in February, 1920, with C. G. Watson in charge. As mining claims are recorded in each Mining Division, sketches and recording notices are forwarded by the Recorders to the Draughting Office, and the same practice applies when surveys are filed. Tracings are prepared from the data furnished and blueprints supplied to the Recorders and to the general public at a nominal charge. North Bay is a convenient centre and considerable time is saved through the mails compared with former practice when blueprints were prepared at Toronto.

During the calendar year, 1930, there were 1,048 blueprints distributed from the North Bay office, and total receipts from this source were $276.75. In addition maps were supplied by this office to Mining Recorders, who sold 3,501 blueprints during the calendar year 1930.

LIST OF MINES, QUARRIES AND METALLURGICAL WORKS

METALLICS

Operator	Mine and Location	Manager	Address
Chrome			
Consolidated Chromium Corporation	Obonga L., west of L. Nipigon	A. R. Globe	Allanwater, via Collins.
Copper			
Shield Development Co., Ltd	Tip Top Kashabowie, Thunder Bay	Jas. Cooper	132 St. James St., Montreal.
White Lake Mines, Ltd	White Lake, Tp. I.A., Algoma District	D. J. Russell	Blind River, and 301 Royal Bank Bldg. Toronto.
Copper-Zinc-Lead			
Sudbury Basin Mines, Ltd	Vermillion L., Fairbank tp	J. T. Travers	100 Adelaide St. W., Toronto.
Treadwell Yukon Company, Ltd	Errington, Creighton tp	V. C. Clauson	Bradley.
Gold			
Barry-Hollinger Gold Mines, Ltd	Barry-Hollinger, Boston Creek	Jas. Houston	Boston Creek.
Beardmore Gold Mines, Ltd	Beardmore	W. A. Roberts	Beardmore.
Bennett-Pacaud Mines, Ltd. (under option)	Goudreau		1454 Yonge St., Toronto.
Bidgood Consolidated Mines, Ltd	Bidgood, Lebel tp	John McPhee	Kirkland Lake.
British Canadian Mines, Ltd	Foley, Mine Centre	F. McQueen	8 Bloor St. E., Toronto.
Bunker Hill Extension Mines, Ltd	Tough-Oakes Burnside, Kirkland Lake	F. J. Hotchkins	Kirkland Lake.
*Canadian Champion Reef Mining Co., Ltd	Champion Reef, West Shiningtree		1302 Canada Permanent Bldg., Toronto.
Canadian Kirkland Mines, Ltd	Canadian Kirkland, Kirkland Lake	Hugh Jardine	Kirkland Lake.
Canusa Mining and Exploration Co., Ltd	Scottish-Ontario, Whitney tp	Geo. Bannerman	Timmins.
Central Canada Mines, Ltd	Walsh		Union Bank Bldg., Fort William.
Central Patricia Mines, Ltd	Central Patricia, Patricia Portion	J. P. Millenback	Allanwater.
Coniaurum Mines, Ltd	Coniaurum, Porcupine	John Redington	Schumacher.

*Successors to West Tree Mines, Ltd.

GOLD (*Continued*)

OPERATOR	MINE AND LOCATION	MANAGER	ADDRESS
Cooper Gold Mines, Ltd	Minto, Michipicoten	John Knox, Jr	Wawa.
De Santis Gold Mining Co., Ltd. (under option)	De Santis, Kamiskotia	Peter De Santis	Timmins.
Dome Mines, Ltd	Dome, Porcupine	H. P. De Pencier	South Porcupine.
Goldbank Syndicate	Goldbank	J. H. Sharmen	404 Talbot St., London.
Golden Summit Mines, Ltd	Golden Summit, lot 6, con. I, Maisonville	William J. Simpson	594 Bloor St. W., Toronto.
Harvey Kirkland Mines, Ltd	Harvey Kirkland, Lebel tp	Morris Hastie	Kirkland Lake.
Hayden Gold Mines Co., Ltd	Hayden, Porcupine	T. C. Fawcett	Timmins.
Hollinger Consolidated Gold Mines, Ltd	Hollinger, Porcupine	A. F. Brigham	Timmins.
Howey Gold Mines, Ltd	Howey, Red Lake	H. G. Young	Red Lake.
Kenora Prospectors and Miners, Ltd	Mikado, Cornucopia, and King, Lake of the Woods		100 Adelaide St. W., Toronto.
Kirkland Lake Gold Mining Co., Ltd	Kirkland Lake Gold, Kirkland Lake	W. M. Sixt	Kirkland Lake.
Lakeland Gold Mines, Ltd	Lakeland, lots 4, 5, 6, con. V, VI, Maisonville tp	K. A. Deacon	Bourkes, and 19 Sun Life Bldg., Hamilton.
Lake Shore Mines, Ltd	Lake Shore, Kirkland Lake	E. B. Knapp	Kirkland Lake.
McIntyre-Porcupine Mines, Ltd	McIntyre, Porcupine	R. J. Ennis	Schumacher.
March Gold, Ltd	March, Porcupine	Martin O. Knutson	South Porcupine.
Metals Development, Ltd	Goodall and Dent tps., Patricia portion	J. C. Nelson	811 Sterling Tower Bldg., Toronto.
Moss Mines, Ltd	Moss, Thunder Bay district	J. G. Harkness	Kashabowie.
Parkhill Gold Mines, Ltd	Parkhill, Michipicoten	J. A. S. Roussac	Wawa.
Porcupine United Gold Mines, Ltd	Rochester, Porcupine	J. D. Tolman	Timmins.
Power and Mines Corporation, Ltd	Grace, Michipicoten	C. A. Chisholm	1254 St. Catherine St. W., Montreal.
Ritchie Gold Mines, Ltd	Ritchie, Gauthier tp		71 York St., Toronto.
Sylvanite Gold Mines, Ltd	Sylvanite, Kirkland Lake	C. E. Rodgers	Kirkland Lake.
Tashota Gold Mines, Ltd	Tashota, Thunder Bay district		1111 Beaver Hall Hill, Montreal.
Teck-Hughes Gold Mines, Ltd	Teck-Hughes, Kirkland Lake	D. L. H. Forbes	Kirkland Lake.
Telluride Gold Mines of Canada, Ltd	Telluride, lot 2, con. II, Skead tp	H. Hollands-Hurst	405 Northern Ontario Bldg., Toronto.
United Mineral Lands Corp	Paymaster, Porcupine		South Porcupine.
Vipond Consolidated Mines, Ltd	Vipond, Porcupine	Robert E. Dye	Timmins.
West Dome Lake Gold Mines, Ltd	West Dome, Porcupine		South Porcupine.
Wright-Hargreaves Mines, Ltd	Wright-Hargreaves, Kirkland Lake	M. W. Summerhayes	Kirkland Lake.

LEAD

Kingdon Mining, Smelting and Manufacturing Co., Ltd	Kingdon, Carleton county	R. R. Rose	Galetta.

Lead and Zinc

Lake Geneva Mining Co., Ltd., (under option)	Lake Geneva, Sudbury district	W. E. Bawden	Geneva, via Cartier.

Nickel and Copper

Falconbridge Nickel Mines, Ltd	Falconbridge, Sudbury district	Ernest Craig	Garson.
International Nickel Co. of Canada, Ltd	Creighton, Sudbury district	S. J. Kidder	Creighton Mine.
International Nickel Co. of Canada, Ltd	Frood, Sudbury district	R. D. Parker	Frood Mine.
International Nickel Co. of Canada, Ltd	Garson, Sudbury district	W. J. Mumford	Garson.
International Nickel Co. of Canada, Ltd	Levack, Sudbury district	A. L. Sharp	Levack.

Silver

Animikie Mines, Ltd. (under option)	Badger, Silver Mountain	S. W. Ray	223 Victoria St., Port Arthur.
Animikie Mines, Ltd. (under option)	Keystone (Climax), Silver Mountain	S. W. Ray	223 Victoria St., Port Arthur.
Animikie Mines, Ltd. (under option)	Porcupine, Silver Mountain	S. W. Ray	223 Victoria St., Port Arthur.
Brocklebank, Arthur (under lease)	Kerr Lake, Cobalt	Arthur Brocklebank	Cobalt.
Bunclark, Richard (under lease)	Penn Canadian, Cobalt	Richard Bunclark	Cobalt.
Cain, C. E., and associates	Beaver, Cobalt	C. E. Cain	Cobalt.
Castle-Trethewey Mines, Ltd	Capitol, Gowganda	Angus D. Campbell	Bestel.
Castle-Trethewey Mines, Ltd	Castle, Gowganda	Angus D. Campbell	Bestel.
Clemens, E. H. (under lease), deceased	Coniagas, Cobalt	E. H. Clemens	Coniagas Mines, Ltd., 320 Bay St., Toronto.
Cobalt Contact Mines, Ltd	Cobalt Contact, Cobalt	J. M. C. Dunlop	North Cobalt, and 57 Bloor W., Toronto
Jemmett, D. L., Ltd	Agaunico, Cobalt	D. L. Jemmett	Cobalt.
Jemmett, Henry (under lease)	Waldman, Cobalt	Henry Jemmett	Cobalt.
Keeley Silver Mines, Ltd	Keeley, South Lorrain	W. J. Dobbins	Silver Centre.
Laurentian Mines, Ltd. (under lease)	Laurentian, Lake of the Woods		
Lynch, E. (under lease)	Peterson Lake, Cobalt	E. Lynch	Cobalt.
Martin, George (under lease)	Crown Reserve, Cobalt	George Martin	Cobalt.
Mining Corporation of Canada, Ltd	Cobalt Lake, Buffalo, and Townsite-City	Arnold Smith	Cobalt.
Mining Corporation of Canada, Ltd	Frontier, South Lorrain	Arnold Smith	Cobalt.
Morrison Mines, Ltd	Morrison, Gowganda	Horace F. Strong	Haileybury.
Newton, William (under lease)	Silver Queen, Cobalt	William Newton	New Liskeard.
Nipissing Mining Co., Ltd	Nipissing, Cobalt	Hugh Park	Cobalt.
O'Brien, M. J., Ltd	Cross Lake, Cobalt	W. A. O'Flynn	Cobalt.
O'Brien, M. J., Ltd	Miller Lake O'Brien, Gowganda	H. G. Kennedy	Bestel.
O'Brien, M. J., Ltd	O'Brien, Cobalt,	W. A. O'Flynn	Cobalt.
Price, C. W. (under lease)	Foster, Cobalt	C. W. Price	Cobalt.
Roper, C. P. (under lease)	Silver Cliff, Cobalt	C. P. Roper	Cobalt.

SILVER (*Continued*)

OPERATOR	MINE OR PLANT	MANAGER	ADDRESS
Sandoe, Richard, and Moyle, H. (under lease)	Temiskaming, Cobalt	Richard Sandoe	Cobalt.
Sarabura, A. (under lease)	Lumsden, Cobalt	A. Sarabura	Cobalt.
Smith, W. H., and Laycock (under lease)	Hudson Bay, Cobalt	W. H. Smith	Cobalt.
Sullivan, Roy (under lease)	Provincial, Cobalt	Roy Sullivan	Cobalt.
Sutherland, Hugh	La Rose, Cobalt		
Todd, F. H. (under lease)	Victory, Cobalt	F. H. Todd	Cobalt.
Tuer, C. F. (under lease)	Kissinger, Cobalt	C. F. Tuer	Cobalt.
Ward, R. N. (under lease)	Stoneham, Cobalt	R. N. Ward	Cobalt.
White Reserve	White Reserve, Montreal river	Mr. Kuhorski	Cobalt.
Yorkshire Cobalt Mining Co	Yorkshire, Cobalt	Wm. E. McCready	Cobalt.

METALLURGICAL WORKS

Algoma Steel Corporation, Ltd	Iron blast furnace	Jas. H. Bell	Sault Ste. Marie.
Canadian Furnace Co., Ltd	Iron blast furnace	Richard C. Yates	Port Colborne.
Canadian Industries, Ltd	Acid and chemical plant	W. H. De Blois	Copper Cliff.
Cobalt Reduction Co., Ltd., operated by Mining Corporation of Canada, Ltd	Silver refinery		Cobalt.
Deloro Smelting and Refining Co., Ltd	Silver-cobalt refinery	S. B. Wright	Deloro.
Falconbridge Nickel Mines, Ltd	Blast furnace	J. R. Gill	Falconbridge.
International Nickel Co. of Canada, Ltd	Blast furnace	Peter Macdonald	Copper Cliff.
International Nickel Co. of Canada, Ltd	Blast furnace	Peter Macdonald	Coniston.
International Nickel Co. of Canada, Ltd	Nickel refinery	H. W. Walter	Port Colborne.
Ontario Refining Co., Ltd	Electrolytic copper refinery	C. H. Aldrich	Copper Cliff.
Steel Company of Canada, Ltd	Iron blast furnace	R. A. Gillies	Hamilton.

NON-METALLICS

ACTINOLITE

Building Services, Ltd	Actinolite, Elzevir tp	George Seller	1111 Beaver Hall Hill, Montreal.

ARSENIC

Deloro Smelting and Refining Co., Ltd	Silver-cobalt refinery	S. B. Wright	Deloro

Feldspar

Anderson & Son, James G	Britt, lots 3-5, con. I, Henvey tp	Jas G. Anderson	Lucknow.
Bathurst Feldspar Mines, Ltd	Bathurst, Bathurst tp	B. S. Hyde	230 King St. E., Toronto.
Craig, T. H	McDonald, E. ½ lot 12, con. IX, Bathurst	T. H. Craig	Perth.
Feldspar Quarries, Ltd	Furlong, Perth	W. H. Evans	Buckingham, P.Q.
Feldspar Glass, Ltd	Bathurst tp	W. J. McCallum	301 Royal Bank Bldg., Toronto.
Genesee Feldspar Co., Inc	Dwyer, near Hybla	Peter McDonald	Boxart St., Rochester, N.Y.
	Richardson, near Verona	Ross Morey	
Verona Quarries, Ltd	Verona		
Frontenac Floor and Wall Tile Co., Ltd	Grinding plant, Kingston	Everett Townsend	Box 178, Kingston.

Fluorspar

Stoklosar, Chas. A	W. ½ lot 3, con. I, Madoc tp	Chas. A. Stoklosar	Madoc, Ont.

Graphite

Black Donald Graphite Co., Ltd	Black Donald, Brougham tp	R. F. Bunting	Calabogie.

Gypsum

Gypsum, Lime and Alabastine, Canada, Ltd.	Caledonia	L. V. Robinson	Caledonia.
Gypsum, Lime and Alabastine, Canada, Ltd.	Lythmore	L. V. Robinson	Caledonia.

Iron Pyrites and Sulphuric Acid

Canadian Pyrites, Ltd	Caldwell Mine, Flower Station	O. M. Hook, Sec	1400 Guardian Bldg., Cleveland, Ohio.
Canadian Industries, Ltd	Acid plants, Coniston and Copper Cliff	W. H. DeBlois	Copper Cliff.

Lignite

Ontario Department of Mines	Onakawana, near Abitibi river	W. F. Fancy	Coral Rapids.

Mica

Operator	Mine, Quarry, or Works	Manager	Address
Austin, Louis		Louis Austin	Perth Road.
Lee, W. W.	Buck Lake Mine	W. W. Lee	Bedford Mills.
Loughborough Mining Co., Ltd	Lacey Mine, Loughborough tp		General Electric Co., Schenectady, N.Y.
O'Connor, W. J.	Leeds county		Lombardy.

Mineral Waters

Canada Dry Ginger Ale, Ltd	Caledonia Springs and Bourget	J. C. Haggarty	6380 St. Urbain St., Montreal.
Carlsbad, Ltd	Carlsbad Springs	Barclay Boyd	Carlsbad Springs.
Deneault, F	Bourget Springs	F. Deneault	Bourget.
Gurd, Chas., and Co., Ltd	Caledonia tp, Prescott county		1016 Bleury St., Montreal.
Sanitaris, Ltd	Pakenham tp, Lanark county	L. Macnamara	Arnprior.

Quartz, Quartzite and Silica Brick

Algoma Steel Corporation, Ltd	Silica brick from Deroche tp. quarry		Sault Ste. Marie.
Dominion Mines & Quarries, Ltd	Killarney, North Shore Lake Huron, East Neebish Island (idle)		40 University Avenue, Toronto.
Falconbridge Nickel Mines, Ltd	Quarry on property	Ernest Craig	Falconbridge.
Wright Co	Quartz quarry, Deroche tp	Geo. S. Cowie	Sault Ste. Marie.

Salt

Brunner, Mond Canada, Ltd	Amherstburg (Brine for chemical use)		Amherstburg.
Canadian Industries, Ltd	Sandwich (Chemicals and salt)		P.O. Box 1260, Montreal.
Dominion Salt Co., Ltd., The	Sarnia		1610 Bank of Commerce Bldg., Toronto.
Goderich Salt Co., Ltd	Goderich		Goderich.
Kincardine Salt, Ltd	Kincardine	Now operated by Canadian Industries, Ltd.	P.O. Box 1260, Montreal.
Western Canada Flour Mills Co., Ltd	Goderich		287 MacPherson Ave., Toronto.
Western Salt Co., Ltd	Courtright		1610 Bank of Commerce Bldg., Toronto.

Talc

Canada Talc Co., Ltd	Connolly	Roy Taylor	Madoc.
Geo. H. Gillespie Co., Ltd	Henderson	Geo. H. Gillespie	Madoc.

STRUCTURAL MATERIALS

Cement

Canada Cement Co., Ltd	Belleville, Plant No. 5 Lakefield, Plant No. 7 Port Colborne, Plant No. 8		Canada Cement Bldg., Phillips Sq., Montreal, P.Q.
St. Marys Cement Co., Ltd	St. Marys		357 Bay St., Toronto.

Lime

American Cyanamid Company	Quarry at Beachville, Kilns at Niagara Falls	A. J. Kennedy	535 Fifth Ave., New York.
Biederman, Albert G	Golden Lake	Albert G. Biederman	Golden Lake.
Brunner, Mond Canada, Ltd	Lots 6, 7, 8, con. I; lots 2, 3, con. II, Anderdon tp	F. Nill	Amherstburg.
Cameron, W. M	Ramsay tp	W. M. Cameron	Carleton Place.
Canada Lime Co., Ltd	Coboconk	Chas. R. Christie	6 Toronto St., Toronto.
Chalmers & Campbell	Owen Sound	M. Chalmers	689-7th Street W., Owen Sound.
Dominion Sugar Co., Ltd	Wallaceburg	R. A. Lauper	Wallaceburg.
Dominion Sugar Co., Ltd	Chatham	C. Moulthrop	Chatham.
Dominion Rock Products, Ltd	Eganville, 4 miles southeast	W. L. Paterson	506 Dominion Square Bldg., Montreal.
Gallagher Lime & Stone Co., Ltd., The	*Hamilton	Raymond Gallagher	R.R. 4, Hamilton.
Gypsum, Lime and Alabastine, Canada, Ltd.	*Beachville	T. F. Robinson	Beachville.
	*Elora	J. H. Robinson	Elora.
	*Hespeler	M. M. Millen	Hespeler.
	Milton	Robt. F. Adams	Milton.
	Limehouse	Wm. Gowdy	Limehouse.
Innerkip Lime and Stone Co., Ltd	Innerkip	C. E. Downing	Beachville.
Jamieson Lime Co	Renfrew	J. A. Jamieson	Renfrew.
Shane Lime Co	Eganville	Geo. R. Shane	Eganville.
Standard White Lime Co., Ltd	*Guelph	D. E. Kennedy	15 Douglas St., Guelph.
Toronto Brick Co., Ltd	Coboconk	F. Conway James	897 Bay St., Toronto.
Weppler, Henry	Lots 6, 7, con. II, Glenelg tp	H. Weppler	R.R. 2, Priceville.

*Hydrated lime plants.

Sand and Gravel* (Pit Operations)

Operator	Pit or Quarry and Location	Manager	Address
Bast, Aaron	Bridgeport, Waterloo tp		112 Lydia St., Kitchener.
Benson & Patterson	Stamford tp., Welland county		Stamford.
Brantford, City of	Webster St. and Harold St		City Hall, Brantford.
Carroll Bros	Sherkston, Humberstone tp		490 Ellicott Sq., Buffalo, N.Y.
Conlin, Herbert L	Highland Creek		156 Front St. E., Toronto.
Consolidated Sand and Gravel, Ltd	Paris		402 Harbour Bldg., Toronto.
Durham Stone & Sand Co., Ltd	Durham.		
Fuller Gravel, Ltd	Fuller.		
Waterford Sand & Gravel Co., Ltd	Waterford.		
Dominion Concrete Co., Ltd	S. Gower and Oxford tps, Grenville county		Van Buren St., Kemptville.
Donald, Andrew	Lot 22, con. 7, Dereham tp., Oxford county		R.R. 1, Ingersoll.
Ellins Bros	Scarlett Rd., Etobicoke tp		Station "D," West Toronto.
Empire Limestone Co	Sherkston, Humberstone tp		19 Hudson St., Buffalo, N.Y.
Foster, R. R	Nepean and Gloucester tps., Carleton county		86 Spadina Ave., Ottawa.
Goodreau, Chas	Chatham tp., Kent county		R.R. 6, Thamesville.
Greenburn Sand & Gravel Co., Ltd	Lot 8, con. V, Pickering tp		331 Bay St., Toronto.
Halpenny, Lewis E	Arthur tp., Wellington county		R.R. 4, Arthur.
Hill, John D	Woodstock		R.R. 6, Woodstock.
Hinde, Jas. H	Northlands Ave., York tp		134 Northlands Ave., Toronto.
Howard, N. H	Lot 7, con. I, E. Flamborough tp., Wentworth county		Aldershot.
Jago Concrete Products Co	Summerville, Toronto tp		Summerville.
Johnston, G. F	Westminster tp		R.R. 2, Wilton Grove.
Kingston Sand & Gravel Co	Lots 33, 34, con V, Kingston tp		183 William St., Kingston.
Maple Sand, Gravel & Brick Co	Maple, Vaughan tp		454 King St. W., Toronto.
Peterborough, City of	Cor. Rogers and Wilson Sts		133 Simcoe St., Peterborough.
Quigleys	Saltfleet tp., Waterdown, and Port Maitland		317 Main St. E., Hamilton.
Sherman & Hubbell	Lot 17, con. B, Camden tp		R.R. 5, Thamesville.
Smythe, C., Ltd	Lambton Rd., Etobicoke tp		11 King St. W., Toronto.
Sutherland, Hugh A	Lot 6, con. II, W. Zorra tp., Oxford county		R.R. 4, Embro.
Vallery, Frank	West Garafraxa		Box 107, Belwood.
West Oxford Township	Lot 7, con. I, Dereham tp		R.R. 5, Ingersoll.
Wilson, M	Lot 25, con. III, Vaughan tp		R.R. 1, Maple.
Windsor Sand & Gravel Co., Ltd	S. Gosfield tp. Essex county		30 Sandwich St., East Windsor.

*Only operators producing 5,000 tons or over are listed.

Sand and Gravel* (Licensed Dredging Operations)

Cadwell Dredging Co., Ltd	Lake Erie		24 Chatham St. W., Windsor.
Construction Materials Corporation	Lake Erie, St. Clair river		33 N. LaSalle St., Chicago, Ill.
Great Lakes Dredge & Dock Co	Lake Erie		104 S. Michigan St., Chicago, Ill.
Hadley's Chatham, Ltd	Thames river		Chatham.
Homegardner Sand Co	Lake Erie		Sandusky, Ohio.
Interlake Transportation Co., Ltd	Lake Erie, Ontario		315 St. Sacrament St., Montreal, P.Q.
Kelley Island Lime & Transport Co., Ltd	Lake Erie		Sandusky, Ohio.
Lake Erie Sand Company	Lake Erie		Sandusky, Ohio.
Lapish; F. C	Lake Superior		433 Cedar St., Sault Ste. Marie, Mich.
McLean, A. B., & Sons	Lake Superior, St. Marys river		Sault Ste. Marie, Mich.
Merlo, Merlo & Ray, Ltd	Lake Huron, St. Clair river		East Windsor.
National Sand & Material Co., Ltd	Lake Erie, Ontario, St. Clair and St. Lawrence rivers		402 Harbour Bldg., Toronto.
Ontario Gravel Freighting Co., Ltd	Lake Erie, Ontario		228 Sandwich St. W., Windsor.
Pyke Salvage Company	St. Lawrence river		506 Princess St., Kingston.
Scott, T. G	Lake Superior		Sault Ste. Marie.
Sin-Mac Lines, Ltd	Lake Superior		Port Arthur.
Wallaceburg Sand & Gravel Co., Ltd	St. Clair river		Wallaceburg.

*Only operators producing 5,000 tons or over are listed.

Stone (Limestone)

American Cyanamid Co	Beachville	A. J. Kennedy	Beachville.
Bolender Bros	Haliburton	Chas. Bolender	Haliburton.
Bonter, F. and J	Marmora tp	J. W. Bonter	Box 61, Marmora.
Bourgie, J. B	Con. VIII, Russell tp	J. B. Bourgie	Embrun.
Brule, E. D., & Sons, Ltd	Billings Bridge	E. D. Brule	Billings Bridge.
Brunner, Mond Canada, Ltd	Lots 6, 7, 8, con. I; lots 2, 3, con. II, Anderdon	F. Nill	Amherstburg.
Canada Cement Co., Ltd	Thurlow tp	J. H. Legate	Belleville.
Canada Crushed Stone Corp., Ltd	Dundas, Town of	J. Stephens	35 Cline Cres., Hamilton.
Hagersville Contracting Co., Ltd	Walpole tp., Haldimand county	Gordon Gilbertson	Hagersville.
Puslinch Quarry, Ltd	Puslinch tp., Wellington county	H. Hill	Puslinch.
Queenston Quarries, Ltd	Niagara tp	A. Michie	Box 110, Niagara Falls.
Wentworth Quarries, Ltd	Lot 4, con. V, Saltfleet tp	Destroyed by fire July 24, 1929, now dismantled.	
Cartnell, Ellen, Estate of	1½ miles east of Thorold	John Cartnell	Thorold.
Cloutier & Grenon	Con. X, Cambridge tp	Samuel Forgue	Casselman.

STONE (Limestone)—*Continued*

OPERATOR	QUARRY AND LOCATION	MANAGER	ADDRESS
Coldwater Crushed Stone, Ltd.	Lots 19, 20, con. XIII, Medonte tp.	Thos. Langton	Coldwater.
Cook, J. S.	Lots, 7, 8, con. XXIV, Amabel tp.	J. S. Cook	Wiarton.
Cooper, Alfred	Lot 25, con. V, Neebing, N.R.	Gordon A. Cooper	1215 Victoria Ave., Fort William.
Crystallite Products, Ltd	Bancroft	P. J. Stringer	Bancroft.
Decewsville Crushed Stone, Ltd. (idle).			
Dibblee Construction Co., Ltd.	Carleton and Grenville counties		1417 University Tower, Montreal.
Dufferin Construction Co., Ltd.		H. H. Salmon	Fleet and Bathurst Streets, Toronto.
Dufferin Paving and Crushed Stone Co., Ltd.		H. H. Salmon	Fleet and Bathurst Streets, Toronto.
Hagersville Quarries, Ltd.	Walpole tp.	Wm. T. McRae	Hagersville.
Innerkip Quarries, Ltd.	East Zorra tp.	H. M. McQuoid	Innerkip.
Kirkfield Crushed Stone, Ltd.	Kirkfield	John Welch	Kirkfield.
St. Marys Crushed Stone, Ltd. (idle).			
Edgar Irvine Co., Ltd., The	Tamworth-Newburgh Road	T. Hooker	Alexandria.
Foster, R. R.	Merivale Road, Ottawa	R. R. Foster	86 Spadina Ave., Ottawa.
Gordon Crushed Stone Co., Ltd., The	Hagersville	C. F. Anderson	Hagersville.
Grant Bros. Construction Co., Ltd.	2 miles north of Brockville	C. M. Woodland	Cardinal.
Grenville Crushed Rock Co., Ltd.	Oxford tp., Grenville county	W. H. Roberts	Oxford Mills.
Gypsum, Lime and Alabastine, Canada, Ltd.	Lot 3, con. VI, Nassagaweya tp., Halton county	R. S. Adams	Milton.
Gypsum, Lime and Alabastine, Canada, Ltd.	Beachville, Oxford county	T. F. Robinson	Woodstock.
Hagersville Contracting Co., Ltd.	*See* Canada Crushed Stone Corp. above.		
Hagersville Quarries, Ltd.	*See* Dufferin Construction Co., Ltd.		
Henniger, M. G.	Drummond tp., Lanark county	M. G. Henniger	Smiths Falls.
Highways Department	Various quarries	R. M. Smith	Parliament Bldgs., Toronto.
Holdcroft Construction Co., Ltd.		W. Holdcroft D. Springer	Kingston. Waterdown.
Huffman Construction Co., Ltd., The R. C.	Clappison cut, Wentworth county.		
Humberstone Township	Lot 4, con. I; lot 30, con. III; lot 19, con. V	Phillip Crumb	Wainfleet, R.R. 1.
Innerkip Quarries, Ltd.	*See* Dufferin Construction Co.		
Johnson Bros. Co., Ltd.	Mille Roches, Stormont county		431½ Market St., Brantford.
Kingston Penitentiary	Portsmouth	Samuel Donaldson	34 Pembroke St., Kingston.
Kirkfield Crushed Stone, Ltd.	*See* Dufferin Construction Co.		
Lapierre, M. C.	Owen Sound	M. C. Lapierre	1994-9th Avenue E., Owen Sound.
Law Construction Co., Ltd.	Provincial Highway 26, 4 miles east of Owen Sound	B. J. Williams	225 Sterling Rd., Toronto.
Limestone Products, Ltd.	Uhthoff, Orillia tp.	Geo. F. Morse	R.R. 4, Orillia.
Longford Crushed Stone Co., Ltd.	Lots 20 to 24, Front con., Rama tp.	R. M. Craig	Longford Mills.

MacDonald, A. N	Bronte	Ivan MacDonald	Bronte.
McGinnis & O'Connor	Barriefield	E. G. Reynolds	Kingston.
McQuigge, J. R	Clarence tp., Russell county	J. R. McQuigge	Arnprior.
Middleton, J. N	Ancaster village	J. N. Middleton	Ancaster.
Nelson Crushed Stone Co	Lot 16, con. II, Nelson tp., Halton county	R. L. Millar	R.R. 1, Freeman.
Noranda Mines, Ltd	Farr quarry, Haileybury		804 Royal Bank Bldg., Toronto.
Ontario Reformatory	Guelph	C. F. Neelands	Guelph.
Owen Sound, City of	City Quarry, 8th Street West	Robt. Cranney	6th Street East, Owen Sound.
Pembroke, Corporation of	Markus Quarry	J. P. Howe	Pembroke.
Pirson, John	Hydro dump, Stamford tp.	John Pirson	Stevensville.
Puslinch Quarry, Ltd	*See* Canada Crushed Stone Corp.		
Queenston Quarries, Ltd	*See* Canada Crushed Stone Corp.		
Quinton, W. Y	Kitley tp., Leeds county	W. Y. Quinton	Jasper.
Rayner Construction Co., Ltd	Wolford tp., Grenville county Campbellford	Geo. Rayner	159 Bay St., Toronto.
Robillard, H., & Son	Gloucester tp., Carleton county	B. E. Robillard	195 Nicholas St., Ottawa.
Roddy, J. M	Division St., Kingston	J. M. Roddy	293 Division St., Kingston.
Routly, H. T	West Garafraxa tp., Wellington county Augusta tp., Grenville county	H. T. Routly	21 Dundas Square, Toronto.
Walker Bros., Ltd	Stamford tp., Welland county	David Walker	Box 586, Thorold.
Wallace, R., & Son	Brown farm, Kingston tp., Frontenac county	R. R. Wallace	484 Bagot St., Kingston.
Wehman, John	Lot 24, con. II, Kingston tp., Frontenac county	John Wehman	251 Division St., Kingston.
Welland Ship Canal	Rock excavation	A. J. Grant	St. Catharines.
Wickett, Ltd., James A	Lonsdale, Tyendinaga tp		16 Saulter St., Toronto.
Wilford & Co., Ltd., R. F	Nottawasaga tp., Simcoe county	C. Brownell	Box 119, Lindsay.
(*) Windmill Point Crushed Stone Co., Ltd	Ridgeway	R. E. Law	225 Sterling Rd., Toronto.

(*) Subsidiary of Law Construction Company, Ltd.

STONE (Granite)

Beresford, John	Gananoque	John Beresford	Gananoque.
Code, W. Harry	Leeds tp., Leeds county	W. Harry Code	26 Cornelia St., Smith's Falls.
Grenville Crushed Rock Co., Ltd	Hawk Lake, 25 miles east of Kenora	J. P. Bains	917 Keefer Bldg., Montreal.
Gordon Granite Co	5 miles north of Gananoque	A. E. Gordon, Gananoque	Head Office, 239 Confederation Life Bldg., Toronto.
Hokanson, Swan	Leeds tp., lot 7, con. II	Swan Hokanson	Box 653, Gananoque.
Horne, Wm	Butler	Wm. Horne	Suite M, Ashford Block, Winnipeg.
Mills Geo	Leeds tp		
McKee Bros	Leeds tp., lot 8, con. II	James McKee	Lansdowne.
Peninsula Granite Quarries, Ltd	Peninsula	Wm. Morrison	Peninsula.
Reece-Hall, R	Mill Lake Quarry, McDougall tp., lots 24, 25, con. III, Parry Sound district	R. Reece-Hall	Box 115, Parry Sound.

STONE (Sandstone)

OPERATOR	MINE AND LOCATION	MANAGER	ADDRESS
Credit Valley Quarries, Ltd	Glenwilliams, Halton county	S. H. Hurst	86 Kennedy Ave., Toronto.
Danforth Quarry, Ltd	Limehouse, Halton county		736 Danforth Ave., Toronto.
Logan, Hugh	Halton county	Hugh Logan	Glenwilliams.
Norrie and McHardy	Halton county		Georgetown.
Norton, A. W	Halton county		Georgetown.
Rogers, Frank	Halton county		Georgetown.
Smeaton, R. C	Halton county		Georgetown.
Thompson, F	Halton county		Georgetown.

STONE (Trap)

Fort William, City of	Rifle Range Site	C. B. Symes	City Hall, Fort William.
Hydro-Electric Power Commission	Alexander Power Development, Hydro	J. N. Stanley	University Ave., Toronto.
Ontario Rock Co., Ltd	Belmont and Methuen tps	H. L. Scott	Havelock, R.R. 3.
Quinn Stone & Ore Co	Fort William	J. E. McKee	Fort William.

CLAY PRODUCTS

See Report, Vol. XXXIX, Part 4, 1929, The Ceramic Industry of Ontario, by R. J. Montgomery.

MINES OF ONTARIO IN 1930

By

Chief Inspector of Mines, D. G. Sinclair, Toronto; Inspectors, R. H. Cleland, Timmins; E. C. Keeley, Kirkland Lake; D. F. Cooper, Sudbury; A. R. Webster, Toronto.

CHROME

Consolidated Chromium Corporation

This company was incorporated under the laws of the state of Delaware on November 19, 1929. The authorized capital stock is 500,000 shares of class "A" stock, par value $25 per share, and 1,500,000 shares of common stock of no par value. The officers of the company are: R. S. McClellan, president; J. C. Parkes, vice-president; F. C. Russell, secretary-treasurer; W. B. Wallder, assistant vice-president; James P. Ronaghan, assistant secretary; C. B. Reinold, assistant secretary. The directors are: R. S. McClellan, F. C. Russell, Charles Cason, C. V. Bob, J. C. Parkes.

The company was formed to acquire the rights under options granted to L. P. Jubien, Suite 1636, 120 Broadway, New York, on some 40 claims, as well as the interest in 15 claims staked by Mr. Jubien and his associates on chromite-bearing ground south of Collins and west of Lake Nipigon in Thunder Bay district. It is proposed to form a Canadian subsidiary for the purpose of acquiring title to these mining claims.

The following is a résumé of A. R. Graham's report to the Ontario Department of Mines on the geological features of the deposit: The segregations and injections of chromite ore lie near the footwall side of an elliptical-shaped peridotite dike some 3¾ miles long and three-quarters of a mile wide at its widest point.

The dike is intrusive in the contact zone between a Laurentian granite, altered to gneiss near the contact, and the earlier volcanics. These volcanics near the contact have been altered to micaceous schists and recrystallized greenstone.

Mr. Jubien states that some eighteen exposures of chromite have been found over a total length of 18,000 feet in a footwall zone about 600 feet wide. The chromite occurs in the form of wide segregations of low- and medium-grade material, in which occur presumably later injections of high-grade material. The widths of these occurrences are exceptional, as high-grade exposures have been found over widths as great as 17 feet with good and medium-grade exposures in widths up to nearly 50 feet.

Surface work on the property was started in the late fall of 1929, when camps for the accommodation of 40 men were erected.

The plant consists of two 85 h.p. boilers, one Ingersoll-Rand 300-foot compressor, one Jenckes 6- by 8-inch single-drum hoist. Steel is sharpened by hand.

In March, 1930, a two-compartment shaft was started on claim T.B. 8,814; 350 feet of sinking was completed and three levels were opened up. Early in September a total of 750 feet of lateral work had been done on the upper two levels. A second shaft was started on claim T.B. 8,422 on another high-grade section of the deposit, but in the late fall financial difficulties compelled the cessation of all operations.

Camps on the property consist of the following: cookery, 22 by 23 feet; two bunk-houses, 18 by 32 feet and 16 by 23 feet; assay office, 15 by 18 feet; office, 12 by 20 feet; and residence, 22 by 28 feet. These are located on the shore of a small lake. The No. 1 shaft is about 1½ miles east, and the No. 2 about a quarter of a mile north of the camps.

While operations were being carried on, 39 men were employed under the direction of A. R. Globe, manager, and C. Rutherford, superintendent.

COPPER

White Lake Mines, Limited

The authorized capital of this company is 2,000,000 shares of $1 par value. The directors and officials are: W. A. Lamport, president; J. C. Allan, secretary-treasurer; W. J. McCallum and D. G. Miller, directors. The head office is at 301 Royal Bank Building, Toronto.

The company operates a copper property in township 1A in the Mississagi Forest Reserve, district of Algoma, about 45 miles northeast of Iron Bridge.

Underground work was continuous throughout 1930, except between October 12 and November 10. The company reports the following development work done during the year: east adit, 486 feet of drifting; west adit, 904 feet of drifting and crosscutting and 84 feet of raising; diamond-drilling, 1,652 feet. No additions were made to the Diesel mining plant during 1930.

An average of 18 men was employed, 11 underground and 7 on surface. In December, 1930, O. G. Carstens was succeeded by D. J. Russell as superintendent.

COPPER-ZINC-LEAD

Treadwell Yukon Company, Limited

The officers of this company are: F. W. Bradley, president; C. D. O'Sullivan, first vice-president; C. A. Norris, second vice-president; F. A. Hammersmith, secretary-treasurer; W. D. Miracle, assistant secretary-treasurer; V. R. Prather, assistant secretary.

The directors are: F. W. Bradley, C. A. Norris, F. A. Hammersmith, C. D. O'Sullivan, and J. W. Crosby.

Operations at the Errington mine, situated in Creighton township, Sudbury district, were severely curtailed during 1930, owing to the low market prices of the metals produced.

Mine

On January 16, 1930, sinking was resumed at No. 2 shaft, which had then a depth of 675 feet. It was deepened to 1,571 feet, and stations were cut at the 750-, 1,000-, 1,250-, and 1,500-foot horizons. Sinking was completed on July 14, 1930. This is a vertical shaft, 6 feet 3 inches by 15 feet 8 inches, outside dimensions.

Development footages throughout the mine for 1930 were distributed on the various levels as follows:—

Level	Drifts	Crosscuts	Raises
		feet	feet
300-foot	.....	.....	34
500-foot	581	596	918
1,500-foot	910	1,558	.....
Total	1,491	2,154	952

Adding 896 feet of sinking brings the total development to 5,493 feet. In addition, 3,099 feet of diamond-drilling was done.

All stoping was suspended on November 8, 1930. The ore broken and the ore hoisted during 1930 was as follows:—

Level	Ore broken	Ore hoisted
	tons	tons
300-foot	4,700	33,023
500-foot	45,300	31,836
Total	50,000	64,859

At the end of 1930, underground work was confined to crosscutting on the 1,500-foot level.

Mill

The flotation mill operated until November 13, 1930, to which date it had treated a total of 64,859 tons of ore since the beginning of the year.

Concentrates produced during 1930 totalled as follows: copper, 3,444.61 tons; zinc, 4,374.12 tons; lead, 676.69 tons; pyrite, 7,634.33 tons.

General

There were no material additions to plant or equipment during 1930. An average of 141 men was employed, distributed as follows: underground, 89; mill, 18; surface, 34.

Joseph Errington is manager, and V. C. Clauson is general superintendent. The mine address is Bradley, Ont.

GOLD

Barry-Hollinger Gold Mines, Limited

Barry-Hollinger Gold Mines, Limited, operated their property at Boston Creek, Pacaud township, district of Timiskaming, during 1930. The capital is 4,000,000 shares, of $1 par value. H. C. Crow is president; E. M. Tice is secretary-treasurer; Dr. E. H. Greene, P. A. Barry, M. J. Conkey, and G. H. Morris are directors. Jas. Houston is superintendent.

The superintendent's report for the year 1930 is as follows:—

Development

During the year a two-compartment winze was sunk 129.5 feet, on the inclined dip of No. 7 vein, from the 1,625-foot level to the 1,750-foot level. It was necessary to do this exploratory work in this manner, as the hoisting equipment in the main winze would not permit the handling of ore below the 1,625-foot level.

After opening up the 1,750-foot level for a little over 400 feet laterally, work was discontinued. The hoist was then moved up to the 1,375-foot level, and the sinking of the main three-compartment winze below the 1,625-foot level was started on December 1. At the present date this winze is down 98 feet below the 1,625-foot level. Stations will be cut at the 1,750- and 1,875-foot levels. The waste rock from sinking operations is handled through the manway compartment to the 1,375-foot level, and No. 1,507 stope is utilized as a waste pocket.

At the present time a new double-drum electric hoist is being installed at the 1,000-foot level. This hoist will permit doubling the hoisting capacity of the winze, where at present all development work is being concentrated.

Electric pumping equipment was installed in the main shaft during the early part of the year. This additional equipment enabled us to disconnect one of the air compressors which was used entirely for pumping. A considerable saving was thereby effected in power charges.

500-foot Level.—An exploratory crosscut was driven southwest on this level, which cut Nos. 8 and 9 veins. Four hundred and sixty feet of crosscutting and drifting was completed

in doing this work. Where encountered, the above-mentioned veins did not carry sufficient values to warrant extensive lateral work.

1,375-foot Level.—The "A" ore shoot on No. 7 vein was stoped through to the 1,250-foot level and produced 5,100 tons of ore. A 50-foot section of ore remains to be developed on this level.

1,500-foot Level.—No. 1,507 stope was mined through to the 1,375-foot level. This stope produced over 16,500 tons of ore. A sublevel drift was driven west from No. 1,507 stope, 65 feet above the 1,500-foot level, to tap the downward extension of No. 1,307A stope ore. This opened up an ore length of 50 feet.

Later, a raise was put up from the 1,500-foot level, and at the present time this stope (No. 1,507A) is being opened up.

1,625-foot Level.—Three hundred and fifty-five feet of drifting was done on No. 7 vein shearing on this level; 160 feet of this was through the main ore shoot.

A stope for this length was carried through to the 1,500-foot level. Operations are still being carried on, and when completed this stope (No. 1,607) is expected to produce over 20,000 tons of ore. This is the best section of ore so far opened up in the mine.

To the east of this, ore drifting was continued for a distance of 100 feet on lower grade material Fifty per cent. of the rock broken in this drift was put through the mill.

1,750-foot Level.—Four hundred and eight feet of drifting has been completed to date on No. 7 vein shearing on this level. Two ore shoots, one 40 feet long and one 50 feet long, together with two shorter lenses, west of the 50-foot shoot, have been opened up. When stoping operations are continued above the level, these three ore shoots may link up as continuous ore.

Summary of Underground Operations.—During the year ending December 31, 1930, the following development work was completed:—

	Feet
Drifting and crosscutting	1,909.5
Raising	568.5
Sinking	222.5
	Cu. ft.
Station work	4,570

Thirty-one thousand seven hundred tons of ore were hoisted, of which 30,250 tons were taken from the stopes, the balance being taken from the development drifts.

Mill

During the past year the mill has been operating continuously, except for minor delays, on a tonnage of from 90 to 100 tons per day.

The following is a summary of mill returns based on government quarterly returns for the year:—

	Production	Dry tons milled	Recovery per ton milled
January, February, and March	$49,923.84	7,844	$6.36
April, May, and June	52,510.52	8,007	6.56
July, August, and September	55,082.85	7,988	6.90
October, November, and December	60,507.80	7,886	7.67

Production

Total bullion produced for the year amounted to $218,025.01 from 31,725 dry tons milled, making an average recovery of $6.87 per ton. This compares with a recovery of $151,611.62 for the year 1929 and $111,767.21 for the year 1928.

The increase in production over the year 1929 was 43.8 per cent., due to increase in tonnage and to a slight increase in recovery per ton.

Future Development

Sinking of the three-compartment winze will be continued to the 1,875-foot level, and crosscuts will be driven to No. 7 vein on both the 1,750- and 1,875-foot levels.

Immediately the ore is opened up on these two levels, sinking will be continued to the 2,000- and 2,125-foot levels, and these two levels will be developed simultaneously.

With the installation of the new electric hoist, development work can be speeded up and exploration work undertaken which was impossible to do with the old hoisting equipment.

On the 1,875-foot level, a crosscut of approximately 50 feet will tap the downward extension of No. 1 vein. This work will be undertaken at an early date.

The east drift on No. 7 vein shearing on the 1,625-foot level will also be continued. Over 1,000 feet of favourable ground lies in this direction before reaching the east boundary of the property.

The possibility of locating other ore zones in this area are good, and this exploration work will be started at an early date.

Ore Reserves

On account of suspension of development operations laterally while depth development was undertaken, ore reserves above the 1,625-foot level have been reduced from 18,000 tons to 10,000 tons since October 1, the date of the last report. These reserves will be added to when raises are put through the ore shoots on the 1,750-foot level to the level above. Other sections of the mine will be opened up and can be expected to add ore to the above figure.

Beardmore Gold Mines, Limited

The property of this company is located on the north shore of Lake Superior in the Nipigon Forest Reserve, district of Thunder Bay, and is about 132 miles northeast of Port Arthur. It is easily accessible from Beardmore, which is on the Canadian National railway.

The officers and directors are: Chas. D. Bertram, president; F. C. Sutherland, vice-president; Joseph Montgomery, secretary-treasurer; J. P. Leask and Charles Thompson, directors.

The authorized capital is 5,000,000 shares of $1 par value. The head office is at 85 Richmond Street West, Toronto.

Previous to 1930 a shaft had been put down and levels opened up at the 100-foot and 200-foot horizons. A small amount of lateral work had been done on these levels.

During 1930 a total of 235 feet of drifting and crosscutting was done. Underground work was stopped in February, and surface work only was carried on for the remainder of the year. A saw-mill, water tank, and hoist were installed during the year.

An average of ten men was employed, with W. A. Roberts in charge.

Bennett-Pacaud Mines, Limited

During 1930 an option was taken by the Bennett-Pacaud Mines, Limited, on the property of the Goudreau Gold Mines, Limited, situated four miles from Goudreau on the Algoma Central railway, in township 28, range XXVI, district of Algoma.

No underground work had been done on this property since 1926, and the total development work at the time of suspension was reported in the Thirty-fifth Annual Report of the Department of Mines, as follows:—

SHAFTS (vertical):
No. 1 sunk to the 400-foot level.
No. 2 sunk to the 200-foot level.

CROSSCUTTING:
On 100-foot level, 190 feet.
On 200-foot level, 641 feet.
On 400-foot level, 311 feet.

DRIFTING:
On 100-foot level, 355 feet.
On 200-foot level, 893 feet.
On 400-foot level, 381 feet.

Dewatering was commenced on June 1, 1930, and carried on intermittently until August 30. Sublevels were driven from No. 1 shaft at the 130-foot and 160-foot horizons. Operations were suspended on November 15, 1930, and the option was dropped.

Development work done by the optioner was as follows:—

STATION-CUTTING:
On sublevels, equivalent to 30 feet drifting.

DRIFTING:
On 130-foot sublevel, 30 feet.
On 160-foot sublevel, 100 feet.

RAISING:
On 130-foot sublevel, 10 feet.
On 160-foot sublevel, 10 feet.

WINZING:
On 100-foot level, 10 feet.

An average of 8 men was employed underground and 4 on surface, under the supervision of J. M. C. Dunlop.

British Canadian Mines, Limited

This company has an authorized capital of 3,000,000 shares of $1 par value. The officers and directors are: J. M. Aitken, president; F. McQueen, secretary-treasurer; W. W. Canham, A. G. Halstead, E. P. Barry, and H. F. Coombs, directors. The head office is at 8 Bloor Street East, Toronto.

During 1930, no active mining work was done at the Foley mine, at Shoal lake, Rainy River district, but the mine was kept dewatered in expectation of an early resumption of operations.

Bunker Hill Extension Mines, Limited

Tough-Oakes Burnside mine, in Teck township, district of Timiskaming, was operated during 1930 by the Bunker Hill Extension Mines, Limited, under option, with an average force of 10 men. The work consisted of surveying, sampling, and diamond-drilling. About 7,200 samples were cut and assayed, and a complete geological survey was made of the seven miles of underground work. Sixty-two holes were diamond-drilled, with a total of 6,200 feet.

F. J. Hotchkins was manager.

Canadian Champion Reef Mining Company, Limited

No further work was carried on at the property of this company in the West Shiningtree area, district of Sudbury, after the suspension of operations in April, 1930, reported in the Thirty-ninth Annual Report of the Department of Mines.

Canadian Kirkland Mines, Limited

The property of the Canadian Kirkland Mines, Limited, is situated in the township of Teck, district of Timiskaming. The officers and directors of the company are: George Tough, president; W. B. McPherson, secretary-treasurer; J. A. Hough, F. J. Carew, and B. L. McLean, directors. Hugh Jardine was manager.

The property was operated from June, 1930, to March, 1931, when the mine was closed. The underground work consisted of 100 feet of crosscutting and 60 feet of drifting on the 125-foot level of the No. 2 shaft just west of the road, and 30 feet of drifting on the 65-foot level. No. 3 shaft, which is west of No. 2, was sunk 50 feet and 90 feet of crosscutting was done on the 50-foot level.

An average of 8 men was employed during the period of operation.

Canusa Mining and Exploration Company, Limited

The company operates a small property in Whitney township, district of Cochrane, which was known for years as the Scottish-Ontario and was one of the first worked in the Porcupine camp.

After a shut-down of more than a year, the mine was dewatered in July, 1930, and development in a small way started. Underground work from the main shaft, which has a depth of 320 feet, totals more than 1,500 feet on two levels, the 90- and 300-foot. A small shaft was started early in 1931 just west of the main shaft in the open cut on the vein from which a small syndicate in 1927 extracted ore worth $5,893.

There has been an average of 10 men employed on the property under the direction of Geo. Bannerman, one of the original stakers.

Central Canada Mines, Limited

This company has an authorized capital of 3,000,000 shares of $1 par value. The officers and directors are: D. E. McKay, president; A. B. Evans, vice-president; J. McClure, secretary-treasurer; A. G. Seaman, M. Hayne, E. E. Johnson, and R. McTavish, directors. The head office is located in the Union Bank Building, Fort William.

The properties held by this company are situated in McCaul and Hutchinson townships in the Sapawe Lake area, Rainy River district, about 125 miles west of Fort William, and are close to Hematite on the Canadian National railway. They consist of three groups of claims, comprising 894 acres, and include what formerly were known as the Jacks Lake mine and the Walsh property.

Work was commenced on March 15, 1930, on the old Walsh property on the north side of Sapawe lake. An old 40-foot shaft, 7 by 9 feet, was cleaned out and sunk to a depth of 92 feet. Some 50 feet of crosscutting was done at this level. This work was done by a contractor using a small portable gasoline plant.

Operations were stopped in mid-August owing to financial difficulties.

Central Patricia Mines, Limited

This company is capitalized at $4,000,000, divided into 4,000,000 shares of $1 par value.

The officers of the company are: F. M. Connell, president; K. A. MacPhadyen, secretary-treasurer; Alan Cockeram, assistant secretary-treasurer. J. H. C. Waite, Louis Cohen, and W. H. Connell are directors. The head office of the company is at 1610 Canada Permanent Building, 320 Bay Street, Toronto.

The property is in the Pickle Lake–Crow River area, district of Kenora (Patricia portion), about 100 miles north of Savant Lake station on the Canadian National railway. The summer and winter routes to the property are about the same, approximately 125 miles from Savant Lake station, through Savant lake, across McCrea lake, through Lake St. Joseph past Osnaburgh House, through Doghole lake, Little Ochig and Big Ochig lakes, and Pickle lake. There are about 25 miles of portages on this route. A good flying service is maintained to the area by the Western Canada Airways, Limited, with base at Sioux Lookout.

The property consists of some 18 claims, staked during the summer of 1928. Surface work started in the winter of that year, when camps to accommodate 40 men were erected.

Early in 1929, a surface diamond-drill campaign was started, which totalled 6,881 feet. Surface work during 1929 warranted underground exploration. This

was definitely outlined, and supplies and equipment were hauled by tractor to the property as soon as the winter road was ready.

The plant consists of the following: two 110 h.p. return tubular boilers, a 934-foot cross-compound C.I.R. compressor, a 12- by 15-inch single-drum hoist, a steel sharpener, an oil furnace, and a small saw-mill.

To the end of August, 1930, the following underground work had been accomplished: shaft-sinking, 527 feet; crosscutting, 994 feet; drifting, 1,713 feet. Four levels at 125-foot intervals were opened up, and the ore was explored on each. In August, the lateral work totalled 1,270 feet.

The property closed down in September, 1930. During active operation 57 men were employed under the direction of A. J. Keast and later, J. P. Millenback.

Coniaurum Mines, Limited

This company has an authorized capitalization of 6,000,000 shares of no par value. The mine is in the township of Tisdale, district of Cochrane, and adjoins the property of the McIntyre-Porcupine Mines on its east boundary.

The officers and directors of the new company organized under Ventures, Limited, are as follows: Thayer Lindsley, president; A. L. Bishop, vice-president; H. Whittingham, secretary; J. Gordon Hardy, D. M. Hogarth, Alex. Longwell, and T. H. Rea, directors. The head office is at 100 Adelaide Street West, Toronto.

The following statement is taken from the report of the general manager, John Redington, for the year 1930:—

Development

Development has been continued throughout the year. Several of the known veins have been opened up in the main levels and sublevels, as well as raises. These have met with fair encouragement for the future.

Summary of Development

	Feet
Drifting	2,882
Crosscutting	1,210
Raising	676
Winze-sinking	533
Diamond-drilling	4,995
	Cu. ft.
Station-cutting	4,808

The total footage in ore is 2,243 feet with an average value of $6.68 across a width of 3.8 feet. Veins Nos. 2, 6, 7, 12, and 15 were developed. Three of the most important ore shoots have been indicated in No. 2 vein on the 525-foot level, No. 15 vein on the 1,000-foot level, and No. 7 vein on the 2,000-foot level. The latter has considerable promise of adding, when fully developed, quite a tonnage to the present ore reserves. With constant care, from these narrow widths, operations for the year have shown a small margin of profit as well as taking care of quite an extensive development campaign.

Development of the property at greater depth has been commenced through a two-compartment winze from the 2,000-foot level. During the year it was equipped and sunk to a depth of 533 feet, with the establishing of two new levels at the 2,250- and 2,500-foot horizons. The winze is located in No. 12 crosscut at the 2,000-foot level, approximately 30 feet north of No. 12 vein. Crosscutting on the new levels is being pushed with all possible speed both north and south. In the south crosscuts on the 2,250- and 2,500-foot levels, No. 12 vein has been encountered and is being driven on both east and west at the 2,250-foot level. The vein at this point is quite well defined, but the values are low. Just above this, on the 2,000-foot level, No. 12 vein did not show high values.

Milling

The mill treated 122,972 tons of ore during the year, with an average recovery of $5.992 and extraction of 96.35 per cent. of the gold content, operating 359.33 days, or 98.45 per cent. of the possible running time.

Ore Reserves

Stoping during the year added 135,387 tons of broken ore, and development yielded a further 7,783 tons. With the 70,412 tons of broken ore carried forward from the previous year, this gave a total of 213,582 tons broken ore available. Milling during the year drew 122,972 tons from the above total, leaving a carry-forward of 90,610 tons of broken ore at the end of the period under this review. The grade of this broken ore is approximately that of the year's average milling, say $6.21.

As to unbroken ore, our experience has been that it is unwise to translate our expectations into figures owing to the erratic distribution of values so far found in our veins, and to the fact that we are still on a hand-to-mouth policy of ore production that precludes the regular blocking out of ore reserves. It is our feeling, though, that we have greater reason for ore expectations now than at any previous time in the history of the mine.

Cooper Gold Mines, Limited

This company operated its Jubilee property in the Michipicoten area, township 29, range 23, district of Algoma, four miles from Wawa on the Algoma Central railway, until March 29, 1930.

Development footages at the Jubilee from January 1 to March 29, 1930, were as follows: drifting, 382 feet; crosscutting, 350 feet; raising, 43 feet.

The total underground work at the Jubilee mine from the beginning of operations until the shut-down on March 29, 1930, was as follows:—

	Feet
Sinking:	
Shaft	546
Winze	123
Drifting	3,512
Crosscutting	4,887
Raising	183
Total	9,251
Cutting:	**Cu. ft.**
Stations	13,580
Sump	4,800
Total	18,380

John Knox, Jr., was manager; and Frank McLennan, underground superintendent.

In June, 1930, John Knox, Jr., obtained a working option on all mineral rights contained in the properties owned by the Cooper Gold Mines, Limited. These consist of the Minto, Jubilee, and Cooper properties in the Michipicoten area, near Wawa.

It was decided to operate the Minto property first, and on August 1 work was commenced in moving all suitable mining and milling equipment, which had been used at the Jubilee mine, and a 20-ton test mill to the Minto. Additional machinery was purchased to equip a 75-ton cyanide mill, also a single-drum electric hoist.

By December 31 a mill building, 97 by 56 feet, had been erected and 75 per cent. of the milling equipment installed. The compressor, hoist, transformers, and motors for the mining plant were also in place.

No underground work was done during 1930.

De Santis Gold Mining Company, Limited

During 1930, the company optioned claims H.S. 805, 961-966, H.R. 960, and P. 6,132, formerly known as the Langmuir property, in Ogden township, district of Cochrane, about 1½ miles west of the old Hollinger Reserve mine. This property is referred to in the Ontario Department of Mines Report, Volume XXXV, part 6, page 27. Former operators sank three shallow shafts.

During the year the company placed their Turnbull property plant on claim H.S. 805, with the intention of crosscutting east from the bottom of an old 90-foot shaft to intersect quartz stringers showing on surface. The plant was not yet in operation at the end of the year. Peter De Santis is in charge of operations.

Dome Mines, Limited

The authorized capital stock of Dome Mines, Limited, consists of 1,000,000 shares of no nominal or par value, of which 46,666 are held under an agreement in trust for the company; the dividends on these shares are returned to the treasury of the company. The mine is in the township of Tisdale, district of Cochrane.

The officers of the company are: Jules S. Bache, president and treasurer; H. P. De Pencier, first vice-president; G. C. Miller, second vice-president; Morton F. Stern, third vice-president; Alex. Fasken, secretary; E. P. Goetz, assistant treasurer and assistant secretary; C. C. Calvin, assistant secretary; John B. Robinson, assistant secretary.

The directors are: Jules S. Bache, Morton F. Stern, New York; G. C. Miller, Buffalo; Dwight B. Lee, Detroit; G. H. Harris, Innis P. Allen, Rochester; Alex. Fasken, Frank E. Maulson, Toronto.

H. P. De Pencier is the general manager of the company, and J. H. Stovel is general superintendent.

The office of the executive and financial department is at 42 Broadway, New York. The Toronto office is at 36 Toronto Street.

The following statements are taken from the report of the directors to the shareholders on January 10, 1931:—

No change has taken place in the authorized capital stock of the company, and 46,666 shares are still held under agreement with the Trusts and Guarantee Company, Limited, in trust for the company, and dividends on these shares are returned to the treasury of the company as and when paid.

Your directors are pleased to report that the net excess of current assets over current liabilities (including dividend payable January 20, 1931, $238,333.50) is the sum of $5,113,247.62, which includes the sum of $2,785,427.01 set apart as a dividend assurance fund. Dividends were paid for the year out of our general accounts and not out of the dividend assurance fund.

Your attention is also drawn to the fact that the net income for the year was $117,895.20, despite the fact that the mill operated only two months in 1930, while mining and development were carried on throughout the year. Surplus has decreased by $888,199.17.

Your directors with deep regret record the death of Hon. Wallace Nesbitt, who for several years was one of your directors and whose able co-operation was fully appreciated by his fellow members.

The report of the general manager is as follows:—

The main activities of the year were centred around the tearing down of the steel wreckage of the old mill, the cleaning up of the site, and the building and equipping of the new mill. The addition of a Symons cone crusher to our crushing plant necessitated the remodelling of this plant. This construction was completed and the crusher plant and mill started crushing ore on October 28. Until that date, necessary mining and development had been carried on by a reduced crew. The mining staff was kept intact and employment given to most of our married employees. The clean-up plant, installed in the refinery after the fire, operated continuously until the end of September, when it had to be torn out to permit the refinery to be made ready for regular operations. Very little, if any, recoverable values remained in the mill at this time.

Automatic sprinkler protection was installed in both mill and crusher plant. This necessitated the erection of a 60,000-gallon steel water tank and the laying of considerable eight-inch water mains.

During the year, 130,700 tons was hoisted: 97,100 tons was ore, of which 67,600 tons was sent to the mill and treated, and 29,500 tons was stored in one of the old open pits. The remainder, 33,600 tons, was waste, which was dumped on the surface.

The 67,600 tons milled yielded bullion worth $398,063.61, the average yield per ton being $5.8885. For the preceding year the yield per ton was $7.579. In tuning up the mill, low-grade ore was used as much as possible, and some absorption of values took place in the mill.

In addition to the above production, bullion worth $377,202.16 was recovered from the ruins of the mill. This, added to the amount recovered in November and December of 1929, makes a total recovery of $534,848.47 from the mill ruins.

The following statement gives particulars of revenue and expenditures for the year under review.

EARNINGS STATEMENT

For the year ended December 31, 1930

EARNINGS:		
Recoveries from ore in process at date of fire, mill wreckage, and from high-grade		$377,202.16
Bullion production, November and December		398,063.61
		$775,265.77
Non-operating revenue		324,117.72
		$1,099,383.49
OPERATING AND MAINTENANCE EXPENDITURE:		
Mining, including hoisting	$290,176.86	
Development and exploration	359,914.04	
Crushing and conveying	19,917.41	
Salvage recovery costs	15,802.99	
Milling	88,668.96	
Bullion expense	8,514.57	
Fire protection	8,380.81	
Warehouse expense	7,962.31	
Auditors' expense	2,410.80	
Administrative expense:		
Mine office	84,610.43	
Executive offices	21,203.25	
Municipal taxes	27,111.44	
Insurance	18,814.42	
	$953,488.29	
Reserve for Dominion of Canada and United States taxes	28,000.00	
		$981,488.29
PROFIT FOR THE YEAR		$117,895.20

Mining

Following are particulars of the principal stopes:—

Open Pit.—Ore was stored in one of the open pits during the time the mill was being rebuilt. From this storage 994 tons, averaging $4.54, was drawn, and 42,866 tons of broken ore remains to be drawn.

No. 301.—Mining was completed in this stope above the 3rd level, and 45,348 tons of broken ore remains to be drawn.

Seventh Level.—No. 715 stope under No. 621 in the Dome Extension has yielded 2,581 tons averaging $4.60, and 12,902 tons of broken ore remains to be drawn.

No. 741 stope has yielded 242 tons averaging $8.50 and has been drawn nearly empty.

The sill under the main hanging wall area has been broken down and will be drawn through No. 807 stope.

Eighth Level.—No. 807 stope has yielded 690 tons averaging $7, and 46,296 tons of broken ore remains to be drawn.

No. 841 stope in the greenstones has yielded 9,151 tons averaging $4.73, and 11,090 tons of broken ore remains to be drawn. Stoping was completed in this stope.

Ninth Level.—The sills under No. 910 and No. 918 stopes in the eastern sedimentary area have been broken down into No. 1,030 stope.

Tenth Level.—No. 1,022 sill has been broken down into No. 1,103 stope, through which the broken ore will be drawn.

No. 1,030 stope has yielded 1,666 tons averaging $9.17, and 8,327 tons of broken ore remains to be drawn.

The four greenstone stopes on this level, Nos. 1,041, 1,042, 1,044, and 1,054, yielded 11,996 tons averaging $5.52, and 146,368 tons of broken ore remains to be drawn. No. 1,054 stope was mined throughout the shutdown.

A small stope, No. 1,058, has been opened up on one of the small carbonate dikes and has yielded 307 tons averaging $4.14.

Eleventh Level.—No. 1,103 stope has yielded 8,231 tons averaging $8.35, and 63,414 tons of broken ore remains to be drawn.

No. 1,140 stope in the greenstones has yielded 2,531 tons averaging $5.75, and 9,136 tons of broken ore remains to be drawn.

Twelfth Level.—The hanging-wall area, No. 1,209 stope, in this level has yielded 462 tons averaging $8.44, and 7,543 tons of broken ore remains to be drawn, the greater part of which is storage ore.

The eastern stopes, Nos. 1,208 to 1,232, have yielded 1,694 tons averaging $10.91, and 14,351 tons of broken ore remains to be drawn.

No. 1,236 stope in the greenstones has yielded 4,136 tons averaging $4.58, and 17,459 tons of broken ore remains to be drawn.

Thirteenth Level.—At the 13th level, the hanging-wall area yielded 3,275 tons averaging $7.52, and 64,878 tons of broken ore remains to be drawn. No. 1,323 stope was mined throughout the shutdown.

Fourteenth Level.—Two small stopes, Nos. 1,417 and 1,418, in the northern greenstone area were being opened up and have yielded 130 tons averaging $8.07.

Fifteenth Level.—No. 1,517 stope in the northern greenstone area has been opened up and has yielded 3,899 tons averaging $10.01, and 301 tons of broken ore remains to be drawn.

Sixteenth Level.—A new stope, No. 1,621, adjoining No. 1,617 to the east, was opened up and has yielded 2,566 tons averaging $11.58, and 434 tons of broken ore remains to be drawn.

Seventeenth Level.—No. 1,702 stope was drawn empty and has yielded 229 tons averaging $3.15.

Eighteenth Level.—In stopes Nos. 1,801 to 1,805, in the sedimentary area, mining was completed. The stopes have yielded 254 tons averaging $6.91, and 41,602 tons of broken ore remains to be drawn.

In the northern greenstone area, two stopes, Nos. 1,813 and 1,814, have been opened up and have yielded 5,366 tons averaging $7.68, and 2,274 tons of broken ore remains to be drawn.

Development

The following table gives details of the development accomplished during the year:—

SUMMARY OF DEVELOPMENT WORK FOR YEAR 1930

Level	Drifts	Cross-cuts	Drifts and crosscut slash	Raises	Winzes	Box-holes	Raises, winzes, and box-hole slash	Total	Diamond-drilling
	feet	feet	feet	feet	feet	feet	feet	feet	feet
7th	123	.....	61	.....	28	.....	4	216	797
8th	.....	.....	1	5	.....	.....	6	12	.....
9th	45	42	7	45	7	.....	7	153	269
10th	305	30	32	128	69	450	43	1,057	426
11th	65	264	62	422	86	188	9	1,096	1,552
12th	530	192	70	212	194	259	9	1,466	915
13th	338	631	67	164	45	37	14	1,296	719
14th	81	.....	5	161	56	.....	9	312	500
15th	65	40	10	115	23	215	.....	468	852
16th	285	11	11	129	128	269	18	851	1,329
17th	853	121	77	493	129	341	12	2,026	1,975
18th	323	147	49	362	14	267	38	1,200	2,434.5
23rd	708	519	18	.....	.....	.....	.....	1,245	2,872.5
Total	3,721	1,997	470	2,236	779	2,026	169	11,398	14,641

Waste hoisted, 33,600 tons.

By far the greater portion of development has been done in the greenstone areas, north of the sedimentary basin, where approximately 10,200 feet of drifting, crosscutting, raising, winzing, and box-holing has been done in course of searching for and opening up the various ore shoots.

Above the 12th level, practically all of the work done was in connection with known ore bodies. Some work was done at the 10th, 11th, and 12th levels opening up a carbonate vein system a short distance east of the shaft, but this work did not disclose ore of importance.

At the 12th level, No. 1,235 drift west was extended westerly 268 feet to prove up the results shown in diamond-drill hole No. 1,265, which had given an intersection of 44 feet of ore, averaging $5.34 per ton. The drift disclosed 165 feet of ore, averaging $9.75 over the width of the drift. Box-holing already done indicates that the width of ore will be approximately 25 feet.

At the 13th level, No. 1,339 crosscut was driven 631 feet to cut the intersection of ore shown in diamond-drill hole No. 1,273 (21 feet, averaging $3.27 per ton). The crosscut intersected the ore late in December, and only 22 feet of drifting was done, this giving an average of $4.46 per ton over the width of the drift. This ore and the ore drifted on in No. 1,235 drift west is most probably a downward extension of the westerly end of No. 1,136 stope.

At the 17th level, development was continued and 974 feet of drifting and crosscutting was done. Two zones, Nos. 1,711 and 1,712, were opened up, both having a length of 110 feet. No. 1,711 corresponds to No. 1,618 stope and averages $4.62 per ton over the width of the drift. No. 1,712 corresponds to No. 1,617 stope and averages $5.30 per ton over the width of the drift.

At the 18th level, further crosscutting and drifting has disclosed two small ore bodies. No. 1,814 stope has a length of 180 feet and a width of about 25 feet, and the ore drawn from it averaged $5.72 per ton. No. 1,813 stope has a length of 130 feet and an average width of about 30 feet, and the ore drawn to date averaged $11.91 per ton. This value was largely due to some exceptional free gold encountered in stoping.

At the 23rd level, the northeasterly crosscut was extended 519 feet, and 708 feet of drifting was done along the area favourable to ore deposition in an effort to prove the downward extension of the known ore bodies. This work was augmented by 2,872 feet of diamond-drilling. No ore was discovered in drifting or crosscutting, and only one diamond-drill hole disclosed any values and these were both very scattered and low grade.

During the year, 14,641 feet of diamond-drilling was done. This was almost wholly in connection with the development work in the greenstone area. Much useful information was obtained from this drilling, both from a geological and development viewpoint. Diamond-drill holes Nos. 1,265 and 1,273 were the only holes resulting in any major development of ore.

Of the tonnage milled, the stopes yielded 60,400 tons, averaging $6.8219 per ton, and development work 7,200 tons, averaging $5.5460 per ton, a total of 67,600 tons, averaging $6.6861 per ton.

The expenditure on mining was $290,176.86. No representative tonnage costs can be given for mining and development expenditures as the mill operated only two months of the year, whereas mining and development was continuous throughout the year.

The expenditure on development and exploration work charged to operating was $359,914.04. This includes $35,128.07 for outside exploration work carried on during the year.

The ore drawn from the Dome Extension ground during the year was 50,793 tons containing $289,031.34, or $5.6904 per ton.

Ore Reserves

The ore reserves are estimated at 1,900,000 tons. This includes 906,000 tons of broken ore.

Exploration

Our exploration engineers have continued to examine properties and have given consideration to many propositions. Some drilling was done in Quebec, but the results were not satisfactory. No property has been found as yet sufficiently attractive to acquire.

Mill

The following are the results of the mill operation for November and December:—

	Total value	Value per ton	Extraction per cent.
Heads	.....	$6.6565	.....
Bullion	$398,063.61	5.8885	88.4627

After the mill started, it was found that sufficient treatment time had not been provided, consequently both the extraction and the tonnage treated were low during this period. Four additional Pachuca agitating tanks were installed and ready for operation on December 31. This will permit of the full tonnage (1,500 tons per day) being handled and will greatly improve the extraction.

General

Operating costs for November and December were $4.12 per ton milled. These cannot be taken as normal, as the tonnage treated was low and the general expense in starting up was high.

The new crusher plant is operating satisfactorily and providing a much finer feed to the mill bin than did the old crusher plant.

In addition to the mill and crusher plant construction and the installation of automatic sprinklers in these buildings, the major items of construction were as follows: installation of

an automatic stoker on one of the boilers in the power-house; installation of new power lines from power-house to mill; installation of an insulated steam line from power-house to mill to furnish heat for the mill.

During the year, construction was the main item of work, and it is worthy of note that the mill was completed in the time specified and within the estimated cost.

Goldbank Syndicate

The Goldbank Syndicate operated their property in the township of Teck, district of Timiskaming, from June 16, 1929, with a force of 3 men. The officers and directors of the company are: C. M. Baker, president; J. H. Sharmen, vice-president and manager; G. B. Baker, secretary-treasurer; Andrew Grey, George Jacques, and Robert McComb, directors.

The syndicate is capitalized at $83,500, divided into 835 shares of $100 par value. The head office of the company is at 404 Talbot Street, London, Ont.

The development work consisted of 70 feet of sinking and 14 feet of crosscutting. Two test pits were sunk 7 feet and 8 feet deep, respectively. A small cabin, stable, hoist-house, and powder magazine were built. About 1,000 feet of surface trenching was done.

Harvey Kirkland Mines, Limited

This company has a capitalization of $5,000,000, in shares of $1 par value. The officers are: Charles J. Beilby, president; Douglas I. Grant, Jr., secretary; H. Graham, treasurer. Reginald Dimond is a director.

The property in Lebel township, district of Timiskaming, was operated from October 18, 1929, to May 30, 1930. About 200 feet of crosscutting was done.

Morris Hastie was manager, employing about 18 men.

Hayden Gold Mines Company, Limited

This company is capitalized at $5,000,000, in shares of $1 par value. There are approximately 4,000,000 shares issued.

The following are the officers of the company: Jas. S. Pierce, Rochester, president and managing director; A. E. Davis, Rochester, vice-president; O. W. Summer, Rochester, secretary-treasurer; B. J. Fryatt, East Rochester; J. Montgomery, Toronto, T. W. Heberle and O. L. Pritchard, Rochester, are directors. The executive offices are at 421 Temple Building, Rochester, N.Y., and 611 Federal Building, Toronto.

The company's holdings are in the townships of Ogden and Deloro, district of Cochrane, and consist of 8 claims, with an option on 5 more directly west of the original group.

The following underground work was done during the year: drifting and crosscutting, 2,039 feet; diamond-drilling, 2,432 feet.

The average number of men employed during the year was 18. T. C. Fawcett is in charge of operations at the mine.

Hollinger Consolidated Gold Mines, Limited

The authorized capital of this company is $25,000,000, in 5,000,000 shares of $5 par value; 4,920,000 shares were outstanding on December 31, 1929. The head office is at Timmins, Ont.

The officers of the company are: Noah A. Timmins, president; Allen A. McMartin, vice-president; John B. Holden, secretary-treasurer; A. F. Brigham, general manager; John Knox, assistant general manager. The directors are: Noah A. Timmins, John B. Holden, Jules R. Timmins, Wilson Bell, Senator W. L. McDougald, Leo H. Timmins, and Allen A. McMartin.

The following information is taken from the twentieth annual report of the directors to the shareholders, covering operations for the year ending December 31, 1930:—

Satisfactory progress has been made during the year. In addition to the usual dividend of one per cent. every four weeks, an extra one per cent. was paid by way of bonus at the end of the year.

The geological investigation of the mine by Dr. L. C. Graton, of Harvard, is proceeding according to schedule. It will be recalled that when the engagement of Dr. Graton was announced it was intimated that the work would in all probability take at least three years. Judging from enquiries and comments made from time to time, this statement appears to have been overlooked. In a recent report, Dr. Graton makes the following remarks under the heading "Plan for the Future":—

"The underground mapping will be steadily carried along and should be essentially completed by the beginning of the summer. Microscopical work, both at the mine and in Cambridge, will be continued, with constant effort to make it add constructively to the field work. This will leave about a year of our three-year programme available for still more intensive study of the veins themselves, and especially for the formulation of the many exploratory recommendations that will form the immediate tangible result of this geological undertaking. On this basis, we shall be approximately abreast of the schedule outlined at the beginning of our work, wherein it was anticipated that specific recommendations could not be expected or promised until after about two years of intensive study had been accomplished."

Your directors sincerely regret to record the death on the 1st of June last of their valued friend and colleague, Louis Henry Timmins, a director of the company since its inception, and at the time of his death vice-president thereof. His interest in the affairs of the company and his sound judgment have been greatly missed. His untimely demise, while most keenly felt by his family and fellow directors, was also much regretted by many of our shareholders, to whom he was known as a warm personal friend. The vacancy on the board thus created has been filled by the election of Allen A. McMartin, of Montreal, a son of the late Duncan McMartin, formerly a director and one of the original proprietors of the Hollinger mine. The number of our shareholders remains about the same as last year, namely 8,000.

Conditions at the mine and mill are satisfactory. Labour conditions have also been satisfactory throughout the year and the available supply of labour is quite adequate to meet our requirements.

The general manager's report for the year ending December 31, 1930, is as follows:—

PROFIT AND LOSS STATEMENT

SOURCES OF 1930 INCOME:			
Gold and silver produced			$10,263,504.75
Premium on U.S. exchange			15,596.49
Interest on investments and other income			623,830.15
			$10,902,931.39
DISPOSAL OF 1930 INCOME:			
General charges		$646,572.51	
Mining charges		4,850,140.17	
Milling charges		1,033,187.65	
			6,529,900.33
Operating profit			$4,373,031.06
DEDUCT:			
Taxes—			
Province of Ontario	$22,398.40		
Royalty to town of Timmins	18,158.87		
Municipal to town of Timmins	90,995.61		
Municipal to township of Tisdale	2,049.13		
Dominion of Canada, reserve for	155,547.55		
		$289,149.56	
Depreciation—			
Plant	$3,964.89		
Investments in other companies and properties written down	3,868.04		
Expenditures on properties abandoned	112,320.50		
		120,153.43	
			409,302.99
NET PROFIT FROM OPERATIONS			$3,963,728.07
PAID OUT IN DIVIDENDS			3,444,000.00
ADDED TO SURPLUS			$519,728.07

BULLION STATEMENT

INVENTORY, JANUARY 1, 1930:		
Solutions		$98,315.44
Slags, litharge, and miscellaneous		743.00
Precipitates held over		5,176.00
Total		$104,234.44
VALUES PRODUCED IN 1930:		
Ore milled	$10,652,232.75	
Tailings loss	388,728.00	
		10,263,504.75
INVENTORY, DECEMBER 31, 1930:		$10,367,739.19
Solutions		$103,625.96
Slags, litharge, and miscellaneous		880.00
Precipitates held over		2,283.00
		$106,788.96
BULLION SHIPPED DURING 1930		10,260,950.23
		$10,367,739.19

YEARLY AVERAGE COSTS

Account	Sundries	Labour	Stores	Total	Per ton ore milled
General miscellaneous charges and administration	.....	$334,818.44	$62,052.50	$396,870.94	$0.2442
Surface services	.....	43,575.39	24,992.68	68,568.07	.0422
Insurance	$12,438.03	.....	.....	12,438.03	.0076
Marketing bullion	30,955.12	.....	.....	30,955.12	.0190
Workmen's compensation	.....	137,740.35	.....	137,740.35	.0847
Milling charges	.....	406,472.97	626,714.68	1,033,187.65	.6355
Mining charges	.....	3,254,643.59	1,595,496.58	4,850,140.17	2.9831
Total charges	$43,393.15	$4,177,250.74	$2,309,256.44	$6,529,900.33	$4.0163

Employees

The average number of men employed during the year has been 2,263, distributed as follows:—

MINERS:		MECHANICS:		GENERAL:	
Exploration	35	Operation	102	Mill and refinery	187
Development	345	Maintenance	162	Engineering staff	61
Production	1,192			Clerical staff	39
				Miscellaneous	140
Total	1,572	Total	264	Total	427

The Mill

Milling results were as follows:—

Ore milled	tons	1,625,868
Average value per ton		$6.55
Gross value	$10,652,232.75	
Deduct loss in tailings	388,728.00	
Net value recovered		$10,263,504.75
Average tons per day		4,479
Per cent. of possible time run		94.2
Tons per 100 per cent. running time		4,755
Solution precipitated per ton ore	tons	1.05
Value per ton in tailings		$0.24
Cyanide consumed per ton of ore	lbs.	0.439
Zinc consumed per ton of ore	lbs.	.053
Zinc consumed per ton of solution	lbs.	.051
Lime consumed per ton of ore	lbs.	2.099
Lead nitrate per ton of ore	lbs.	.009
Average value of pregnant solution		$5.98

The Mine

The development progress during the year was as follows: sinking, 1,246 feet; drifting, 51,784 feet; crosscutting, 14,630 feet; raising, 479 feet; a total of 68,139 feet. Some 134,976 feet of diamond-drilling was accomplished.

Production

At January 1, 1930, the broken ore in the mine amounted to 1,079,526 tons. Ore broken during 1930 was 1,545,063 tons, and ore removed during 1930 was 1,625,449 tons, leaving 999,140 tons of broken ore in the mine as at December 31, 1930.

General

It will be gratifying to shareholders to know that the situation at this writing is greatly improved over that of two years ago. We have not found it necessary to draw upon our ore reserves, notwithstanding an increase in bullion recovery of $829,737, and further, have augmented the ore reserves by $987,287.

The results of the year from the deep levels encourages us to sink a new shaft from the 4,000-foot to the 5,500-foot level. This we hope to have well under way in 1931.

The following résumé of progress from the beginning of operations might be of interest at this time:—

Total income from all sources	$167,139,514.39
Working expenses, including all charges	101,358,128.32
Profits	$65,781,386.07
Paid out in dividends	54,786,400.00
Surplus	$11,629,888.19

To the above gross figures should be added the balance of ore reserves at this date, and all further additions thereto, to get a real picture of Hollinger and its operations.

Howey Gold Mines, Limited

This company is capitalized at $5,000,000, in shares of $1 par value. There are 4,900,000 shares issued. The head office of the company is at 1206 Star Building, Toronto, and the mine office is at Red Lake. The following is a list of the executive officers and directors: R. T. Birks, president; W. S. Cherry, vice-president; Andre Dorfman, secretary-treasurer; H. G. Young, mine manager; R. Home Smith and John A. Northway, directors.

The company's holdings lie at the southeast corner of the lower part of Red lake and include the following claims situated in Dome and Heyson townships, district of Kenora (Patricia portion): K. 740-43, 1,400-406, 1,364-72, 1,397-99, and 867. These claims lie directly north of Favel on the C.N.R.

Hudson, a station on the Canadian National railway (mileage 1,132.7 from Montreal), is the starting point for power-boat lines which take travellers, without change, to Goldpines (Pine Ridge) at the west end of Lac Seul; from there smaller boats are used down the English river, the Mattawa river, Pakwash lake, Gull Rock lake, Keg lake, and the Chukuni river into Red lake. From Hudson to Goldpines is 115 miles, and from Goldpines to Red lake, 60 miles.

In winter there is a well-travelled road to Goldpines from Hudson, cutting off a part of the lower water route and making the distance 78 miles. Another route leads from Sunstrum, another station at mileage 1,152.7 on the Canadian National railway, to Goldpines. The rest of the winter route to Red lake follows very much the line of the summer route over the lakes.

Summer or winter there is excellent air service provided by the Western Canada Airways, with a base at Sioux Lookout, from which point Red lake can be reached in about an hour and a half. The journey by water requires two whole days.

The following is an extract from the mine manager's report for the twenty months ending August 31, 1930:—

CONSTRUCTION, 1929–1930

	1929	1930	Total to Aug. 31, 1930
Improvements to portages	$10,000.00	.....	$10,000.00
Saw-mill	11,418.66	$2,262.80	13,681.46
Cyanide mill	348,164.30	91,629.47	439,793.77
Coarse crushing station	40,641.71	6,279.26	46,920.97
Refinery	1,867.47	2,653.59	4,521.06
Headframe and ore bin	29,139.67	4,520.60	33,660.27
Power-house	79,072.96	8,147.96	87,220.92
Shops	16,369.78	1,741.99	18,111.77
44,000-volt substation complete	15,580.67	207.72	15,788.39
Mill substation and elec., outside mill	6,061.76	229.44	6,291.20
Underground pumps, signal system, and lighting	3,918.32	1,920.92	5,839.24
New bunk-house	5,323.37	.....	5,323.37
Surface tramways	5,167.87	.....	5,167.87
Surface pipe lines	5,942.64	5,366.56	11,309.20
Miscellaneous jobs	19,741.86	2,855.58	22,597.44
Total	$598,411.04	$127,815.89	$726,226.93
ADDITIONS TO PLANT AND EQUIPMENT:			
Power-house equipment	$125.00	.....	$125.00
Underground equipment	14,977.11	$8,235.56	23,212.67
Assay office equipment	1,625.89	436.93	2,062.82
Shop equipment	165.83	50.64	216.47
Office and engineering equipment	294.00	480.50	774.50
Cookery equipment	298.50	.....	298.50
Bunk-house equipment	3,147.20	183.48	3,330.68
Dwellings equipment	197.46	29.31	226.77
Miscellaneous surface equipment	4,926.77	.....	4,926.77
Total	$25,757.76	$9,416.42	$35,174.18

The cyanide mill cost $439,793.77 and the coarse crushing plant $46,920.97, or a total for these two items of $486,714.74, which includes the cost of metallurgical experimental work and general engineering company's fees. Transportation of machinery and supplies from the steel for this construction was about $100,000. The plant is so designed and constructed that its expansion to double capacity, or 1,000 tons per day, can be carried out for $75,000. The total cost, therefore, can be considered as very favourable. We are well pleased with its service and operation. All construction has worked out very well indeed, and our plant is splendid in all details.

DEVELOPMENT, 1927–1930

	Shafts, stations, and sumps	Drifts	Cross-cuts	Raises	Pockets and haulage levels	Box-holes	Diamond-drilling, surface	Diamond-drilling, underground
	feet	feet	feet	feet	cu. yds.	feet	feet	feet
1927	655.1	855.7	834.2	.....	.....	.....	.....	.....
1928	.....	6,009.7	4,305.8	.....	.....	.....	3,852	2,019
1929	752.1	1,912	2,254.5	257	533.8	.....	45	.....
Total	1,407.2	8,777.4	7,394.5	257	533.8	.....	3,897	2,019
Jan. 1 to Aug. 31, 1930	.....	561	215.5	1,917.5	2,069.5	760.5	.....	.....
Grand total	1,407.2	9,338.4	7,610	2,174.5	2,603.3	760.5	3,897	2,019

The expenditure on this account for the year 1929 was $291,037.87, and during 1930 to August 31 was $153,470.19. The work accomplished was as per statement above.

During the year 1929, the shaft was put down from a depth of 521 feet to 1,083.5 feet, and four new levels established at 625, 750, 875, and 1,000 feet below the collar. On these levels the following work was accomplished:—

Level	Drifts		Crosscuts		Raises		Box-holes, 1930 (8 mos.)	Shafts and sumps, 1930 (8 mos.)
	1929	1930 (8 mos.)	1929	1930 (8 mos.)	1929	1930 (8 mos.)		
	feet	feet	feet	feet	feet	feet	feet	feet
625-foot	571.5	.....	466.5	.....	24.5	.....	372	.....
750-foot	575.5	62.5	530.5	.....	41	113.5	525	.....
875-foot	229	267.5	298.5	94	22.5	134.5	245	.....
1,000-foot	419	93	492	121.5	19.5	130.5	122	20
Total	1,795	423	1,787.5	215.5	107.5	378.5	1,264	20

The result of this development was the opening up of ore on various levels as follows:—

Level	Lineal feet of ore	Width	Value in gold per ton
		feet	
625-foot	370	17.1	$6.84
750-foot	443	19.6	6.80
875-foot	252	36.4	6.13
1,000-foot	450	13.8	5.74
Total	1,515	[1]20.1	[2]$6.40

[1]Average width.
[2]Average value.

During 1929 we resampled the four upper levels and obtained an average of $6.67 over a width of 16 feet for a length of 1,485 feet. The total length of ore in the mine so far developed is, therefore, 3,000 lineal feet of a grade of $6.52 over a width of 18 feet, or a grade of $5.80 for a width of 22.3 feet.

SOURCE OF ORE HOISTED TO MILL FROM MARCH 1 TO AUGUST 31, 1930

	Stopes			Development	Slash	Total	Ore dump	Dump, per cent. of total to mill	Grand total	Average value per ton milled
	Sills	Backs	Box-holes							
MONTH:										
March	1,255	.....	.....	500	.....	1,755	.....	.....	1,755	.....
April	6,652	.....	.....	60	.....	6,712	.....	.....	6,712	3.07
May	7,874	.....	.....	439	.....	8,313	.....	.....	8,313	5.00
June	6,136	4,150	472	196	245	11,199	253	2	11,452	4.94
July	6,590	3,275	924	445	295	11,529	2,450	18	13,979	3.99
August	5,600	4,225	919	1,465	496	12,705	3,599	22	16,304	4.12
Total	34,107	11,650	2,315	3,105	1,036	52,213	6,302	.....	58,515	.....
LEVEL:										
125-foot	5,465	.....	380	1,133	150	7,128	.....	.....	.....	.....
500-foot	1,970	.....	180	.....	92	2,242	.....	.....	.....	.....
625-foot	9,377	3,400	433	53	60	13,323	.....	.....	.....	.....
750-foot	7,990	4,550	795	589	125	14,049	.....	.....	.....	.....
875-foot	5,535	2,850	392	1,002	420	10,199	.....	.....	.....	.....
1,000-foot	3,770	850	135	328	189	5,272	.....	.....	.....	.....
Total	34,107	11,650	2,315	3,105	1,036	52,213	6,302	.....	58,515	.....

Ore broken in stopes, 65,776 tons.
Ore hoisted from stopes, 45,757 tons.
Broken ore in mine, 20,019 tons.

In January, 1930, we started to open up stopes by box-holing and silling out, and to date have accomplished the following silling out of stopes on the various levels as shown:—

Level	Sill length	Sill width	No. of box-holes
	feet	feet	feet
125-foot	308	28.7	20
500-foot	185	16.5	10
625-foot	333	38.1	23
750-foot	388	40	31
875-foot	158	47.2	18
1,000-foot	160	[1]37.1	8
Total	1,532	[2]35.6	110

[1]Sill width incomplete.
[2]Average width.

Gross values based on bullion recovery plus values held up in solution and ore in treatment gives us an average value of mill heads for 56,529 tons treated as $4.43 per ton. In this tonnage we have 6,088 tons of dump ore and 4,000 tons of development ore. If we deduct the value of these, we have 46,441 tons treated from stopes with an average gold content of $4.73 per ton. The average grade of ore hoisted from above the 500-foot level was $3.99 per ton and from below that level $4.88 per ton. To date the ore from the sill and its development has constituted 85 per cent. of mill feed, and the length of silling out accomplished represents 50 per cent. of the developed ore of the mine. The average width of sill is 35.6 feet, which is about 18 feet wider than development indicated. The extra width has averaged $3.00 per ton, which is too low, and it is admitted that sill development has been carried too wide, with consequent too much dilution. This is being corrected by starting the shrinkage stopes above the sill narrower, by dropping hanging-wall margins which proved unpromising on sill development. It is anticipated that grade will improve in proportion as mill feed is derived from these shrinkage stopes, instead of from sill development, as to date.

SUMMARY OF OPERATIONS SINCE INCEPTION OF MILLING, APRIL 2, 1930

	Dry tons milled	Value per ton	Total value	Loss in tailings per ton	Total loss in tailings	Total recovery	Cost per ton milled	Total operating expense before D.&T.	Profit	Loss
April	6,682	$3.07	$20,493.21	$0.20	$1,201.00	$19,292.21	$5.443	$36,373.29	.....	$17,081.08
May	7,995	5.00	40,236.11	.20	1,599.00	38,637.11	5.757	46,029.11	.....	7,392.00
June	10,844	4.94	53,545.02	.21	2,311.20	51,233.82	4.499	48,789.17	$2,444.65	.....
July	14,564	3.99	58,134.97	.20	2,956.79	55,178.18	3.694	53,801.81	1,376.37	.....
August	16,444	4.12	67,719.94	.29	4,763.97	62,955.97	3.245	53,362.78	9,593.19	.....
Total	56,529	.....	$240,129.25	$0.227	$12,831.96	$227,297.29	.....	$238,356.16	$13,414.21	$24,473.08
Interest earned	.....	.....	.....	.....	.....	.....	.....	.....	242.08	.....
In process (est.)	.....	.....	10,000.00	.....	.....	.....	.....	.....	10,000.00	.....
Slag on hand	.....	.....	380.00	.....	.....	.....	.....	.....	380.00	.....
Total	.....	.....	$250,509.25	.....	.....	.....	.....	.....	$24,036.29	$24,473.08

NOTE.—Tailings unusually high in August due to agitator trouble.

We started the first unit of the mill on April 2, and the second on April 16, 1930. Due to a misinterpretation on the part of all concerned as to the hardness of our ore the manufacturers first supplied the ball mills equipped with pinions, which gave too slow a speed. The result was that our mill capacity was about 40 per cent. below normal for the first three months of operation. On July 1 we installed faster pinions, supplied by the manufacturers, and since then have been crushing 500 tons per day. In August we averaged 530 tons per day.

Metallurgical experiments, prior to the design of plant, indicated exactly the correct procedure, and no difficulties have been encountered whatever in handling the ore. The following is the average performance during the five months since inception of milling: grinding 2 to 3 per cent. on 40 mesh; 95 per cent. extraction; tailings average 22.7 cents; operating efficiency, 92 per cent.; cost per ton milled, $1.05 (includes coarse crushing and handling dump ore). On this basis, cost in August was 97 cents.

We are experiencing no mechanical troubles whatever, and the whole plant operates very smoothly.

OPERATING COSTS[1]

	April	May	June	July	August
Tons milled	6,682	7,995	10,844	14,564	16,444
Development	$6,471.63	$1,850.94	$1,058.77	$3,222.18	$6,226.98
Slash and haul. levels	5,613.14	95.77	351.44	521.13	.....
Mining	10,685.83	18,979.79	22,938.29	23,511.51	20,568.49
Box-holes	.....	1,609.16	1,936.12	3,932.85	1,870.88
Crushing and conveying	750.22	1,472.44	1,771.55	1,921.17	3,157.44
Milling	5,505.61	9,783.59	10,202.49	11,655.70	12,766.90
General expense	2,591.25	7,195.66	5,736.78	3,936.76	3,644.35
Total	$31,617.68	$40,987.35	$43,995.44	$48,701.30	$48,235.04
Cost per ton	$4.732	$5.127	$4.057	$3.344	$2.934
Head office expense, including interest	$4,755.61	$5,041.76	$4,793.73	$5,100.51	$5,127.74
Grand total	$36,373.29	$46,029.11	$48,789.17	$53,801.81	$53,362.78
Cost per ton	$5.443	$5.757	$4.499	$3.694	$3.245

[1]Not including depreciation and taxation.

In the table above you will note that operating costs per ton milled have dropped in proportion to tonnage increase.

Ore Reserves

Positive ore amounts to 1,125,000 tons, and probable ore to 375,000 tons, a total of 1,500,000 tons. Probable ore does not include any tonnage below the 1,000-foot level, but is allowed entirely on the extensions of the four lower levels on the known rake of the ore body. This ore can be developed quickly.

Transmission Line and Power

The survey of the power line between Ear Falls and Red Lake was completed in June, 1929, and contract let to Morrow and Beatty for its construction on the 26th of June that year. In December, 1929, the whole line was completed for a distance of 41.5 miles. The total cost of this work was $190,815.62, or practically $4,600 per mile, which reflects credit on the contractors and on Wm. Durrell, our representative on this work, also the Hydro-Electric Power Commission's representatives. The line is H-frame construction throughout and is a splendid piece of work in every particular. The Hydro-Electric Power Commission and contractors Morrow and Beatty finished the power development early in December, 1929, and power was delivered to our motors February 15 and lighting January 27, 1930. The service by the Power Commission in the operation and in power delivery has been excellent in every detail.

Power consumption on a basis of 550 tons per day milled is 1,300 h.p., which includes transformer losses and transmission line loss. As our contract calls for supply and payment of 2,000 h.p., we have available for expansion and mill enlargement 700 h.p. already being paid for and carried in our costs. This additional power is adequate to handle our expansion to 1,000 tons per day, or double present tonnage. Power consumption now is 2.36 h.p. per ton treated.

Transport

The improvement to portages by installing marine railways has been satisfactory, and we are pleased to report a further decrease of 20 per cent. in the cost of handling freight this year.

General

Net profits to date have been small, but show gradual increase with increased tonnage. The grade of ore has been fairly well established. Operating costs before "Depreciation and Taxation," considering our location, have been favourable. Ore reserves are splendid and adequate. With these factors determined and sound, it is established that net profits will be satisfactory and in proportion to the volume of ore treated.

The following is an extract from the report on the mine by the Huronian Mining and Finance Company:—

The Howey ores are a gold occurrence in a vertical quartz porphyry dike. The gold values are associated with quartz stringer systems occurring and recurring in a sheared zone of the dike and found in varying widths of the dike from narrow occurrences to wide bodies, but always within the dike.

The ore bodies have been developed by workings to a depth of 1,000 feet from the surface, by eight levels running within the dike, spaced at 125-foot intervals from the surface, from a vertical shaft outside the dike. The levels and workings extend east and west of the shaft.

During the five months ending August 31, the tonnage milled amounted to 56,529 tons, which yielded $4.177 gold per ton by mint returns and to which, adding the tailings loss of $0.226 per ton, showed a total gold content of $4.403 per ton. There was also recovered 2.66 cents silver value per ton. This tonnage included 6,302 tons of ore from the dump mined last year, the value of which is estimated at somewhere around $3.50 per ton. The actual ores mined during the first five months of production thus total 50,227 tons of a gold value of about $4.52 per ton average. During the last three months, June, July, and August, the tonnage produced from the mine was 11,199, 11,529, and 12,705 tons, respectively, together averaging $4.37 gold value per ton.

On account of the erratic nature of the ore occurrences in the dike, it is difficult to estimate from pre-production development work and sampling, however exhaustive this latter may have been, the average value of ore that it is possible to mine by selective methods. Not only are the ore intersections themselves in the development crosscuts difficult to sample and assess by reason of the spotty occurrence of the gold, but the lack of continuity in the dike of the gold-bearing stringer systems themselves makes it impossible from such assessments to deduce minable grades after the unavoidable dilution with barren dike rock in the process of mining them. The pre-production development work does appear to indicate an aggregate of 2,592 feet in length spread over all levels to date, in which length the dike as a whole averages a minimum of $2.75 per ton for 50 feet of width. In all the 33 crosscuts within this developed length, richer ore, averaging $5.78 per ton over intersections averaging 24.5 feet, has been encountered. For these reasons it appears probable that minable grades by selective methods may be expected in this development length.

Whilst average value of the ore mined to date showed a gold content of $4.52 per ton, it should be stated that this ore, either from sills or stopes, was not extracted from lower grade areas.

It is difficult to assess true costs during the early months of operating a property with new equipment, both in mine and mill, but no profits have so far been made. It is also difficult to forecast future operating costs, and the best chance of producing a favourable balance now appears to lie in the possibility of increasing the grade of the ore by surface sorting.

Study so far lends ground for hope that 25 per cent. to 30 per cent. of the mine rock may be discarded as waste by surface sorting, and the mill grade thereby increased to over $5.00 per ton. Should this be accomplished it may also be found possible to adopt cheaper mining methods by exploiting all or most of the dike, relying for grade upon surface sorting.

Due to the fact that production is being drawn from incompleted shrinkage stopes, large additional tonnages will have to be broken and left in stopes in nearby current operations over and above the tonnage which can be drawn for milling. The cost of this and also for other improvements including a sorting plant, if sorting be successful, will be appreciable, for which funds should be provided.

The tonnage of minable reserves opened up by the above 2,592 feet of development and mining to date cannot be stated, owing to the irregular discontinuous nature of the ore occurrences and the lack of raises between levels.

The eastern regions of the four upper levels are in barren dikes, and diamond-drilling from the surface farther east at these horizons has been unpromising. The eastern faces and stopes on the four lower levels, however, show that the limits of the ore zone at these levels have not been reached there. Further ore reserves of similar tenor to those already developed are probable, by continuing eastwards the development of these four levels.

The chances of the ore zone extending below the 1,000-foot horizon are excellent. The general grade of ores found within the zone from the first to the 1,000-foot level with regional exceptions varies little, and similar grades of ore may be expected below. If sorting tests show that the ores can be profitably treated after sorting, development at depth, to at least 1,500 feet, should be started from the eastern extension of the body from the 1,000-foot level.

It is our opinion that the physical condition of the mining and milling equipment, which has a capacity of over 500 tons per day, is conducive to efficient and low-cost operation.

Kirkland Lake Gold Mining Company, Limited

Kirkland Lake Gold Mining Company, Limited, has a capital of 5,500,000 shares of $1 par value. The officers and directors are: D. B. Hanna, president; J. B. Tyrrell, vice-president; R. Graham, secretary; R. G. O. Thomson, A. C. Matthews, J. A. Dalton, J. C. Haight, W. M. Sixt, and A. M. McQueen. W. M. Sixt is mine manager. The head office is at Canadian Bank of Commerce Building, Toronto.

On an average, 513 men are employed at the mine, which is in the township of Teck, district of Timiskaming.

The following summary of operations for the year is taken from the managing director's report:—

During the year 1929, our energies were largely devoted to sinking from the 3,225- to the 4,000-foot level in order to reach the large mass of porphyry which we had reason to believe was underlying our property at depth, and also to reach the rich veins of gold ore which, doubtless, would be associated with it. During the year 1930, we continued to sink to a depth of 4,300 feet, and we also continued the exploration of the ore-bearing veins down to that depth. As a result of this exploration, we have reached a great body of porphyry on the east side of our property, and have disclosed gold ore of high grade in many places on all the levels from 3,600 down to 4,300 feet.

Any indications which point to the continuance of ore bodies beyond the bounds of our present discoveries are of major interest and value to us. Therefore, I am drawing your attention to the fact that on the south side of the great fault which cuts through the rocks of the country from east to west, we have found under the sill of lamprophyre which we have penetrated, and from the 3,800-foot level down to the bottom of our workings at 4,300 feet, Timiskaming sediments, including coarse grey conglomerates similar to the conglomerates which occur so generally on the surface throughout the Kirkland Lake area.

As, at our lower levels, these conglomerates, and the other sediments associated with them, are surrounded and underlain by porphyry, there is here a close duplication of the rock conditions occurring on the south side of the same fault at the surface of the Lake Shore and Wright-Hargreaves mines to the east of us. We can, therefore, continue to sink in our mine with the assurance that we will encounter rocks, and associations of rocks, similar to those which have been encountered in those other mines, from the surface downwards, and with the hope that, being on the same vein, having the same grade and character of ore, and having the same kinds of country rock, we may find large bodies of this ore, comparable in size to those of our neighbours.

Among the interesting features encountered in our deep workings, where porphyry is the prevailing rock, is a change in the metal content of our ore. In the report on the "Kirkland Lake Gold Area," by E. W. Todd, published by the Ontario Department of Mines in 1928, the percentages of silver shown as occurring in the refined bullion from the following mines of Kirkland Lake for the years 1924 to 1928, inclusive, are as follows:[1]—

	Per cent.
Lake Shore	8.4
Teck-Hughes	7.6
Kirkland Lake	17

During these years the ore from the first two of these mines had been extracted from veins in porphyry country rock, while the ore from the Kirkland Lake mine had been extracted from veins associated with syenite and not porphyry, and had been taken from levels above 2,800 feet. At the present time the bullion from our mine is averaging between 11 and 12 per cent. silver. The ore now being sent to the mill is derived partly from veins in syenite above the 3,000-foot level containing 17 per cent. silver, and partly from veins associated with porphyry below the 3,600-foot level, the latter ore evidently having a much lower silver content, probably about the same as the porphyry ore from the mines to the east of us.

As the ore on our lower levels is more or less closely associated with a body of feldspar porphyry which extends to our eastern boundary line, and downward indefinitely as far as we know, and as the character of our bullion has changed from that of our upper levels, so that it is now similar to that which, according to Government reports, is obtained from the mines to the east of us, it is reasonable to believe that we have definitely reached the westward continuation or extension of the large and rich ore bodies which occur in those mines.

The operations of the year consisted in sinking the winze 269 feet to the 4,300-foot level and to the bottom of the sump below that level. Stations were cut or completed at the 3,750-, 4,150-, and 4,300-foot levels. Some 2,178 feet of crosscutting was completed, of which 319 feet were on the 400-, 500-, and 800-foot levels; 72 feet on the 3,100- and 3,600-foot levels, while the rest was on the levels from 3,750 down to 4,300 feet, either establishing connections between the winze and the veins at or near the main fault plane, or exploring at right angles to these veins.

In exploring one or more of the veins that had already been extensively worked and stoped in the upper part of the mine, and in exploring and opening up the veins discovered during the year in the lower part of the mine at or below the 3,700-foot level, 4,149 feet of drifting was done on these veins. In driving these drifts, and the crosscuts from them, we were fortunate in finding ore, often of high grade, on all the lower levels.

In addition to sinking, crosscutting, and drifting, we diamond-drilled for 3,166 feet in order to determine in advance of actual mining operations the character of the rocks to be encountered, or the occurrence of ore. As a result of this drilling, we have located favourable geological conditions and several bodies of ore.

In consequence of finding ore at the lower levels, and of finding the favourable geological conditions for the continuance of ore already mentioned, it has been decided to continue sinking the winze.

[1]Vol. XXXVII, pt. 2, pp. 8-10.

The conditions for sinking and mining at deep levels are particularly favourable in the Kirkland Lake gold mine. The rock is hard and stands up well. The most serious trouble that we have had is in sinking and crosscutting in the porphyry at or close to the contact with the lamprophyre. In that contact zone, from comparatively shallow depths down to the bottom so far reached, the porphyry is under strain, and occasionally snaps off with considerable violence. In other parts of the mine, and especially when drifting in ore, drilling, breaking, and mucking can be prosecuted with very little trouble.

No difficulty has yet been encountered from heat, as the rock temperature at a depth of 4,300 feet is only 69° F. Assuming a rock temperature of 40 degrees near the surface, this is an increase of 29° F. in a depth of 4,300 feet, or 1° F. for each 148 feet.

In our last annual report we stated that "a competent system of ventilation has been installed to the bottom level of the mine." However, in order to provide a second outlet from the mine, entirely independent of the main shaft and winze, and separated from them, where necessary, by tight-fitting partitions and doors, we were obliged to drive raises connecting the various levels, and independent of the stopes, for 2,046 feet. These raises are equipped, where necessary, with good ladders so that the men can use them to escape from the mine in case of emergency, but we hope and believe that as we have provided competent refuge stations at various levels, and with the care that is constantly exercised to keep the workings clear and sanitary, no such emergency will arise.

The raises, with doors, and a little additional work on refuge stations, cost, exclusive of overhead charges, during the year, $34,155.93. Exploration and development, exclusive of these raises, but inclusive of the cost of sinking the winze, amounted to $144,654.91.

The total quantity of rock and ore raised was 81,578 tons. Of this, 5,770 tons of waste were dumped back into the old stopes, and the balance was hoisted to the surface. Of the 75,808 tons hoisted to the surface, 52,106 tons was ore which was sent to the mill, from which gold to the value of $534,397.43 was extracted, giving an average value of $10.245 extracted from each ton of ore. This compares favourably with the production for 1929, when the ore yielded $6.60 per ton. In the first three months of 1930 there was but little improvement on the extraction of the previous year, the ore yielding $6.86 to the ton; while in the last three months of the year, when some of the ore sent to the mill was from the lower levels, the production was $12.53 per ton.

Lake Shore Mines, Limited

Lake Shore Mines, Limited, has a capital of 2,000,000 shares of a par value of $1. The executive officers of the company are: Harry Oakes, president and managing director; W. H. Wright, vice-president; Dr. W. P. St. Charles, treasurer; Kirkland Securities, Limited, secretary. The directors are: Harry Oakes, Albert Wende, Louis Oakes, and Ernest Martin. E. B. Knapp is mine superintendent. The mine and works are at Kirkland Lake, township of Teck, district of Timiskaming. During the year an average of 1,100 men was employed.

The following information is taken from the fifteenth annual report of the company for the year ending June 30, 1930:—

During the year, 467,648 tons of ore were treated, yielding bullion to the amount of $6,576,780.45. This shows an increase of 100,633 tons milled over last year, with a corresponding increase in bullion of $1,071,921.81.

TOTAL PRODUCTION AND DIVIDENDS SINCE THE COMMENCEMENT OF MILLING OPERATIONS IN 1918

Period	Months	Tons milled	Bullion production	Dividends paid
Mar. 1, 1918, to Nov. 30, 1918	9	14,948	$369,680.31	$100,000
Dec. 1, 1918, to Nov. 30, 1919	9	11,907	294,513.72	100,000
Dec. 1, 1919, to Nov. 30, 1920	12	18,889	483,701.93	80,000
Dec. 1, 1920, to Nov. 30, 1921	12	21,681	460,186.37	120,000
Dec. 1, 1921, to June 30, 1923	19	36,825	833,664.89	160,000
July 1, 1923, to June 30, 1924	12	24,223	578,242.59	160,000
July 1, 1924, to June 30, 1925	12	96,838	1,812,494.66	600,000
July 1, 1925, to June 30, 1926	12	125,676	2,235,184.40	700,000
July 1, 1926, to June 30, 1927	12	214,335	3,105,047.85	1,200,000
July 1, 1927, to June 30, 1928	12	237,962	3,629,317.57	1,600,000
July 1, 1928, to June 30, 1929	12	367,015	5,504,858.64	2,000,000
July 1, 1929, to June 30, 1930	12	467,648	6,576,780.45	2,600,000
Total			$25,883,673.38	$9,420,000

Mining and Development

The tonnage milled during the year was made up of 59,572 tons of ore from development and 408,076 tons from mining. The broken ore reserves are now valued at $6,105,400. The broken tonnage will in future be somewhat reduced, owing to our adoption of a combination of the cut-and-fill stope system of mining which will, in certain sections of the mine, replace the shrinkage method heretofore used exclusively.

New work on the No. 2 vein system on the 1,800-, 2,000-, and 2,200-foot levels continues to show very satisfactory results, with values perhaps somewhat better than any corresponding section above. No. 3 shaft is being continued below the 2,200-foot level, and additional levels are now being opened up.

DEVELOPMENT FOOTAGE FOR YEAR 1929

Level	Drifting	Cross-cutting	Raising	Shaft-sinking	Ore passing	Winze	Total footage	Diamond-drilling	Box-holes	Station-cutting	Total
	feet	feet	feet	feet	feet	feet		feet	cu. ft.	cu. ft.	cu. ft.
200-foot	809.81	.....	238.31	.....	.....	.....	1,048.12	.....	.....	.....	.....
400-foot	109.5	.....	129.80	.....	.....	.....	239.3	.....	.....	.....	.....
600-foot	476.26	28.5	221.1	.....	.....	.....	725.86	.....	.....	.....	.....
800-foot	5	10	1,992.4	.....	.....	.....	2,007.4	.....	243	.....	243
1,000-foot	289.87	406.39	1,226.29	.....	.....	.....	1,922.55	2,324	11,284	.....	11,284
1,200-foot	1,274.29	22	1,835.36	.....	.....	12	3,143.65	701	24,398	.....	24,398
1,400-foot	622.11	57.75	2,574.74	.....	.....	.....	3,254.6	1,303	10,908	.....	10,908
1,600-foot	628.29	34.5	1,685.9	.....	.....	.....	2,348.69	4,557.2	.....	.....	.....
1,800-foot	1,167.39	225.79	371.8	169.5	255.5	.....	2,189.98	1,844	588	4,920	5,508
2,000-foot	1,579.23	276.19	513	191.5	8.5	.....	2,568.42	.....	5,456	28,588	34,044
2,200-foot	441.81	265.41	68	261.4	94.9	.....	1,131.52	167	.....	33,313	33,313
Total	7,403.56	1,326.53	10,856.7	622.4	358.9	12	20,580.09	10,896.2	52,877	66,821	119,698

SUMMARY OF ORE AND WASTE HOISTED FOR THE YEAR 1929

Level	Ore from development	Ore from mining	Waste
	tons	tons	tons
200-foot	.....	.....	9,702
400-foot	.....	2,164	2,752
600-foot	5,907	22,771	909
800-foot	5,187	65,733	790
1,000-foot	5,715	68,328	3,355
1,200-foot	12,785	82,479	1,667
1,400-foot	7,457	86,958	2,197
1,600-foot	5,147	55,277	2,461
1,800-foot	5,985	10,932	8,150
2,000-foot	8,832	13,434	9,245
2,200-foot	2,557	.....	14,662
Total	59,572	408,076	55,890

TOTAL FOOTAGE OF DEVELOPMENT AND EXPLORATION WORK SINCE BEGINNING OF OPERATIONS

	Feet
Drifting	45,739
Crosscutting	9,461
Raising	32,663
Sinking	5,084
Ore passing	2,113
Winze	257
Diamond-drilling	34,138
	Cu. ft.
Box-holing	218,888
Station-cutting	344,810
Sump	28,295

Milling

The additional milling equipment installed during the latter part of the last fiscal year has resulted in a satisfactory increase in tonnage. The anticipated mill enlargement has been carried out with some slight delays owing to irregular deliveries of material and also due to the

necessity of keeping the present mill running during construction. However, the new thickener tanks are at present in operation, and the remainder of the equipment will come into use within a short time.

Costs

	Total cost	Cost per ton milled
Development	$833,252.67	$1.781
Mining	1,267,556.32	2.710
Milling and refining	462,808.21	.990
General and administrative expense	173,328.40	.371
Total	$2,736,945.60	$5.852
Depreciation	510,469.31	1.092
Grand total	$3,247,414.91	$6.944

General

All the new construction relative to an increased production has been practically completed and paid for from current earnings. In addition, the new office has been completed during the year and the old office has been moved and converted into a residence. A modern six-apartment building has also been completed.

McIntyre-Porcupine Mines, Limited

The authorized capital of this company is $4,000,000, divided into 800,000 shares of a par value of $5, of which 798,000 are issued.

The officers of the company are: J. P. Bickell, president; W. J. Sheppard, vice-president; M. P. Van Der Voort, secretary; Balmer Neilly, treasurer. The directors are: J. P. Bickell, W. J. Sheppard, J. B. Tudhope, D. H. McDougall, Strachan Johnston.

The mines and plant are at Schumacher, in the township of Tisdale, district of Cochrane. The head office of the company is at Schumacher, and the executive offices are at 15 King Street West, Toronto.

The following information is taken from the ninteenth annual report of the company for the year ending March 31, 1931:—

Under present industrial conditions, it will afford our shareholders real satisfaction to know that once more we have established new high records in gross production, earnings, and in the estimated gross value of our ore reserves. The la.ter estimate now stands at 2,562,465 tons, averaging $8 per ton, or a gross value of $20,480,964. Comparing this with last year's estimate, and having regard for the year's production of $4,934,122, it is apparent that there was put in sight during the period new ore with an estimated gross value of approximately $6,000,000.

During the same period, construction of our new plant adjacent to No. 11 shaft has been actively prosecuted. The new mill, practically complete, is expected to go into operation about June 1. There still remains the completion of the new change-house and office building, the removal of our refinery from the south side of the lake, and the actual concentration of all surface activities in the new area.

The proximity of the new mill to No. 11 shaft diminishes the cost of transporting ore between the two units to a minimum. As soon as the ore has been reduced to, say, 60 mesh, it is routed to the flotation section of the mill, where a very complete separation is made between the sulphides plus the free and attached gold on the one hand, and the almost barren rock on the other hand. The latter is immediately discarded as waste, and only the valuable portion, amounting to, say, 15 per cent. of the original ore by weight, is retained in the mill circuit for fine grinding and cyanidation of the gold content. In other words, we are saved the cost of fine grinding and cyaniding that portion that is discarded at the end of the flotation process, as well as the carrying charges on such additional building and equipment as would have been necessitated by the adoption of the heretofore standard practice. Another advantage is derived from the fact that

the treatment provided for the concentrates is under such control that a satisfactory recovery is at all times assured.

During the year a crosscut on the 3,750-foot level was extended south and east into that portion of our property commonly referred to as the Platt Vet ground. From the face of this crosscut a diamond-drill hole was pointed south, and subsequent to the date upon which the general manager's report was submitted, results have been obtained that indicate ore deposits assaying well above mine average. As this area is separate and distinct from the Pearl Lake shear zone, from which all our ore has been mined up to the present time, we feel justified in considering these discoveries as of major importance.

The general manager's report is as follows:—

PRODUCTION

Ore treated.....tons	558,115
Value per ton	$8.84
Gross value	4,934,122.00
Bullion recovered	4,633,140.73
Bullion recovered per ton	8.30
Bullion contained:	
Gold, 223,325,019 fine ounces	4,616,537.49
Silver, 51,982,859 fine ounces	16,603.24
Premium on U.S. funds	182.81
	$4,633,323.54

PRODUCTION SINCE THE BEGINNING OF MILLING OPERATIONS IN 1912

Period	Months	Tons milled	Value per ton	Gross value	Recovery per ton	Total value
1912	12	14,500	$7.00	$101,555.16	$5.25	$76,166.38
1913	12	31,979	7.85	251,314.45	7.05	225,752.25
Jan. 1, '14, to Mar. 31, '15	15	85,654	8.87	760,232.16	8.39	718,331.71
Apr. 1, '15, to Mar. 31, '16	12	105,758	7.71	815,345.49	7.38	779,990.94
Apr. 1, '16, to June 30, '17	15	195,307	10.00	1,954,793.28	9.55	1,864,914.28
July 1, '17, to June 30, '18	12	178,327	10.05	1,793,197.55	9.61	1,714,258.00
July 1, '18, to June 30, '19	12	179,874	9.78	1,759,627.40	9.29	1,671,646.03
July 1, '19, to June 30, '20	12	188,835	11.52	2,175,891.31	11.02	2,080,178.44
July 1, '20, to June 30, '21	12	171,916	11.67	2,005,672.00	11.08	1,904,326.36
July 1, '21, to June 30, '22	12	193,971	10.69	2,074,088.40	9.99	1,937,105.07
July 1, '22, to June 30, '23	12	240,615	9.96	2,397,303.00	9.35	2,249,741.63
July 1, '23, to June 30, '24	12	360,140	9.69	3,488,863.00	9.14	3,291,178.22
July 1, '24, to June 30, '25	12	400,259	9.43	3,774,068.00	8.86	3,546,637.52
July 1, '25, to June 30, '26	12	460,909	8.72	4,020,326.00	8.25	3,804,774.90
July 1, '26, to Mar. 31, '27	9	385,409	8.08	3,113,500.07	7.67	2,957,060.97
Apr. 1, '27, to Mar. 31, '28	12	520,460	8.09	4,207,553.00	7.66	3,987,634.94
Apr. 1, '28, to Mar. 31, '29	12	538,165	8.24	4,433,378.00	7.83	4,212,624.82
Apr. 1, '29, to Mar. 31, '30	12	550,495	8.46	4,657,188.00	8.05	4,433,626.45
Apr. 1, '30, to Mar. 31, '31	12	558,115	8.84	4,934,122.00	8.30	4,633,140.73
Total	.....	5,360,688	$9.09	$48,718,018.27	$8.60	$46,089,089.64

Mining

	Tons
Ore broken in stopes	453,258
Ore from development	86,625
Drawn from broken ore reserves	17,221
Ore hoisted	557,104

Cut-and-fill methods of mining were used for approximately 50 per cent. of the ore stoped. Current back-fill requirements were met by waste rock from development.

ORE HOISTED BY LEVELS

Level	Tons	Assay	Value
200-foot	8,292	$14.15	$117,352
500-foot	4,980	6.55	32,540
1,000-foot	1,839	3.40	6,303
1,250-foot	1,859	4.05	7,534
1,375-foot	8,832	5.20	46,021
1,500-foot	26,303	8.55	225,045
1,625-foot	25,504	7.40	188,923
1,750-foot	49,604	9.60	477,819
1,875-foot	51,726	5.75	296,757
2,000-foot	36,732	9.05	332,060
2,125-foot	59,406	8.20	482,035
2,250-foot	37,942	15.40	586,386
2,375-foot	48,295	12.40	599,093
2,500-foot	66,393	7.45	494,592
2,625-foot	45,813	19.95	473,504
2,750-foot	23,717	7.10	161,599
2,875-foot	19,640	9.30	182,377
3,000-foot[1]	8,828	5.90	52,231
3,125-foot	9,019	4.15	37,453
3,250-foot	7,882	3.00	23,707
3,375-foot	3,099	3.25	10,049
3,500-foot	2,933	3.65	10,681
3,625-foot	4,929	6.05	29,952
3,750-foot	1,335	3.55	4,720
3,875-foot	2,202	1.50	3,309
Total	557,104	$8.75	$4,882,042

[1]The tonnage and value of ore hoisted from below the 2,875-foot level represents production from drift faces taken in accordance with a general policy of milling all development rock that assays $1 or more per ton.

DEVELOPMENT

Development work performed during the year amounted to 28,742 feet, an increase of 847 feet over that of last year. This work included 20,809 feet of drifts, of which, 1,494 feet was on line and 19,315 feet in vein material; 8,837 feet was in ore of $7.30 grade over drift width.

No. 3 Vein.—Stopes produced 115,462 tons of an average grade of $8.20 per ton. On the 1,250-, 1,375-, and 1,875-foot levels, 2,381 feet of drifting was done, of which 905 feet was in ore of $7 grade over drift width.

No. 5 Vein.—Stopes produced 14,774 tons of an average grade of $11.70 per ton. On the 200- and 500-foot levels, 471 feet of drifting was done, of which 338 feet was in ore of $10 grade over drift width.

No. 7 Vein.—Stopes produced 78,088 tons of an average grade of $10 per ton. On the 2,125- and 2,625-foot levels, 726 feet of drifting was done, of which 706 feet was in ore of $8 grade over drift width.

No. 8 Vein.—Stopes produced 2,788 tons of an average grade of $7.50 per ton.

No. 9 Vein.—Stopes produced 35,657 tons of an average grade of $12 per ton.

No. 10 Vein.—Stopes produced 75,230 tons of an average grade of $5.60 per ton. On the 1,625-, 2,500-, 3,000-, 3,125-, and 3,250-foot levels, 2,413 feet of drifting was done, of which 1,123 feet was in ore of $7.50 grade over drift width.

No. 12 Vein.—Stopes produced 9,705 tons of an average grade of $10 per ton. On the 1,225-, 1,500-, 1,625-, 2,000-, 2,125-, 2,250-, and 2,375-foot levels, 3,053 feet of drifting was done, of which 1,391 feet was in ore of $8.50 grade over drift width.

No. 13 Vein.—Stopes produced 40,716 tons of an average grade of $6.25 per ton. On the 2,625-, 2,750-, 3,000-, 3,125-, 3,250-, 3,500-, 3,625-, and 3,750-foot levels, 4,597 feet of drifting was done, of which 2,555 feet was in ore of $6.50 grade over drift width.

No. 14 Vein.—Stopes produced 42,695 tons of an average grade of $6.30 per ton. On the 1,500-, 1,625-, 1,875-, 2,000-, 2,125-, 3,250-, 3,500-, and 3,875-foot levels, a total of 3,461 feet of drifting was done, of which, 1,107 feet was in ore of $7.50 grade over drift width.

No. 15 Vein.—On the 3,250-, 3,375-, and 3,875-foot levels, 1,690 feet of drifting was done, of which 59 feet was in ore of $5 grade over drift width.

No. 16 Vein.—Stopes produced 55,366 tons of an average grade of $18 per ton. On the 1,000-, 2,125-, 2,250-, and 2,675-foot levels, 1,760 feet of drifting was done, of which 654 feet was in ore of $8 grade over drift width.

ORE RESERVES, 1930–1931

	Tons	Assay	Value
McIntyre claims	622,756	7.35	$4,566,326
McIntyre Extension claims	151,648	9.65	1,460,953
Jupiter claims	1,315,320	8.60	11,291,080
Plenaurum claims	237,416	6.65	1,577,056
Total	2,327,140	8.15	18,895,415
Broken ore	235,325	6.75	1,585,549
Total	2,562,465	8.00	$20,480,964

SUMMARY OF DEVELOPMENT AND EXPLORATION, 1930–1931

Period	Drifts	Cross-cuts	Raises	Winzes	Shafts	Stations	Sumps	Pockets and passes	Total footage	Total excavation	Diamond-drilling
	feet	feet	feet	feet	feet	cu. ft.	cu. ft.	cu. ft.		cu. ft.	feet
1	2,003	275	307	.....	.....	6,120	.....	.....	2,585	6,120	3,195
2	1,571	393	178	.....	.....	2,304	.....	.....	2,142	2,304	3,235
3	1,363	748	177	.....	.....	.....	.....	.....	2,288	.....	3,460
4	1,707	790	182	.....	.....	.....	.....	.....	2,679	.....	2,868
5	1,533	753	29	.....	.....	.....	.....	.....	2,315	.....	2,824
6	1,694	658	.....	.....	.....	.....	.....	.....	2,352	.....	2,975
7	1,885	979	.....	.....	.....	6,956	.....	.....	2,864	6,956	2,562
8	2,200	659	.....	.....	.....	120	.....	.....	2,859	120	2,793
9	2,348	456	.....	.....	.....	.....	.....	.....	2,804	.....	3,430
10	2,236	510	.....	.....	.....	.....	.....	.....	2,746	.....	3,300
11	1,029	394	.....	.....	.....	.....	.....	.....	1,423	.....	2,681
12	1,240	445	.....	.....	.....	2,750	.....	.....	1,685	2,750	2,876
Total	20,809	7,060	873	.....	.....	18,250	.....	.....	28,742	18,250	36,199
Previous to date	147,501.3	73,383.8	16,791.4	579.7	12,619.9	656,144	36,823	139,699	250,876.1	832,666	241,754
Total	168,310.3	80,443.8	17,664.4	579.7	12,619.9	674,394	36,823	139,699	279,618.1	850,916	277,953

OPERATING COSTS

	Total	Per ton milled
MINING:		
Exploration	$60,261.44	$0.1080
Development	436,563.74	.7822
Breaking and stoping	1,284,131.32	2.3008
Examination of prospects	13,637.95	.0244
Total mining costs	$1,794,594.45	$3.2154
Crushing and transportation	$98,462.53	$0.1764
Milling	419,119.12	.7510
Heating and maintenance—buildings and camps	45,184.86	.0810
Bullion marketing and general expense—mine office	76,335.08	.1368
Administration and general expense—Toronto office	95,867.35	.1718
Insurance, general	17,711.58	.0317
Total	$2,547,274.97	$4.5641

ANALYSIS OF MINING COSTS PER TON MILLED

	Stoping	Drifting	Cross-cutting	Raising	Stations and sumps	Total cost	Cost per ton
Labour	$586,831.29	$162,784.45	$44,115.31	$8,604.44	$813.53	$803,149.02	$1.4390
Explosives	85,264.36	62,792.98	17,958.77	2,131.36	204.74	168,352.21	.3016
Supplies	45,215.40	17,730.94	5,248.33	2,457.48	153.46	70,805.61	.1269
Power	33,652.00	10,154.36	2,777.74	1,244.00	76.69	47,904.79	.0858
Timbering	153,505.86	.....	168.14	292.12	497.74	154,463.86	.2768
Shaft repairs	6,433.89	.....	.....	.....	.....	6,433.89	.0115
Back-filling	54,795.55	.....	.....	.....	.....	54,795.55	.0982
Steel-sharpening	27,701.95	19,518.12	5,585.07	800.84	115.38	53,721.36	.0963
Drill repairs	13,339.85	4,294.35	1,189.39	478.26	27.49	19,329.34	.0346
Surveying and engineering	24,998.62	7,108.72	1,871.10	692.64	42.53	34,713.61	.0622
Sampling and assaying	38,515.12	3,764.46	967.88	308.15	.....	43,555.61	.0780
Pumping	5,580.54	1,198.54	371.58	147.18	.....	7,297.84	.0131
Ventilating	9,684.49	5,192.06	1,441.95	510.16	20.40	16,849.06	.0302
Tramming	66,514.24	20,779.25	6,500.00	763.94	.....	94,557.43	.1694
Surface tramming	.....	389.82	116.45	208.50	.....	714.77	.0013
Hoisting	132,098.16	30,406.69	4,985.88	3,783.70	.....	171,274.43	.3069
Total	$1,284,131.32	$346,114.74	$93,297.59	$22,422.77	$1,951.96	$1,747,918.38	$3.1318
Less: Charged to undistributed development	.....	.....	3,610.89	22,422.77	1,189.66	27,223.32	.0488
	$1,284,131.32	$346,114.74	$89,686.70	.....	$762.30	$1,720,695.06	$3.0830
Exploration	.....	.....	.....	.....	.....	60,261.44	.1080
						$1,780,956.50	$3.1910
Examination of prospects	.....	.....	.....	.....	.....	13,637.95	.0244
Total	.....	.....	.....	.....	.....	$1,794,594.45	$3.2154
Unit cost per ton	$2.3008	$0.6201	$0.1607	.....	$0.0014	.....	.....

Milling

The operation of the mill was satisfactory until the last two months of the year, when the removal of machinery to be placed in the new mill upset the ordinary routine and resulted in a decreased tonnage and recovery.

MILLING COSTS

	Labour	Supplies	Repairs and maintenance	Power	Total	Costs per ton
Ball milling	$8,410.04	$25,914.46	$313.22	$11,808.17	$46,445.89	$0.0832
Tube milling	8,410.04	40,901.12	818.70	26,958.06	77,087.92	.1382
Classification	10,178.43	3,567.70	964.54	3,853.17	18,563.84	.0333
Flotation	18,927.53	12,652.58	426.24	6,926.33	38,932.68	.0698
Pumping and elevating	6,753.27	3,099.49	619.64	4,292.21	14,764.61	.0265
Agitation	6,753.27	1,872.00	490.12	6,014.27	15,129.66	.0272
Thickening	6,753.27	1,462.52	236.68	2,274.78	10,727.25	.0192
Clarification	9,743.50	2,108.81	116.09	1,755.73	13,724.13	.0246
Precipitation	6,753.27	11,507.76	75.17	2,165.09	20,501.29	.0367
Re-agents	.....	86,190.90	.....	.....	86,190.90	.1544
Filtration	14,877.19	4,740.92	642.41	3,583.16	23,843.68	.0427
Refining and assaying	15,295.23	7,016.77	257.60	506.44	23,076.04	.0413
Heating	.....	14,725.11	32.10	.....	14,757.21	.0264
Tailings disposal	4,794.71	4,480.61	2,834.60	2,535.95	14,645.87	.0262
Mill alterations	.....	349.70	378.45	.....	728.15	.0013
Total	$117,649.75	$220,590.45	$8,205.56	$72,673.36	$419,119.12	$0.7510

Additions to Plant Buildings and Equipment

The following table shows the cost of additions to plant buildings and equipment during the year:—

Dwellings	$4,502.44
Underground equipment	26,366.10
Miscellaneous	858.22
Expenditure to date on new flotation and cyanidation plant, warehouse, shops, office and change-house, steam-heating plant, etc. (construction incomplete)	1,245,788.38
	$1,277,515.14
Less: Equipment and buildings sold or demolished	3,870.13
	$1,273,645.01

General

The satisfactory development programme carried out during the year resulted in a substantial addition to ore reserves and left them in such relationship to our mill requirements that development work on the lower levels was somewhat restricted pending the completion and operation of the new mill.

Several years ago we were seized with the idea that flotation might be economically applied to our metallurgical practice. Experimental work was undertaken on a small scale and the results thus obtained encouraged us to enlarge the effort. As a consequence, a 200-ton flotation unit was added to the old mill and investigation continued on a commercial scale. Having satisfactorily confirmed the original results, and fully convinced that the old mill could not be maintained for the life of the mine, the following recommendations were made:—

1. That the benefits of the improved metallurgical practice should be utilized with the least possible delay, and the mill capacity increased from 1,500 to 2,000 tons per day.
2. That the old plant, located at three different points on the property distant each from the other from one-quarter to one-half of a mile, should be centralized and modernized at one point, and logically in the vicinity of the new or No. 11 shaft.

These recommendations were approved in June last year. On July 5 the detailed plans were under way, and on August 1 the first ground was broken for the new mill. Favoured by extraordinary mild weather, the mill, shops, and store-house were closed in and the foundation and steel superstructure on the change-house and office were completed before the winter season interfered seriously with outside operations.

Since then the shops and store-house, as well as a new pump station, have been completed and modernly equipped. The mill has progressed to the stage where it will be operating to the extent of 1,500 tons per day by June 1 and gradually brought up to 2,000 tons within the following sixty days.

March Gold, Limited

This company owns and operates five claims in Deloro township, district of Cochrane. The officers and directors of the company are as follows: Henry Kobler, Buffalo, president; B. C. Conderman, Hornell, vice-president; Edward G. Kinkel, Buffalo, secretary; F. J. C. Bull, Buffalo, treasurer; Geo. R. Feine, Chas. J. Schmidt, Henry Tiedt, Gustave Loesch, Jacob Schwingel, all of Buffalo, directors. Martin O. Knutson, South Porcupine, is mine manager.

The mine produced throughout the year, resulting in an increase over the previous year by the sum of $49,957.49. The recovery per ton increased by about 29 cents. The following is a statement of production:—

Dry tons milled	53,953	
Crude ounces recovered	20,815.09	
Fine ounces gold recovered	14,794.244	
Value of gold		$305,823
Fine ounces of silver recovered	1,172.92	
Value of silver		438
Total value of production		$306,261

Development during the year was as follows: drifting, 1,110 feet; cross-cutting, 434 feet; diamond-drilling, 1,820 feet.

The average number of men employed throughout the year was 85. The underground work was in charge of Tom Lark.

Moss Mines, Limited

This company operates a gold property in Moss township, district of Thunder Bay. It is situated on Jackfish lake, 26 miles from Kashabowie, a station on the Canadian National railway 80 miles west of Fort William.

The officers and directors are: N. R. Fisher, president; Alistair Fraser, vice-president; James Cooper, secretary-treasurer; R. Blackburn, C. S. Gzowski, T. B. Little, J. D. Paterson, and F. M. Ross, directors.

The authorized capital is 4,000,000 shares of $1 par value. The executive offices are at 132 St. James Street West, Montreal.

Underground work was suspended at the end of 1929, and only pumping and surface work continued during 1930. J. G. Harkness was mine superintendent.

Parkhill Gold Mines, Limited

This company was incorporated in 1929 with an authorized capital of 3,000,000 shares of $1 par value. The officers and directors are: Sir Thomas Tait, president; F. D. Burpee, vice-president; Geo. M. McKee and Geo. Glendenning, directors; G. S. Andrews, secretary-treasurer. The head office is at Sault Ste. Marie and the executive office at 212 Keefer Building, Montreal.

During 1929 this company acquired the Longbottom property, consisting of five claims in township 29, range 23, in the Michipicoten area, district of Algoma, and did considerable surface work.

On March 28, 1930, work was commenced on the installation of a mining plant, and shaft-sinking was started on May 1. During 1930, this shaft, which measured 7 by 9 feet, was sunk to a depth of 262 feet at an inclination of 40 degrees. Levels were opened up at 120 feet and 240 feet, on the incline.

Development footages for 1930 on these two levels were as follows:—

Level	Drifting	Crosscutting
	feet	feet
120-foot	769	63
240-foot	911	560

The mining plant installed consists of two 320-cubic-foot Ingersoll-Rand electric belt-driven compressors, an IR single-drum air hoist, an IR drill sharpener, oil furnace, and power-driven grinding wheel.

Electric power is obtained from the High Falls plant of the New Algoma District Power Company.

The average number of employees during 1930 was 36, of whom 16 were employed underground.

E. S. Turner is general manager, and J. A. S. Roussac, engineer-manager.

Porcupine United Gold Mines, Limited

This company worked continuously throughout the year milling a total of 7,815 tons and producing $56,892. The grade averaged about $7.28 per ton. Some 2,310 feet of surface diamond-drilling was done early in the year, and 40 feet of drifting underground. An average of 24 men was employed on the property during the year. J. D. Tolman is in charge of operations.

Bernard N. Hyman is president of the company, with offices at 330 Walbridge Building, Buffalo, N.Y. The mine office is at Timmins, Ont.

Power and Mines Corporation, Limited

Operations at the Grace mine, in the Michipicoten area, district of Algoma, were suspended in the spring of 1930, as reported in the Thirty-ninth Annual Report of this Department, and were not resumed during 1930.

Sylvanite Gold Mines, Limited

Sylvanite Gold Mines, Limited, has an authorized capital of 3,300,000 shares of $1 par value. The officers and directors of the company are: Edward

L. Koons, president; William L. Marcy, vice-president; Clark L. Ingham, treasurer; Welles V. Moot, managing director; Alfred H. Sharpe and Harry Yates, directors. W. S. Walton is secretary, with offices at 603 Royal Bank Building, Toronto. C. E. Rodgers is general manager, with a working force of 220 men. The property is situated in the township of Teck, district of Timiskaming.

The general manager's report for the fiscal year ending March 31, 1931, is as follows:—

Production

The value of bullion produced was $837,013.97, showing an average recovery per ton milled of $10.08. The tonnage treated amounted to 83,034, or at the rate of 227.4 tons per day on the actual 95.7 per cent. running time, and 237.6 tons per day as the daily rate on the basis of 100 per cent. operation. This represents an increase of 7,626 tons above that treated the previous year, and 12,201 tons greater than for the year ending March 31, 1929. Comparative results are given below for the past three years' production:—

TONS MILLED AND YEARLY PRODUCTION FOR FISCAL YEARS ENDING MARCH 31

Year	Tons	Production	Average recovery
1929	70,833	$737,573.12	$10.41
1930	75,408	690,400.14	9.16
1931	83,034	837,013.97	10.08

Mining

Some 59,734 tons of ore came from stopes and 33,046 resulted from development, the total broken being 92,780 tons. Waste broken was 25,884 tons; of this, 5,318 tons were hoisted to surface through No. 2 shaft and 6,766 tons were used for back-fill in that area. The remaining 13,800 tons were delivered to the surface through No. 4 shaft. The greatest tonnage of ore broken in one month was 8,969, while 3,824 tons represented the highest amount of waste for a corresponding period. Total ore and waste broken for the year amounted to 118,664 tons.

At the end of the year broken ore was estimated at 67,722 tons in stopes and 6,528 tons still on the surface dump, or a total of 74,250 tons. Compared with the two preceding years in their order, this shows an increase of 21.3 and 57.1 per cent.

Development and Exploration

Below is given a general summary of development and exploration footages showing annual mining progress during this and the previous year and also progress since the beginning of operations:—

Class of work	Year ending March 31, 1931	Year ending March 31, 1930	Total from beginning of operations to March 31, 1931
	feet	feet	feet
Drifting	5,911.5	4,121	24,099.5
Crosscutting	2,506.5	1,951	13,951.5
Raising	1,232.5	488	5,211.5
Sublevel drifting	325.5	711	2,474.5
Box-hole raising	702.5	1,228	3,521.5
Box-hole pillar drifting	591.5	827	1,733.5
Shaft-sinking	586	1,480	4,346.5
Total	11,856	10,806	55,338.5
Diamond-drilling	5,910 cu. ft.	13,998 cu. ft.	37,742 cu. ft.
Shaft stations and sump excavations	22,768	24,534	142,909

No. 2 shaft was deepened from 2,030.5 feet to 2,334.5 feet, and sinking is being continued with a probable temporary objective of 3,000 feet.

Aside from work in the more intensively explored and known productive areas in this part of the mine, which produced 61.2 per cent. of the ore treated during the year, several hundred feet of drifting was done on the main south vein at the 1,100-foot horizon. There a considerable tonnage of an indicated grade of about $6 across 8 to 10 feet was developed west and east of a fault displacing the vein about 120 feet to the south on the east side.

Another section partially explored during the year was that on the 400-foot level at about 600 feet north of the shaft. Two veins were indicated; one at least (as shown by diamond-drilling) extends east of the Sylvanite major fault. In addition to drifting, a limited amount of stoping and diamond-drilling was done. Work thus completed gave fair promise for the development of easterly extensions of known ore bodies of importance to the west, and exploration is being continued. During the year a substantial tonnage of the richest ore yet found in the property was mined from this north vein system below the 1,000-foot level.

Sinking at No. 4 shaft was continued from 1,480 feet to 1,762 feet, or for 282 feet. In addition, station and sump excavations were made here to the extent of 13,915 cubic feet.

In this area lateral work was done on eleven levels from 200 to 1,750 feet. Some stoping was also done, and stope preparation was carried on at a number of levels. As a whole, highly satisfactory results were obtained, 38.8 per cent. of the mill feed for the year having been supplied from this section. Ore bodies of good size were developed and substantial additions to these are confidently expected.

Diamond-Drilling.—Work of this nature was decidedly helpful in directing exploration and contributed very materially in developing important sources of ore. The average depth of the holes drilled was 144 feet, and total footage amounted to 5,910 feet. This represents but 35 per cent. of the work of this class done the previous year.

Operating Costs

The following three-year comparison gives operating costs on the basis of per ton of ore milled, per ton of ore broken, and per ton of total ore and waste broken:—

	Total cost			Cost per ton								
				Ore milled			Ore broken			Total ore and waste		
	1929	1930	1931	1929	1930	1931	1929	1930	1931	1929	1930	1931
Development and exploration	$170,695.21	$206,426.48	$212,792.08	$2.410	$2.738	$2.563	$1.896	$2.412	$2.293	$1.604	$1.789	$1.793
Mining	234,177.27	236,501.18	267,376.14	3.306	3.136	3.220	2.601	2.763	2.882	2.199	2.049	2.253
Milling	94,025.89	100,570.17	106,575.54	1.327	1.334	1.283	1.044	1.175	1.149	.883	.872	.898
General charges	74,584.91	50,176.06	34,187.94	1.053	.665	.412	.828	.586	.368	.701	.435	.288
Administrative charges[1]		19,756.45	21,213.75		.262	.255		.231	.229		.171	.179
Total	$573,483.28	$613,430.34	$642,145.45	$8.096	$8.135	$7.733	$6.369	$7.167	$6.921	$5.387	$5.316	$5.411

[1]Comprises administration and management, including Buffalo office, legal, stock transfer, and miscellaneous.

Considering all conditions, including the fact that 12,000 feet of development and exploration was done during the year, exclusive of shaft-station excavations and diamond-drilling, the resulting profit of $134,000 after deducting all charges was very satisfactory, particularly in view of the proportion of ore treated to total volume of work done.

New Buildings and Equipment

A suitable and attractive residence for the mine superintendent was purchased. An addition was also made to the mine change-house to provide the increased space required.

Equipment purchased included: one vibrating screen for the crusher station; additional pumping, thickening, agitating, and precipitation equipment for the mill; fuel oil storage suitable for railway tank-car quantities; an automobile truck for mine service; a new drill steel-sharpening machine, mine pumps, etc.

Summary

During the year 5,911 feet of drifting was completed. Of that amount approximately 3,000 feet was in ore. This shows a high percentage of ore developed and indicated in proportion to the exploration carried on in this manner.

A large part of your mining operations were conducted in No. 4 shaft section, and results obtained there were highly encouraging. Broken ore reserves were also increased considerably, notwithstanding the fact of a very material increase in tonnage milled.

The year's work developed important sources of ore. Some were entirely new; others were the further development of known deposits. In addition, there are extensive areas, even on and above the 1,000-foot level, where excellent possibilities exist for the discovery of more ore. Finally, shaft-sinking now in progress will permit exploration of several new levels, regarding which sufficient exact information is not now available from which to forecast results. However, the ground has been shown by diamond-drilling to contain vein indications in geologically favourable formation. It therefore seems reasonable to expect that the development of ore should be largely a question of future time and intensive work.

Tashota Gold Mines, Limited

The authorized capital of this company was increased during 1929 from 2,000,000 shares to 4,000,000 shares of $1 par value.

The officers of the company are as follows: H. H. Vaughan, president; F. C. Shorey, vice-president; P. W. Ogden, secretary-treasurer. The directors are: Thos. Arnold, R. M. Davy, J. Bonsall Porter, F. C. Shorey, and H. H. Vaughan, Montreal; E. R. Read and L. Soliaque, Toronto.

The property held by the Tashota Gold Mines, Limited, consists of 8 claims in the Tashota area, district of Thunder Bay, and 21 claims in the Boston Creek area, McElroy township, district of Timiskaming.

Work at the mine in the Tashota area was stopped on March 4, 1930, to which time the following work had been done on the property: drifting, 800 feet; crosscutting, 700 feet; sinking, 230 feet; diamond-drilling, 5,000 feet.

Teck-Hughes Gold Mines, Limited

Teck-Hughes Gold Mines, Limited, has an issued capital of 4,467,144 shares of $1 par value. The officers and directors of the company are: Albert W. Johnston, president; George C. Miller, vice-president and secretary; W. C. Himrod, treasurer; K. P. Emmons, assistant treasurer; Robert W. Pomeroy, J. F. Thompson, Conrad E. Wettlaufer, W. W. Reilley, and John F. Lash, directors. D. L. H. Forbes is general manager, and 600 men are employed. The head office is at 111 Broadway, New York.

The addition to the mill was completed and operations were started on March 18, 1931, increasing the tonnage from 1,000 to 1,250 a day. Preparations are being made to sink two winzes below the 3,600-foot level, one on the footwall of the ore body and the large vertical winze about 50 feet north of the south shaft.

The report of the general manager for the fiscal year ending August 28, 1930, is as follows:—

During this period 340,675 tons of ore and tailings were treated. Bullion amounting to $5,415,970.47, or $15.90 per ton, was recovered. The value of this bullion is the equivalent of 261,997.63 fine ounces of gold. The gross revenue was $5,512,033.78, or $16.18 per ton. The total direct operating cost was $1,970,336.06, or $5.78 per ton. Depreciation on buildings and plant amounting to $215,383.92 was charged, making the total of direct and indirect charges come to $2,185,719.98, or $6.41 per ton. After making a provision of $274,427.52, equal to $0.81 per ton, for taxes, the surplus was $3,051,886.28, out of which dividends amounting to $2,870,786.40 were paid. The following is a statement of operating costs:—

	Total cost	Cost per ton of ore treated	Cost per ounce of gold produced
Development and exploration	$486,805.46	$1.43	$1.858
Mining	857,106.02	2.52	3.271
Milling	423,024.10	1.24	1.615
General expense	203,400.48	.59	.776
Total direct charges	$1,970,336.06	$5.78	$7.520
Depreciation	215,383.92	.63	.822
Total direct and indirect charges	$2,185,719.98	$6.41	$8.342

From the above, it will be noted that the total cost of producing an ounce of gold was reduced from $9.21 in the previous fiscal year, to $8.34, notwithstanding the larger amount expended for development and exploration. This is probably the lowest gold production cost in the world at the present time and reflects credit upon the entire personnel.

New construction work charged to capital account absorbed $47,371.49, nearly all of which was expended on a programme of plant enlargement that should result in increased earnings before the end of 1930 and in a treatment capacity of 1,250 tons per day by May, 1931.

Central shaft workings were deepened to the 29th level by means of the Central shaft extension winze that was sunk from the 25th level and is being continued to the 30th level. Levels intermediate between the 25th and 30th will soon be opened up from the stations that have already been made in the course of sinking this winze.

South shaft was deepened 2,084 feet, reaching a depth of 3,506 feet at the end of August. The main haulageway crosscut between South shaft and Central shaft workings at the 25th level was completed in May. The 25th level station and skip loading pocket for South shaft, together with the system of ore passes, from the 25th to the 19th levels, were almost completed by the end of August and will be finished before the end of October.

The above work constituted the major development work of the year but, in addition to it, numerous lateral extensions and raise connections were made on the working levels. Classified under the usual headings, the year's development work was as follows:—

	Feet
Drifting	6,902.4
Crosscutting and stations	2,381.8
Raising	3,153
Winzing	559.6
Shaft-sinking	2,130.6
Total	15,127.4

Diamond-drill exploration amounted to 8,891.7 feet. Ore produced from development amounted to 37,767 tons. Impounded tailing to the amount of 6,735 tons was retreated during the first quarter of the fiscal year.

The old mill treated 96,925 tons of $9.28 average grade ore and tailings and recovered $810,560.76, or an average of $8.36 per ton. The new mill treated 243,750 tons of $19.97 average grade ore and recovered $4,605,409.71, or an average of $18.89 per ton. Milling costs were $1.20 per ton for the old mill and $1.26 for the new.

Provision is made in the present programme of mill additions for another step in fine grinding for the ore that will be delivered from the South shaft crushing plant to the old mill, and it is expected that, with this extra grinding of the ore, the old mill recovery percentage will be raised to correspond with that of the new mill without any noticeable increase in the per ton milling cost on the combined tonnage of both mills.

Development on the 20th and 21st levels continued to give excellent results, and, from diamond-drilling and the small amount of lateral work done on the 22nd, 23rd, 24th, and 25th levels, numerous indications of possible new ore and substantial increases to partly developed ore were obtained.

As the mine was already well supplied with reserves of broken and blocked ore, no effort was made to break or block out more than sufficient to replace the tonnage treated. After November 1, when the present part of the programme of mine-deepening operations will have been completed, more extensive lateral development and blocking out work will be undertaken in the section of the mine tapped by the nine new levels from the 21st to the 30th. Our technical estimate of the positive ore reserve at September 1 is as follows:—

Estimate of Positive Ore as at September 1, 1930

	Tons	Gross value	Average grade
Broken ore	260,912	$4,540,585	$17.40
Blocked ore	315,377	5,503,424	17.45
Total	576,289	$10,044,009	$17.43

Telluride Gold Mines of Canada, Limited

Telluride Gold Mines of Canada, Limited, owns the south half of lots 10 and 11, concession II, Skead township, district of Timiskaming. The company has a capital of 2,000,000 shares of $1 par value. The officers and directors are:

D. M. Gilpin, president; L. L. Brennan, secretary; D. B. Gilpin and Dr. Geo. W. Rogers, directors. H. Hollands-Hurst is consulting engineer. An average of 20 men was employed.

A small amount of work was done in the last six months of the year. A total of 500 tons of ore was raised and milled.

United Mineral Lands Corporation

The mine in Deloro township, district of Cochrane, was kept pumped out for part of the year. This work was stopped during negotiations for financing the company. Final arrangements were not completed till 1931, when an amalgamation of the United Mineral Lands Corporation and West Dome Lake Gold Mines, Limited, was effected, under the new name of Paymaster Consolidated Mines, Limited.

Vipond Consolidated Mines, Limited

The authorized capital of this company is $2,500,000, divided into shares of $1 par value, of which 2,250,000 are issued.

The officers of the company are: R. Home Smith, president; John H. Black, vice-president; J. Ingram, secretary. The directors are: John H. Black, R. Home Smith, A. Dorfman, Toronto; W. H. Stafford, Almonte, Ont.; R. T. Shillington, Haileybury, Ont.; F. H. Hamilton, E. Turk, London, Eng. Robert E. Dye is manager.

The head office of the company is located at Suite 1206, Star Building, 80 King Street West, Toronto. The mine office is at Timmins.

The company owns 320 acres in mining claims and controls 889,612 shares of the 1,150,000 issued in the Inspiration property (3 claims), both this and the Vipond holdings proper lying in the southwest portion of the township of Tisdale, district of Cochrane. Together with these, the Vipond company has a three-quarter interest in the Ridgeley claims (6 in number), lying immediately east of the Coniaurum.

The following summary of company operations is taken from the report of the directors in the eighth annual report for the year ending July 31, 1930:—

Your mine and mill were in continuous operation during the year and produced bullion to the value of $896,397.61, representing a recovery of $7.91 per ton from 113,329 tons milled The cost of production amounted to $543,797.44, or $4.80 per ton milled, as against $5.15 per ton in the previous year.

The operating profit for the year under review (before allowing for depreciation and writing off other charges) amounted to $385,974.35, as against $300,544.14 during the previous year.

The net current assets of your company, not including the subscription of $250,000 to Huronian Mining and Finance Company, Limited, amounted to $723,734.09, as against $641,222.02 in the previous year.

Other assets owned by your company, including 300,000 shares of Huronian Mining and Finance Company, Limited, are a three-quarter interest in the six Ridgeley claims, which adjoin the Coniaurum mine, and 889,612 shares of Inspiration Gold Mines, Limited, out of a total issued capital of 1,150,000 shares.

The following extracts are from the report of the manager, Robert E. Dye, as of September 30, 1930:—

Results of Development

Results of exploration and development work done during the year just ended have been generally favourable, having resulted in a net improvement in the ore reserves position after allowing for the ore extracted during the year. The improvement mentioned has resulted in the main from further development of known lenses, notable contributions toward this having been secured in the old 5-8 system, the No. 709 drift area, and the No. 426 drift area.

The ore body discovered late last year in the northern part of the property at the 400-foot level (No. 426 drift) has since been proved to extend to the 500-foot level, and a search for a further downward extension is now being made at the 600-foot level and at the 733-foot level.

In addition to the ore found in No. 426 drift, other smaller lenses have been found at the same horizon (Nos. 427 and 409), which lead to the belief that further work along the shear zone crossing this section of the property may result in other productive discoveries.

The No. 810 crosscut at the 866-foot level has reached the porphyry contact on the Krist claim. While no ore has been located in this section, indications are not discouraging and the area is considered worthy of further exploration.

Summary of Underground Operations

During the fiscal year ended July 31, 1930, the following development work was done:—

Operation	Feet	Total cost	Cost per foot
Drifting and crosscutting	5,655	$62,049.49	$10.97
Raising	582.5	9,366.10	16.07
Diamond-drilling, underground	11,119	17,763.83	1.60

Some 113,281 tons of ore were hoisted, of which 106,029 tons were taken from the stopes, the remainder resulting from various development operations. The cost of ore delivered to the primary crushing plant averaged $2 per ton.

The Mill

The mill operated continuously during the year, and the following data will indicate the results obtained:—

Tons milled	113,329
Average value per ton	$8.71
Gross value	987,095.59
Bullion recovered	896,397.61
Average running time per cent.	97.02

PRODUCTION

From bullion produced during the year	$896,397.61
From bullion produced during former years	4,485,330.68
Total	$5,381,728.29

The above figures do not include bullion produced by the Porcupine Crown (approximately $2,871,816) before this property was acquired by the company.

COST OF PRODUCTION

	Total cost	Cost per ton
Development	$89,179.42	$0.79
Ore extraction	226,818.00	2.00
Crushing, conveying, milling, and refining	135,440.96	1.19
Shipping and marketing bullion	6,395.76	.06
General camp maintenance	10,887.69	.10
Administration at mine	20,318.14	.18
Toronto office expense	12,909.00	.11
Corporate expense	13,500.45	.12
Taxes	8,606.29	.08
Insurance, including compensation	19,741.73	.17
Total	$543,797.44	$4.80

Ore Reserves

Ore reserves as at July 31, 1930, were estimated to be 163,525 tons at $8.23, or $1,346,000. This represents an increase in quantity of about 36,000 tons and an increase in gross value of approximately $300,000 over the corresponding figures of the previous year, which were 127,500 tons at $8.16, or $1,040,000. This increase in reserves was effected after allowing for the ore extracted during the year just ended.

Conclusions

Operations at the mine went forward steadily during the past year, and the results attained reflect an improvement in the physical condition of the property. The supply of ore is such as to allow a vigorous campaign of development and exploration while continuing to operate at a profit.

West Dome Lake Gold Mines, Limited

Pumping operations only were carried on during the first five months of 1930 at this company's property in the township of Tisdale, district of Cochrane. All work was then suspended, pending the completion of negotiations for amalgamating with the United Mineral Lands Corporation. The arrangements, completed in 1931, resulted in a new company known as Paymaster Consolidated Mines, Limited.

Wright-Hargreaves Mines, Limited

Wright-Hargreaves Mines, Limited, has an authorized capital of 5,500,000 shares of no par value. The officers and directors are: Oliver Cabana, Jr., president; W. H. Wright, vice-president; Gerald F. Miller, treasurer; Edwin Lang Miller, secretary and managing director; James Y. Murdoch, Oliver G. Donaldson, directors.

M. W. Summerhayes is general manager, and 409 men are employed. The report of the general manager for the year 1930 is as follows:—

During this period 220,430 tons of ore were treated in the mill, producing bullion to the value of $2,431,896.87. This is a recovery of $11.03 per ton milled.

ANALYSIS OF OPERATING COSTS

	Total	Cost per Ton milled
Development and exploration	$451,368.61	$2.047
Stoping	424,524.31	1.926
Total	$875,892.92	$3.973
Less: Excess of tons developed to tons milled	215,120.00	.975
	$660,772.92	$2.998
Transporting ore (hoisting, etc.)	225,596.83	1.023
Milling charges	243,684.79	1.105
Marketing bullion	16,911.26	.077
New road construction and general surface	6,580.16	.030
Stock transfer and registrar charges	4,795.97	.022
General and undistributed charges (storehouse, mainten. misc., mine buildings, administration and management, property taxes, insurance, interest and exchange, legal expenses, miscellaneous)	104,692.35	.474
Depreciation plant and equipment	51,378.82	.233
Total	$1,314,413.10	$5.962

SUMMARY OF DEVELOPMENT AND EXPLORATION
December 31, 1930

	Drifting	Shaft-sinking	Cross-cutting	Raising	Diamond-drilling
	feet	feet	feet	feet	feet
December 31, 1929	61,459.25	4,705	12,300.9	942	38,062.5
Fiscal year	17,837.5	321	6,446.2	2,122	10,884
December 31, 1930	79,296.75	5,026	18,747.1	3,064	48,946.5

PRODUCTION RECORD, 1921–1930

Year	Tons milled	Value per ton	Gross value	Recovery per ton	Bullion produced
1921 (8 months)	36,081	$13.96	$503,302	$13.00	$468,665
1922	66,181	12.49	827,447	11.52	762,752
1923	79,242	10.48	830,992	9.52	754,978
1924	84,487	14.16	1,194,217	12.89	1,088,725
1925	147,939	14.49	2,148,554	12.93	1,913,401
1926	153,392	15.66	2,400,795	14.02	2,150,844
1927	209,164	11.77	2,455,460	10.51	2,151,916
1928	256,331	8.36	2,144,002	7.20	1,845,923
1929	188,238	10.29	1,938,552	9.25	1,741,872
1930	220,430	12.20	2,687,828	11.03	2,431,896
Total	1,441,485	$11.85	$17,131,149	$10.62	$15,310,972

MILLING STATISTICS
January 1 to December 31, 1930

Ore milled	tons	220,430
Average value per ton		$12.20
Gross value	$2,687,828	
Loss in tailings	254,511	
Net recovery (mine assays)		$2,433,317
Average tons per day milled		602.4
Per cent. possible running time		86
Tons 100 per cent. running time		700
Solution precipitated	tons	459,124
Solution precipitated per ton of ore	tons	2.8
Value per ton in tailings		$1.15
Cyanide consumed per ton of ore	lbs.	0.659
Zinc consumed per ton of ore	ounces	1.309
Zinc consumed per ton of solution	ounces	.626
Lime consumed per ton of ore	lbs.	3.633
Average value of pregnant solution		$5.038
Average h.p. consumed per day		1,229
Average h.p. consumed per ton of ore		2.03

ORE RESERVES ESTIMATE

	Tons	Grade	Value
On hand January 1, 1930	418,877	$11.30	$4,727,551
Developed in 1930	421,158	12.57	5,294,881
	840,035	$11.93	$10,022,432
Milled in 1930	220,430	12.20	2,687,828
Ore reserves December 31, 1930	619,605	$11.83	$7,334,604

CAPITAL EXPENDITURES

Mine (new equipment)	$28,468.92
Electrical (shop and equipment, transformer)	14,615.95
Machine shops	11,051.88
Mill (new equipment)	97,691.79
Power-house (compressor and equipment)	17,060.50
Surface (equipment)	3,099.40
Office (drafting room and equipment)	1,812.10
Assay office	677.18
Five new houses	22,094.28
Total	$196,572.00

Developments during the year were most satisfactory. Some 421,000 tons of ore were developed, having an average grade of $12.50 per ton. After deducting 220,430 tons milled, over 200,000 tons were left to be added to our ore reserves. Of the 17,837 feet of drifting done in the twelve months, 8,429 feet were on ore.

The most important feature of this year's development work was the remarkable persistence of the ore shoots on the 2,250-foot level, where 2,141 feet of ore were opened up. On the 1,875- and 2,125-foot levels, over 1,100 feet of ore were opened on each level. The balance of the ore found was well distributed in the upper workings, from the 200-foot level down. On the two lower levels there was a considerable improvement in the South vein ore bodies, the values being higher and more consistent.

The better grade of ore mined has been largely due to our being able to control the dilution from the walls of the ore bodies, as well as to the more intensive sampling and supervision given in the stopes.

In the upper levels, where there is no available fill, we have found the open stull stoping the most satisfactory. On the lower levels, however, both "horizontal" and "rill" cut-and-fill stopes are giving excellent results.

The No. 3 shaft was extended from the 2,100- to the 2,400-foot level. This was done by raising 150 feet, then sinking 171 feet. Only a small amount of development has been done on the new 2,400-foot level, enough, however, to prove up the continuity of both the North and South vein systems.

The programme of development laid out for the coming year is to sink the No. 3 shaft to the 3,000-foot level, then the opening up of four new levels, together with the continued work on the 2,400-foot level. We anticipate no difficulty in being able to maintain the present grade and tonnage during the current year.

In the mill, the new equipment planned for in the beginning of the year was finally installed and finished late in October; since that time the extraction has been very much improved and we believe is in line with the most up-to-date metallurgy in the district. Further research is being carried on with the expectation that a still better extraction may be obtained.

GRAPHITE

Black Donald Graphite Company, Limited

Throughout the eighteen months ending June 30, 1931, mine working continued in the lower levels of the inclined shaft, with a continuous recovery of high-grade ore. The ore procured from this incline shaft enabled the mill to produce 2,416 tons of finished graphite.

The officers of the company are: R. F. Bunting, manager; R. A. Telfer, secretary; J. D. Patno, superintendent.

GYPSUM

Gypsum, Lime and Alabastine, Canada, Limited

The Gypsum, Lime and Alabastine, Canada, Limited, operated the mines and mills at Caledonia, Seneca township, and Lythmore, Oneida township, Haldimand county, during the entire year. L. V. Robinson is general superintendent. The head office is at Paris, Ont.

At Caledonia, new equipment was installed for the manufacture of Zonolite-Acoustic Plaster. Mechanical-loading and air-drilling systems were installed in the mine.

From 88,612 tons of rock hoisted, 80,495 tons of plaster were produced. The material was taken from the southwest section of the mine. J. D. Kerr was superintendent, employing an average of 221 men.

At Lythmore the three-entry room and pillar system was started. There were mined from the southwest section of the property 16,177 tons of rock, from which 14,115 tons of plaster were made. Joseph Mark was superintendent, employing an average of 37 men.

In addition to the Caledonia and Lythmore mines, the company operates gypsum plants at Montreal, Winnipeg, Vancouver, and Calgary.

Lime plants are situated at Beachville, Elora, Hespeler, Milton, Limehouse, and Puslinch, Ont., and at St. Mark and Joliette, Que.

Quarries are operated at Mabou, N.S., Gypsumville, Man., and Salmon River, B.C. The alabastine plant is at Paris, Ont.

LEAD

Kingdon Mining, Smelting and Manufacturing Company, Limited

This company operated its lead mine and smelter near Galetta, in Fitzroy township, Carleton county, throughout 1930. Development work during the year is reported as follows: 103 feet of drifting on the 1,275-foot level; 2,406 feet of drifting on the 1,400-foot level. A total of 53,000 tons of ore, obtained from stopes on the 1,275-foot and 1,400-foot levels, was hoisted during 1930.

At the smelter the scotch hearth was in operation all year, but the blast furnace was not in use.

An average of 90 men was employed, distributed as follows: underground, 70; mill, 10; smelter, 5; and surface, 5. R. R. Rose is mine superintendent, and J. U. MacEwan is smelter superintendent.

LEAD AND ZINC

Lake Geneva Mining Company, Limited

This company ceased operations at its property in Hess township, district of Sudbury, after moving in plant and mill machinery during the winter of 1929-30.

It is understood that the part of the option agreement between this company and the original owners, whereby a 50-ton mill was to be erected, has been suspended until the lead-zinc market improves.

LIGNITE

Ontario Department of Mines

In order to check diamond-drill results at the Onakawana lignite field and to obtain large-sized samples for commercial tests, the Department of Mines sank a shaft 150 feet in depth through the lignite beds at a point 2 miles southwest of the point where the seam outcrops on the Abitibi river. This is at diamond-drill hole No. 29. Full particulars of the diamond-drill results are published in the Ontario Department of Mines Report, Volume XXXIX, Part 6.

Drifts were run north and south on the upper and lower seams, and at the end of June, 1931, these drifts had been extended about 100 feet in each direction.

A carload of lignite from the upper seam was sent to Ottawa for test, and it is the intention to send about 120 tons to Germany for beneficiation tests.

The equipment consists of two 20 h.p. upright boilers, fired with lignite, a 300-cubic-foot gas-driven compressor, and a 6- by 8-inch hoist.

The work is under the supervision of W. F. Fancy. About 30 men are employed.

NICKEL AND COPPER

Falconbridge Nickel Mines, Limited

The officers and directors of this company are: Thayer Lindsley, president; Halstead Lindsley and J. Gordon Hardy, vice-presidents; N. F. Parkinson, secretary-treasurer; W. S. Morlock, director. The head office is at 100 Adelaide Street West, Toronto.

The second annual report of the company covering the period from November 1, 1929, to December 31, 1930, contains the following report of Ernest Craig, mine superintendent:—

In submitting the following report for the fiscal period ending December 31, 1930, I wish to respectfully point out that, of the fourteen months under review, the first three months, viz., November, 1929, to January, 1930, inclusive, were confined entirely to completing the mine and smelter plants preparatory to production. This result was definitely attained by the end of January, 1930, and the smelter successfully blown in on February 4, 1930.

I would further point out that, upon instructions from Mr. Hardy, production was temporarily suspended during November and December, 1930, thereby reducing the operating time covered by this report to a period of nine months.

Mine Development

Combined development footages on all levels during the period under review are distributed as follows:—

Drifting and crosscutting, including slashing	feet	3,918
Raising	feet	306
Raise slashing	feet	190
Box-holes completed		75
Station-cutting	cu. ft.	13,596
Pump chambers	cu. ft.	14,200

Of the total of 3,918 feet of drifting and crosscutting recorded, 2,200 feet was driven east and west along the ore zone, being distributed on three levels for the purpose of proving and increasing ore reserves.

During the period of smelter shut-down in November and December, opportunity was taken to cut two stations in the shaft at 500 and 740 feet, respectively, these having been passed up in the hurry to reach the 1,000-foot horizon in the original sinking.

Diamond-Drilling

The total diamond-drilling footage amounted to 8,889 feet, of which 7,252 feet was underground and 1,637 feet surface drilling.

While the surface drilling gave information as to the eastern extension of our main ore body, it was particularly spotted to delimit ore backs above the stopes and under drift covering. The underground drilling was all carried out beneath the 1,000-foot (bottom) level in an endeavour to ascertain the prospects of downward ore extensions.

The results . . . show that beneath the 1,800-foot horizon, a disturbed condition exists. This can best be investigated further when the shaft has been deepened to 1,500 feet, since the angle at which our deepest holes were drilled was not really conducive to reliable results. Nevertheless, the drilling certainly enabled us to indicate considerable reserves.

Ore Reserves

Indicated ore reserves as at October 31, 1929, were estimated at 1,367,000 tons, and during the period we have added an estimated tonnage of 984,480 tons, indicating a total to date of 2,279,453 tons after sorting. The added tonnage has been arrived at through estimates based on development above the 100-foot horizon, while below this level the tonnage is calculated entirely upon diamond-drilling results. The figures would tabulate as follows:—

		Tons sorted ore
As of October 31, 1929		1,367,000
Less: Hoisted during 1930		72,027
Balance, December 31, 1930		1,294,973
New ore 1930:		
Above 1,000 feet	314,770	
Below 1,000 feet	669,710	
Total		984,480
Total, December 31, 1930		2,279,453

Ore Grade

While the grade of our last year's ore reserve was calculated at 2.97 per cent. nickel and 0.97 per cent. copper, it will be noted that our smelter feed average for 1930 was 2.47 per cent. nickel and 1.08 per cent. copper. In view of this, and the fact that the results obtained in sampling

during the current year almost invariably check with last year's figure, we feel that we are conservative in estimating our total ore reserves on the basis of smelter feed. The reason for our preference in taking smelter figures is that the tonnage above stated is that of sorted ore; the variations in sorting being such as to render it more desirable to take actual 1930 results.

Mining

Breaking ore for production commenced January 15, 1930, a total of 148,005 tons being broken, of which 83,931 tons was hoisted, thus leaving a broken reserve of 64,074 tons. . . . This tonnage was mostly taken from above the 225-foot level. No stoping was done in November and December, 1930, owing to the smelter being down and there being an ample supply of broken ore.

Crushing and Transportation

From the 83,931 tons hoisted to the crushing plant, 11,904 tons of waste, or approximately 14 per cent. was eliminated by sorting during the various stages of crushing. The remaining 72,027 tons, of an average grade of 2.47 per cent. nickel and 1.08 per cent. copper, was delivered via the aerial tramway to the smelter bins.

Smelting

As previously intimated, the smelter was blown in on February 4, 1930. However, due to the necessary adjustments and metal absorption throughout the plant, production for this month was naturally low. During the actual productive period the smelter plant was in operation a total of 252 days, all lost time being accounted for by uncontrollable power interruptions necessitating the suspension of production. The most protracted interruption was from June 27 to July 15, inclusive, same being caused by unavoidable floods at the power company's Wanapitei plant.

Due to smelter production having so far exceeded refinery capacity in Norway as to cause an unmanageable accumulation of matte at the lattter point, the smelter was shut down on October 31, 1930, and so remained until January 1, 1931, when it was again blown in.

Including all losses of absorption and in smoothing out of operations at the start, the smelting results for the 71,626 tons of ore smelted tabulate as follows:—

	Nickel	Copper
	lbs.	lbs.
Metals per ton in the ore	49.4	21.6
Metals recovered per ton of ore	42.3	18.3
Metals in process per ton of ore	1.5	.6
Metallurgical and flue losses	5.6	2.7

Production

From the 71,626 tons of ore smelted during the year, 2,630 tons of matte was produced and shipped to the refinery in Norway. This contained 1,514.75 short tons of nickel, 655.97 short tons of copper, and an indeterminate amount of platinum metals.

Construction

Aside from completing the mine and smelter plants to their productive stages, a number of improvements and additions were effected during the year. The installation of a second converter was completed and a pan conveyer installed to handle slag. Construction work in connection with the extension to the blast furnace and converter building was started May 1, all excavations having been completed and the putting in of foundations well advanced. The extension of the charge floor was also completed in order to provide additional space to facilitate the handling of material to the furnace. These extensions to foundations cover the plans for the addition of one more blast furnace and one more converter.

In order to take advantage of the period during which operations were suspended, viz., November and December, 1930, and at the same time provide employment for the married men living on the property, a 5-foot extension was made to the present blast furnace. This work was successfully carried out in ample time to allow the resumption of operations on January 1, 1931, and place us in a position to increase production approximately 40 per cent. with a minimum of delay.

In view of the fact that housing facilities for permanent employees were very limited, the erection of ten standard 5-room cottages was authorized and completed. Three small 3-room cottages and a superintendent's residence were added later in the year.

The mine development footage for November and December, 1929, was included in the last annual report of this Department, and must be subtracted

from the footage given in the foregoing report to obtain the actual footage for the year 1930, which was as follows:—

Drifts and crosscuts, including slashing	feet	2,696
Raises	feet	237
Raise slashing	feet	190
Box-holes completed		46
Station-cutting	cu. ft.	13,596
Pump chambers	cu. ft.	14,200

An average of 294 men was employed during 1930, of whom 75 were employed underground.

Ernest Craig is superintendent; J. R. Gill, smelter superintendent; and R. Oliver, mine engineer.

International Nickel Company of Canada, Limited

The officers of this company are: Charles Hayden, chairman of the board; Robert C. Stanley, president; John L. Agnew, vice-president; John F. Thompson, assistant to the president; James L. Ashley, secretary and treasurer; Paul D. Merica, technical assistant to president.

The directors whose term expires in 1931 are: John L. Agnew, Copper Cliff; J. W. McConnell, Montreal, Que.; Britton Osler, Toronto; J. A. Richardson, Winnipeg, Man.; Rt. Hon. Lord Weir, Glasgow, Scotland; James L. Ashley, John F. Dulles, Charles Hayden, Robert C. Stanley, and Andrew V. Stout, New York; Wm. T. Graham, Greenwich, Conn.; Reg. Halladay, Cresskill, N.J.

The directors whose term expires in 1932 are: E. W. Beatty, Montreal, Que.; John P. Bickell, Toronto; Wm. E. Cory and Wm. N. Cromwell, New York; D. Owen Evans, Sir Harry McGowan, Rt. Hon. Lord Melchett, and Robert L. Mond, London, England; Wm. J. Hutchinson and Seward Prosser, Englewood, N.J.; Wm. W. Mein, San Francisco, Cal.; Thomas Morrison and Grant B. Shipley, Pittsburg, Pa.

The International Nickel Company of Canada and subsidiary companies operate hydro-electric power plants at High Falls, Big Eddy, Wabageshik and Nairn Falls, Ont.; nickel-copper mines in Sudbury district, Ont.; smelters at Copper Cliff and Coniston, Ont.; refineries at Port Colborne, Ont., Acton, London, England, and Clydach, Wales; rolling mills at Birmingham, England, and Huntingdon, W. Va.; a colliery at Pontardawe, Wales; and a foundry at Bayonne, N.J. The general offices are at Copper Cliff, Ont.

The following information is extracted from the annual report of the company covering the calendar and fiscal year ending December 31, 1930:—

This report covers a period of industrial depression, world-wide in extent, which severely affected your company's business in 1930 in common with that of other basic industries; consequently net earnings were substantially less than reported for 1929.

The company, however, made considerable progress during 1930 in that the Frood mine development programme was practically completed; advantage was taken of the recession in demand for nickel to replace depleted stocks; and the sales, research, and development activities were intensified. Therefore, at this time your company is in an excellent position to take advantage of the expected improvement in general business and the consequent upturn in demand for nickel.

The sales of nickel in all forms, including alloys, amounted to 75,284,352 pounds, as compared with 125,577,789 pounds in 1929. The world's consumption of nickel in all forms reached a total of 88,000,000 pounds, as compared with 136,000,000 pounds in 1929 and 117,000,000 pounds in 1928.

Copper sales, inclusive of copper in sulphate, increased from 81,833,776 pounds in 1929 to 109,743,747 pounds in 1930, an increase of 34 per cent. However, due to the decline in the price of copper from 18 cents to 9½ cents, the profit was greatly decreased.

The output of platinum metals from the Acton refinery, which treats all the company's by-product platinum metals, totalled 71,260 ounces in 1930 as compared with 30,513 ounces in 1929, an increase of 133 per cent. Platinum metals and silver, both important by-products from the company's electrolytic refining operations, sold at abnormally low prices during the year.

A net profit of $11,770,060.42 was made in 1930, compared with a net profit of $22,235,996.87 for 1929. Net current assets were $30,102,999.73 at December 31, 1930, as compared with $32,231,839.02 at December 31, 1929.

Capital expenditures incident to the development of the Frood mine and construction of accessory plants are practically completed, and the same may be said of the programme of additions and betterments in Great Britain. Total capital expenditures for the fiscal year ended December 31, 1930, were $12,328,918.35, compared with $21,497,608.60 in 1929. Of the 1930 total, Ontario expenditures accounted for $10,813,469.90, of which $10,623,911.43 was in the Sudbury district and $189,558.47 at Port Colborne.

Capital expenditures during 1931 will be substantially less than those of 1930. Two important items are scheduled for completion in 1931: first, the transfer of the Orford separation process (a smelting operation) from Port Colborne to Copper Cliff; and second, the rehabilitation of the Mond shaft and head-works at the Frood mine. The former will show a substantial saving in operating expenses and the latter is a necessary elimination of fire hazard and will moreover facilitate handling Frood ore from depths below 2,800 feet.

During 1930, the authorized common stock of the company was increased to 15,000,000 shares of no par value.

Ontario Operations

Hydro-Electric Plants.—The new plant at Big Eddy was in operation throughout the year and is giving entire satisfaction. At Wabageshik modern equipment was installed and the dam and plant put in first-class operating condition. The company's four stations at Big Eddy, High Falls, Wabageshik, and Nairn Falls are now highly efficient and have a capacity of 38,000 horsepower.

Mines.—During the year, 902,531 tons of ore were mined at the Frood mine, 861,770 tons at the Creighton mine, and 277,500 tons at the Garson mine, a total of 2,041,801 tons. Total development work at the Frood mine for 1930, embracing shafts, drifts, crosscuts, raises, winzes, and box-holes, amounted to 50,803 lineal feet, or nearly 10 miles. In the past four years, development work of this character at the Frood shows a total of 21.8 miles. This mine can now furnish 5,000 tons of ore per day and mining efficiencies are steadily increasing. At the Levack mine, which was not operated during 1930, the new fireproof headframe and sorting plant have been completed. Steel and concrete construction, modern in every respect, have replaced the head-works destroyed by fire in 1929.

Concentrator.—The first unit of the new concentrator, with a capacity of 4,000 tons of ore per day, was started during August and is satisfactorily milling at the present time 105,000 tons of ore per month. A second unit of like capacity is practically completed and will be ready for operation on April 1, 1931.

Copper Cliff Smelter.—On July 1, 1930, the new smelter was started as scheduled and has shown increased efficiency each successive month. Costs are meeting expectations, and the substantial saving in fuel alone justifies the change in smelting practice from blast furnaces to reverberatory furnaces. The concentrator and smelter handled 1,472,782 tons of ore and produced 106,194 tons of bessemer matte during 1930.

Conistan Smelter.—At Coniston, with the new sintering plant in operation, the smelter continued to show favourable results both as to capacity and operating costs. During the year, 812,345 tons of ore were smelted and 57,879 tons of bessemer matte produced.

Port Colborne Refinery.—There were produced 61,704,271 pounds of nickel in 1930, as against 81,909,339 pounds in 1929. In order to replace normal stocks of nickel depleted in 1929, operations at the Port Colborne refinery were carried on in excess of actual market demand during the first nine months of 1930. On October 1, refinery output was curtailed in order to keep it in step with current sales of nickel. At this plant the platinum metals contained in Frood and Garson ores are recovered as a by-product from the electrolytic refining of nickel and are shipped in the form of concentrates to the Acton plant for refining. The actual current percentage recovery of platinum metals is highly satisfactory and confirms the estimates reported in the past as to the platinum metals content of Frood ore.

Ontario Refining Company, Limited (Associated Company).—The new electrolytic copper refinery of the Ontario Refining Company at Copper Cliff was started successfully in mid-year and is now producing about 6,000 tons of copper per month. Although the plant is running at only 60 per cent. capacity, refining costs are low and it is clear that the investment in this plant is fully justified. Gold and silver contained in Frood and Garson ores are recovered at this plant.

Nitre cake and sulphuric acid are now being regularly produced at the works of Canadian Industries, Limited, recently completed at Copper Cliff. The manufacture in this plant of sulphuric acid from gases, purchased from your Copper Cliff smelter, has proved to be a satisfactory and efficient operation and is returning a profit to your company.

Ore Reserves

Proven ore reserves as of December 31, 1930, aggregated 206,704,000 tons, showing a gain of 6,610,000 tons over 1929. Frood contributed 2,416,000 tons, Creighton 2,648,000 tons, Levack 137,000 tons, and Garson 1,409,000 tons to the increase in ore reserves. The additional Frood ore is below 2,000 feet and grades 4.93 per cent. copper and 3.53 per cent. nickel. The substantial

addition to the Creighton ore reserves resulted from ore found between vertical depths of 2,400 feet and 3,400 feet. Additional ore reserves developed during 1930 contain sufficient nickel to supply market requirements for three years at the rate of 1929 peak consumption.

Outlook

The immediate prospects of the company naturally depend upon a gradual return to normal conditions in world industry generally. Over a period of years the increase of your business will be determined primarily by the expansion of the uses for nickel and nickel alloys, and the experience gained in recent years gives promise that this expansion will be continued.

Due to well-known causes, copper is selling at an abnormally low price. Notwithstanding large stocks of the metal and the imminent output from Rhodesia, the best opinion of the copper industry contemplates the future of the metal with confidence and with this opinion your management agrees. Similar depressions have confronted the industry in the past followed always by periods of heavy demand and higher prices.

The rapid and world-wide expansion of the electrical industry, which uses approximately sixty per cent. of the world's output, and the prevailing low per capita consumption in the rest of the world as contrasted with America, should assure an expanding market for copper for years to come. Your company with ample ore reserves and low-cost production will benefit in large measure with the return of prosperity to the copper industry.

In considering the nickel market situation it should be noted that your company has been fortunate in its conservative price policy, with which, it is gratifying to state, large consumers of nickel generally have expressed entire satisfaction. Sales of nickel during 1930, for new uses, were in some cases in excess of those for 1929, and there is no reason to believe that the world demand for nickel will not resume its forward course. In fact there are distinct signs of improvement, and it is the opinion of many leaders in the industries which consume nickel that 1931 will show a gradual return to normal conditions. While it is impossible to make an accurate forecast it seems probable that the trend of the company's business in 1931 will be the reverse of that recorded in 1930.

It is reasonable to assume that an industry which has shown steady progress for the past decade will continue to progress. Ample ore reserves, modern plants, and an experienced personnel are behind an organized market development effort that will unquestionably extend the use of an essential metal such as nickel. Nothing has occurred during the present depression to permanently disturb the general course of your company's business, and there is every reason to believe that it will continue definitely upward. Your management does not regard the present industrial depression, serious as it now appears, as of major importance in the life of a company so well equipped to serve an expanding world market.

An average force of 5,090 men was employed in the Sudbury area during 1930, distributed as follows:—

Creighton	769
Frood	2,076
Garson	313
Levack	110
Copper Cliff	1,287
Coniston	535
Total	5,090

During the year the company's mines were under the general superintendence of Oliver Hall, with the following superintendents at the various mines: Creighton, S. J. Kidder, succeeded R. D. Parker; Frood, R. D. Parker, succeeded G. L. Helmrich; Garson, W. J. Mumford; Levack, A. L. Sharp.

SILVER

Animikie Mines, Limited

This company was incorporated in 1928 with an authorized capital of 2,000,000 shares of $1 par value. It holds under option 520 acres in Gillies township, district of Thunder Bay, situated some 30 miles west of Port Arthur and 6 miles from Stanley, on the Canadian National railway. This option covers three old silver mines, known as the Badger, Porcupine, and Keystone properties.

The officers and directors are: D. F. Osburn, president; T. H. Graham, vice-president; S. W. Ray, secretary-treasurer; C. L. Bliss, P. J. Farley, D. C. McKenzie, A. L. McEwen, E. W. Robison, and J. A. Wishart, directors.

It is understood that the following development work was done on these properties in the early days:—

Mine	Shafts	Drifts	Raises and winzes
	feet	feet	feet
Badger	280	2,000	190
Porcupine	250	1,690	.....
Keystone	330 70 62 40	325	.....

During 1930, the 62-foot shaft on the Keystone property was dewatered, and several drift rounds were taken out from the bottom by hand work. This was stopped on account of water. Some surface trenching and sampling was also undertaken.

Work was suspended early in July from lack of finances. Chas. W. Miles was in charge.

Arthur Brocklebank

Arthur Brocklebank operated the Kerr Lake mine in Coleman township, district of Timiskaming, under lease, during 1930.

There were shipped to Deloro 287.89 tons of ore, containing 118,330.45 ounces of silver, having a value of $43,216.53, and 50,849 pounds of cobalt, having a value of $23,504.80. Six men were employed.

Richard Bunclark

Richard Bunclark leased the Penn-Canadian mine in Coleman township, district of Timiskaming.

Ore having values of $1,506 in silver and $140 in cobalt was shipped.

C. E. Cain and Associates

The Beaver mine in Coleman township, district of Timiskaming, was operated throughout 1930 by the owners, C. E. Cain, Wesley Preston, and W. D. Taylor. Twenty men were employed.

Ore having a value of $26,053.16 in silver and $1,425.73 in cobalt was shipped.

Castle-Trethewey Mines, Limited

Castle-Trethewey Mines, Limited, has a capital of $2,000,000 in shares of $1 par value. The board of directors comprises: J. P. Bickell, president; J. B. Tudhope, vice-president; Balmer Neilly, secretary-treasurer; W. J. Sheppard, S. R. Wickett, and D. H. McDougall, directors. The executive offices are in the Standard Bank Building, Toronto.

The Castle and Capitol shafts were operated throughout 1930; the Capitol continued to operate until March, 1931, when all work was stopped.

Angus D. Campbell was mine manager, and 92 men were employed at the property, which is in Haultain township, district of Timiskaming.

The following is taken from the manager's report for the fiscal year ending March 31, 1931:—

PRODUCTION

Concentrates shipped, or ready for shipment, dry tons	239.94
Ounces per ton	2,550.07
Total fine ounces silver recovered	611,865
Total pounds cobalt recovered	94,173

REVENUE

Total ounces paid for	625,308.33	
Average price obtained per ounce	$0.3513	
Revenue from sale of silver		$219,670.99
Total pounds of cobalt sold	97,555	
Revenue from sale of cobalt		10,007.73
Total revenue		$229,678.72

PRODUCTION SINCE COMMENCEMENT OF OPERATIONS

Period	Months	Tons milled	Ounces per ton recovered	Gross production, ounces	Gross value, silver and cobalt	Value per ounce of silver
Feb. 1, '22, to June 30, '22.	5	Sorting	.....	40,000	$28,000.00	$0.700
July 1, '22, to June 30, '23.	12	Sorting	.....	62,811	41,146.80	.655
July 1, '23, to June 30, '24.	12	7,607	46.03	350,147	229,656.95	.656
July 1, '24, to June 30, '25.	12	30,273	30.62	927,088	637,712.10	.688
July 1, '25, to June 30, '26.	12	34,425	29.03	999,234	683,601.48	.684
July 1, '26, to Mar. 31, '27.	9	29,136	26.18	762,861	426,928.53	.560
Apr. 1, '27, to Mar. 31, '28.	12	40,250	21.32	858,044	486,186.47	.567
Apr. 1, '28, to Mar. 31, '29.	12	43,186	22.04	951,718	546,937.28	.575
Apr. 1, '29, to Mar. 31, '30.	12	45,302	18.35	831,307	383,766.97	.462
Apr. 1, '30, to Mar. 31, '31.	12	29,691	20.61	611,865	191,729.08	.313
Total	.....	259,870	.....	6,395,075	$3,655,665.66	.....

SUMMARY OF DEVELOPMENT

	Drifts	Crosscuts	Raises	Winzes	Total
	feet	feet	feet	feet	feet
No. 3 shaft	781	298	376.5	.....	1,455.5
Capitol shaft	1,364.6	2,285.6	70.5	98	3,818.7
Total	2,145.6	2,583.6	447	98	5,274.2

ROCK HOISTED

	Tons
Silver ore	29,452
Cobalt ore	731
Total	30,183
Waste	14,752
Total	44,935

MILLING

	Tons	Ounces per ton	Total ounces
Ore treated from mine	29,691	.....	.....
Silver recovered	.....	20.61	[1]611,865
Silver in tailings	.....	2.12	62,868
Total	29,691	22.73	674,733

[1]Smelter retutns.

CONCENTRATES PRODUCED

	Pounds	Ounces	Per cent. cobalt
Metallics	490	5,002	.....
Jigs	92,865	206,060	.....
Sands	266,017	349,122	.....
Slimes	67,890	17,681	.....
Cobalt ore	69,760	.....	14

OPERATING COSTS

	Total cost	Cost per ton	Cost per ounce
Development	$104,146.21	$3.507	$0.170
Mining	41,934.96	1.413	.068
Tramming and hoisting	24,896.24	.839	.041
Milling	34,777.53	1.171	.057
Shipping	6,611.66	.222	.011
Smelting and refining	12,140.24	.409	.020
General expenses, mine	17,053.54	.574	.027
Corporate legal transfer and administration, Toronto office expenses	14,065.90	.474	.023
General maintenance	4,764.19	.161	.008
Insurance and miscellaneous	6,218.01	.209	.010
	$266,608.48	$8.979	$0.435
Less: Earnings derived from milling of custom ore	9,358.42	.315	.015
Total	$257,250.06	$8.664	$0.420

MILLING COSTS

	Labour	Supplies	Power	Total cost	Cost per ton
Conveying to mill and crushing	$3,765.74	$1,788.91	$1,296.00	$6,850.65	$0.231
Jigging	304.45	359.19	962.84	1,626.48	.055
Ball-milling	3,653.36	3,898.46	3,031.02	10,582.84	.355
Tabling	3,481.45	427.57	962.68	4,871.70	.165
Drying and bagging	3.78	245.13	438.91	687.82	.023
Water supply	230.57	13.73	265.06	509.36	.017
Heating	390.46	1,741.69	.....	2,132.15	.072
Tailings disposal	30.47	20.91	.....	51.38	.002
Repairs and maintenance	2,801.10	199.94	.....	3,001.04	.101
Supervision and assaying	4,028.39	348.48	87.24	4,464.11	.150
Total	$18,689.77	$9,044.01	$7,043.75	$34,777.53	.....
Cost per ton milled	$0.629	$0.305	$0.237	.....	$1.171

Development and Mining

The year's mining and development was governed and the results determined to a great extent by the price of silver. At the beginning of the year silver was at the low price of 42 cents per ounce. With small and erratic but rich ore shoots such as found in the diabase rock at this mine, continuous and extensive exploration is necessary. This price did not justify continuing exploration at the main or No. 3 shaft, so that there the known silver was mined and milled.

The Capitol shaft exploration programme, which had been started with silver at higher prices, was proceeded with, since the shaft had been previously pumped out and equipped for work and the chances of finding payable silver were believed to be good. After driving the 800-foot level 1,050 feet through Keewatin rock and 300 feet beyond the dipping contact into the

underlying diabase rock, a high-grade silver vein was found. A number of other veins, five of which contained some ore, were located by further exploration. Of these, vein No. 112 was the richest and most consistent. The 2,000 tons milled from it produced 150,000 ounces of silver.

A total of 5,274 feet, or approximately a mile, of development was done during the year, and of this total 3,818 feet were driven from the Capitol shaft.

Milling

Mill tonnage was reduced one-third below that of the previous year. The grade of the ore was higher.

Power costs were kept to a minimum by means of a varying mill time schedule by which crushing, milling, and mine air compressor peak power demands were arranged at different times of the day. Although the tonnage was 35 per cent. less than the previous year, this arrangement, with other economies, was responsible for a milling cost which was only 5 per cent. greater for the current year.

General

Total operating costs were considerably reduced and, although the lower price of silver was largely responsible for the year's deficit, it must be borne in mind that the expenditure on Capitol shaft exploration was included. For this expenditure veins containing silver ore were discovered at a depth of 800 feet below the surface, which in the course of development produced 250,000 ounces of silver. Some ore was put in shape for future mining, particularly a length of 90 feet on the back of No. 112 vein stope.

No milling was done in March, the final month of the year. During April a mill run of 860 tons from the Capitol produced 66,000 ounces. The mill and mine were then closed, care being taken to leave things in shape for easy reopening if and when such action is deemed advisable.

The mine closes after producing approximately 6,500,000 ounces, over half of which was in the past four years. The Capitol shaft workings, if silver goes back to a normal price, have considerable mining and prospecting value.

E. H. Clemens

The Coniagas mine in Coleman township, district of Timiskaming, was operated under lease by E. H. Clemens up to June 30, 1930.

Ore having a value of $3,527.07 was shipped to the Deloro Smelting and Refining Company, Limited.

Cobalt Contact Mines, Limited

The Cobalt Contact Mines, Limited, operated their properties in Bucke township, district of Timiskaming, with a force of 26 men until September, 1930, when operations were suspended. The officers and directors of the company are: J. M. Aitken, president, Walter H. Coles, vice-president; James A. Stewart, secretary; Sir A. C. Fitzgeorge, Frank C. Loring, H. F. Coombs, directors. J. M. C. Dunlop is mine manager. The head office of the company is at 8 Bloor Street East, Toronto, Ont.

During the year the work was largely confined to shipping mill rock to the Cobalt Reduction plant at Cobalt. A total of 400 feet of drifting, 100 feet of crosscutting, and 200 feet of raising was done before the mine closed in September. The production for the year was as follows:—

	Tons	Ounces silver	Pounds cobalt
Crude silver ore	46.186	47,710	.....
Mill ore	2,175.28	63,804	.....
Cobalt ore	61.862	.....	13,045

D. L. Jemmett, Limited

D. L. Jemmett, Limited, operated the Agaunico mine in Bucke township, district of Timiskaming, throughout the year.

The following buildings were constructed during the year: shaft-house, crusher-house, powder-house, ore dryer, and storehouse. A mill is in course of construction.

Development work consisted of 1,896 feet of drifting and 291 feet of crosscutting. Shipments of nickel amounting to 2,567 pounds and of cobalt amounting to 159,448 pounds were made.

M. C. H. Little was company engineer, employing an average of 51 men.

Henry Jemmett

Henry Jemmett did some work at the Waldman mine in Coleman township, district of Timiskaming, and obtained $54 in silver and cobalt.

Keeley Silver Mines, Limited

Keeley Silver Mines, Limited, has a capital of 2,000,000 shares of $1 par value.

The officers and directors of the company are: R. Home Smith, president; W. H. Stafford, vice-president; J. Ingram, secretary-treasurer; A. Dorfman, managing director; F. H. Hamilton, John H. Black, R. T. Shillington, and E. Turk, directors. The head office is at Silver Centre.

W. J. Dobbins is manager, and 81 men are employed at the mine in South Lorrain township, district of Timiskaming.

The manager's report for the fiscal year ending February 28, 1930, is as follows:—

Summary of Underground Operations

During the year the following underground development has been carried out on the upper contact:—

	Feet	Cost per foot
Drifting and crosscutting	4,694	$15.48
Raising	671	14.74

In addition development on the lower contact was as follows:—

Drifting	feet	2,249
Raising	feet	106
Stoping	cu. ft.	1,425
Total cost		$74,132.74

Some 17,433 tons of ore were hoisted. Of this amount 16,525 tons were taken from the stopes; the remainder came from development.

Results of Development

The footage accomplished during the year showed considerable reduction from the previous year, due mainly to the fact that many sections of the mine have been eliminated from further exploration. In addition to this factor, the low price of silver has not warranted the exploration of minor indications.

While some ore was discovered in the course of development, the principal discoveries of ore were made by the more intensive exploration of certain sections of the mine already opened up. This work produced some very rich shoots, thereby making possible the increased production over that of the previous year and compensating to some extent for the drastic decline in the price of silver.

Work on the lower contact was continuous throughout the year, and while no large shoots of ore were found, some very high grade ore, in small sections, was encountered. Towards the end of the fiscal period encouraging results were obtained in a raise above the main or 1,420-foot level. This raise is on the principal break discovered on the lower contact and although not the Woods fault it has similar strength and characteristic conditions surrounding it.

Mill Statistics

During the year, 13,745 tons of ore was milled. Abbreviated statistics are as follows:—

Ore milled	tons	13,745
Heads average	ounces	25.8
Tails average	ounces	3.5
Extraction average	per cent.	86.7
Average running time	per cent.	78.4

Production

Production for the year (based on actual smelter returns) was as follows:—

	Pounds, net	Silver, ounces	Cobalt, pounds
Picked ore	237,697	617,974.57	26,369
Concentrates	732,690	310,421.44	26,911
Total	970,387	928,396.01	53,280

The corresponding figures for the silver and cobalt produced during the previous year were 684,997 ounces and 100,889 pounds, respectively.

PRODUCTION DURING PREVIOUS YEARS

	Pounds, net	Silver, ounces	Cobalt, pounds
1913	322	872.7	.....
1914	2,327.4	3,183.03	.....
1918	145,048	39,557.25	1,061
1919	31,766	4,565.82	3,160.3
1920	119,770	8,253.44	9,896.86
1921	676,411.5	313,230.88	60,566.72
1922 and first 2 months 1923	2,286,497	1,146,961.56	196,927
Fiscal year, 1923-24	1,973,832.75	1,600,739.68	171,357
Fiscal year, 1924-25	2,668,241.75	1,880,351.88	228,450
Fiscal year, 1925-26	2,077,548	1,514,407.48	181,054
Fiscal year, 1926-27	2,064,742.5	1,640,007.96	185,830
Fiscal year, 1927-28	1,203,207.5	994,582.75	92,962
Fiscal year, 1928-29	992,525	684,997	100,889
Total	14,242,239.4	9,831,711.43	1,232,153.88
Fiscal year, 1929-30	970,387	928,396.01	53,280
Total production to February 28, 1930	15,212,626.4	10,760,107.44	1,285,433.88

COST OF PRODUCTION

(Based on 13,865 tons of ore treated, producing 928,396 ounces silver)

	Total cost	Cost per ton	Cost per ounce
Development	$156,670.20	$11.30	$0.169
Ore extraction	84,900.71	6.12	.091
Ore sorting	7,352.40	.53	.008
Milling	32,672.39	2.36	.035
Shipping and marketing	33,552.92	2.42	.036
Administration	31,006.07	2.24	.033
General maintenance	12,035.98	.87	.013
Head office expense	9,949.21	.72	.011
Corporate expense	17,834.17	1.28	.019
Total	$385,974.05	$27.84	$0.415

Ore Reserves

No attempt has been made to calculate ore reserves. The situation with regard to available ore is as favourable as it was at the beginning of the fiscal period, but the areas of possible exploration have naturally diminished.

Laurentian Mines, Limited

The old Laurentian mine in Coleman township, district of Timiskaming, was operated under lease by Laurentian Mines, Limited.

A small test shipment yielded silver and cobalt having a value of $191.

E. Lynch

E. Lynch operated the Peterson Lake mine in Coleman township, district of Timiskaming, under lease.

From a small test shipment of ore, values of $33 in silver and $138 in cobalt were obtained.

George Martin

The Crown Reserve mine in Coleman township, district of Timiskaming, was leased to George Martin.

Shipments of silver ore and metallics and cobalt ore had a value of $4,612.

Mining Corporation of Canada, Limited

The Mining Corporation of Canada, Limited, has an issued capital of $8,300,250 in shares of $5 par value. The directors and officers of the company are: J. P. Watson, president; E. H. Rose and G. M. Clark, vice-presidents; G. C. Ames, secretary-treasurer; A. B. Stodart, J. G. Watson, and C. E. Trafford, directors. M. F. Fairlie is managing director.

The average number of men employed at Cobalt was 165. During the early part of the year, only about 15 men were employed at Frontier mine, South Lorrain, but extended operations increased the number to 139 during the last six months.

The president's report to the shareholders for the year ended December 31, 1930, is as follows:—

Cobalt and South Lorrain

The item of mining rights, which stood in the last balance sheet at $3,650,000, represented the properties in these areas which are slowly coming to an end, and your directors think it advisable to write this amount off entirely.

The Cobalt Reduction Company realized on its liquid assets, and the amount received was paid over to the corporation.

The total production of silver in 1930 from both Cobalt and South Lorrain was 964,189 ounces, and the production of cobalt was 361,038 pounds (nearly 20 per cent. of the world's consumption of this metal).

The price of cobalt remained satisfactory throughout the year, but the continued drastic decline in silver seriously curtailed the profits at these mines.

Hudson Bay Mining and Smelting Company

The plant is now in production and is running smoothly.

Base Metals Mining Corporation

Operations of this company were discontinued pending a return of more normal metal prices. While the company could still operate at a small profit, the directors deem it inadvisable to continue production at the prevailing low prices.

Quemont Mining Corporation

Work on this property was discontinued in August. The company had money in the treasury, and the directors of the Mining Corporation arranged in November last for Quemont Mining Corporation to obtain a 7½ per cent. interest in the Ashley Gold Mining Corporation

for $25,000, with the right to participate to the extent of a further $25,000 in the option now held by the Mining Corporation on all of the treasury stock. This option will be exercised.

Mincor Exploration and Development Company

Nothing of importance was discovered during the year.

Ashley Gold Mining Corporation

The developments on the holdings of this company up to the date of this report have been good and are described in the managing engineer's report so that the shareholders might have the latest information. The financing of the development of the properties belonging to this company is being undertaken by the Mining Corporation of Canada out of its own treasury funds, as the directors feel that all possible benefits of this new discovery should accrue to the shareholders of the Mining Corporation of Canada. No public financing will, therefore, be undertaken until a better idea of the true value of the Ashley Gold Mining Corporation's holdings is available.

General

The claims staked in the Stikine River area in British Columbia did not come up to expectation and the claims have been dropped.

Claims in the Pascalis district, Quebec, and in Tyrrell township, Ontario, were staked by the corporation's prospectors, and the necessary preliminary work will be done on these claims during the present year.

Increase of Capital

In the notice convening the meeting, shareholders will note that there is a resolution proposing that the capital stock of the corporation be increased from 1,660,050 shares to 2,000,000 shares. The directors also deem it to be in the general interest of the shareholders to change the shares from a par value of $5 each to no par value. In making this change it will enable the directors to deal with the large item standing at the debit of profit and loss represented by the writing off of the item of mining rights and the heavy item of depreciation in investments due to the decline in the market value of the corporation's holdings, but no valuation has been placed upon the corporation's large holding in the Ashley gold property. The increase of capital will put the corporation in a position to issue new shares as and when occasion demands and circumstances warrant, so that your directors may be able to take advantage of any favourable opportunity which presents itself for extending the operations of the corporation. The directors have no intention of issuing any shares in the immediate future, but they cannot, of course, forecast when a favourable opportunity for utilizing further capital may present itself, but in any such issue the shareholders may be assured that their interests will be fully protected and looked after. When it is decided to issue any of the new shares, it is the intention of the directors to make the first offering of shares on advantageous terms to the shareholders *pro rata*.

The managing engineer's report for the year ending December 31, 1930, is as follows:—

Conforming with a policy in force for the past three years, the mining interests of the corporation have become more diversified and now include interests in lead, zinc, copper, and gold properties along with the long-established operations at Cobalt and South Lorrain.

The latter have had to face another year of declining silver prices, requiring a complete change in production methods in order to attain even moderate profits. Silver production of 964,189 ounces compares with 985,249 ounces during 1929.

Fortunately a better market for cobalt metal obtained throughout the year, and under a favourable contract every effort was made to increase the production of that metal. As a result, almost 20 per cent. of the world's requirements of cobalt metal for the year was supplied by this corporation.

PRODUCTION, 1930

	Tons treated	Ounces silver produced
Cobalt properties	20,075	559,286
South Lorrain properties	1,490	404,903
Total	21,565	964,189

Included in the above production, the following tonnages were disposed of without treatment at the local plant of the corporation: 182.39 tons of high-grade silver ore, containing 394,995.69 ounces; 1,530.41 tons of low-silver, high-cobalt ore, containing 151,510.23 ounces. Cobalt metal, contained in high-grade and cobalt ore, amounted to 361,038 pounds, as compared with 21,413 pounds in 1929.

The details of tonnage treated, production, etc., from mill ore in 1930 are given in the table below:—

Tons of mill ore treated	19,853
Assay value, ounces silver per ton	24.59
Ounces contained	488,264.42
Ounces returned by Reduction Company	417,682.90
Percentage returned under contract	85.54

The table below gives the production by years from the mines of the corporation. The aggregate amounted to 47,965,423 fine ounces at December 31, 1930.

TOTAL PRODUCTION IN OUNCES FINE SILVER TO DECEMBER 31, 1930

	Cobalt mines	South Lorrain mines	Total
Prior to 1908	118,616	.....	118,616
Year ended December 31, 1908	633,516	.....	633,516
" " " 1909	442,254	.....	442,254
" " " 1910	471,965	.....	471,965
" " " 1911	1,777,002	.....	1,777,002
" " " 1912	2,827,826	.....	2,827,826
" " " 1913	3,784,718	.....	3,784,718
January 1, 1914, to March 31, 1914	866,622	.....	866,622
April 1, 1914, to December 31, 1914	3,185,124	.....	3,185,124
Year ended December 31, 1915	4,563,956	.....	4,563,956
" " " 1916	4,457,441	.....	4,457,441
" " " 1917	4,485,542	.....	4,485,542
" " " 1918	1,708,252	.....	1,708,252
" " " 1919	1,230,653	.....	1,230,653
" " " 1920	1,664,018	.....	1,664,018
" " " 1921	1,226,717	.....	1,226,717
" " " 1922	1,462,269	.....	1,462,269
" " " 1923	727,115	1,333,334	2,060,449
" " " 1924	851,280	521,878	1,373,158
" " " 1925	898,008	1,134,097	2,032,105
" " " 1926	1,105,456	1,104,597	2,210,053
" " " 1927	1,217,180	902,591	2,119,771
" " " 1928	918,266	395,692	1,313,958
" " " 1929	970,954	14,295	985,249
" " " 1930	559,286	404,903	964,189
Total	42,154,036	5,811,387	47,965,423

Mining Operations

Cobalt.—During the first half of the year, efforts were directed toward meeting declining silver prices by selective mining. Although the grade of mill ore was thereby successfully raised, it was still found impossible to mine and mill low-grade ore at a profit. The milling plant of the Cobalt Reduction Company was, therefore, shut down in August. For the remainder of the year, operations at Cobalt were confined to the mining of the richer sections of silver- and cobalt-bearing veins, the broken ore being subjected to hand-sorting only. By this method a moderate profit was attained.

The cobalt ore produced under the above conditions had a cobalt metal content of 68,687 pounds, exclusive of that contained in milling ore.

South Lorrain.—An increased demand for cobalt metal and a favourable smelter contract permitted the reopening of the Frontier and Crompton properties, where there still remained a considerable tonnage of this hitherto unprofitable ore. In the course of operations, several shoots of high-grade silver ore were developed, which added materially to profits for the year.

Practically no shipments of low-grade ore to Cobalt were made, treatment being confined to hand-sorting and rough concentration of the fines by jigs and tables without preliminary, crushing.

The following shipments of ore represent the production of the Frontier and Crompton properties for the year: 172 tons of mill ore, with a head assay of 51.23 ounces, containing 8,812.30 ounces; 1,178.55 tons of low-silver, high-cobalt ore, assaying 50.94 ounces, containing 60,036.38 ounces; 139.85 tons of high-grade silver ore, assaying 2,408.48 ounces and containing 336,826.30 ounces.

The total silver content of all classes of ore from the Frontier and Crompton properties was 405,674.98 ounces, as compared with 14,422.30 ounces for the previous year. Production of cobalt metal from the two properties was 292,351 pounds.

Ore Reserves.—A limited tonnage of silver and cobalt ore remains to be extracted at Cobalt and South Lorrain. It is probable, however, that production on a moderately profitable basis can be maintained well into the coming year.

Other Properties in Ontario

Bannockburn and Argyle Townships.—Shareholders have already been advised in the last quarterly report of the staking of 18 claims by prospectors in the employ of the corporation, and of the first results of diamond-drilling on the Ashley vein. Since that report, 6 more diamond-drill holes have been completed, proving the continuation of the vein to a total length of 884 feet. There is every reason to suppose that this length will be further extended both north and south. Intersections of the vein in the later holes have been at depths of 200 to 275 feet. Over a length of 525 feet, diamond-drill results have proved average values of $10.68 in gold over a width calculated to 4 feet.

The Ashley vein occurs in Keewatin volcanic rocks, mostly basalt, has a strike approximately north and south, a dip to the west varying from 45 to 60 degrees, and width varying from 5 feet to 11 feet. There is evidence, though yet unproved, that the vein occupies a fault plane. Lost core and ground-up core in the vein zone has made drilling difficult.

Two other veins in addition to the Ashley have already been discovered. One of these, the Garvey vein, lying three-quarters of a mile to the northwest, has been proved by cross-trenching for a length of 500 feet. This vein, with a width of from 3 to 5 feet, dips flatly to the northwest. Some spectacular gold values have been shown in the preliminary trenching. It will be diamond-drilled at depth in the near future.

The third vein, narrow in width but with very high gold values, has been exposed in trenching about 150 feet east of the Ashley vein, of which it seems to be an offshoot

A complete plant and equipment for shaft-sinking and mine development has already been delivered at the property, along with sufficient supplies for full operations during 1931. A shaft will be sunk to 500 feet with four levels, and lateral development will be continued throughout the year along with underground diamond-drilling.

Electric power at reasonable cost will eventually be available at points either 9 miles to the east or 28 miles to the west, the latter being the Ontario Hydro line to Sudbury.

Preliminary results from diamond-drilling point to the Ashley discovery being one of major importance, and shareholders will be kept informed of the results of operations as work during the year proceeds. The above brings the information on this property up to March 12, 1931.

Mosher Group.—These claims, 9 in number, adjoin the Ashley group on the north and are under option to the corporation, in association with the Huronian Mining and Finance Company. They are favourably located and will be prospected during the year.

Tyrrell Township.—Nine claims were staked by prospectors in the employ of the corporation. These claims adjoin a group on which a gold discovery has been made by the McIntyre-Porcupine Mines, and preliminary work will be done following the spring break-up.

Sudbury.—Examination and geological mapping of the large acreage in this district controlled by the corporation continued during the past season, but no important discoveries were made.

Cobalt Reduction Company, Limited

As the operation of the milling plant of this subsidiary of the corporation was stopped in August, the usual tables are not included in this report. A small profit from operations was attained and was paid to the corporation in the form of a dividend.

Morrison Mines, Limited

Morrison Mines, Limited, operated their property in the township of Nicol, district of Timiskaming, throughout the year 1930, with an average force of 17 men. The officers and directors of the company are: Horace F. Strong, president and managing director; Jas. Cunningham, secretary-treasurer; Joseph Montgomery, vice-president; H. D. Fripp and T. F. Ahearn, directors.

The president's report for the year ending December 31, 1930, is as follows:—

During the past twelve months, operations have been maintained without interruption on the company's property, and herewith is submitted a summary of work performed:—

DEVELOPMENT

Level	Drift	Crosscut	Raising	Sinking
	feet	feet	feet	feet
350-foot sub	45	.....	30	.....
370-foot	.....	.....	20	.....
425-foot	278	32	105	46
465-foot	130	.....	30	.....
Total	453	32	185	46

This gives an over-all development footage of 716 feet, about 50 per cent. of which was in ore.

Production

Stoping amounted to about 1,250 cubic yards and, with the ore from development, totalled a tonnage hoisted of 4,024 tons. Some 200 tons of this remain on the ore dump, and 3,824 tons were passed over the sorting grizzley, where 1,436 tons of waste were eliminated. The resultant product, totalling 2,388 tons, was trucked to the Castle-Trethewey Mines, Limited, mill and gave a recovery of 131,753 ounces of silver and 5,565 pounds of cobalt. Average recovery per ton of ore milled is, therefore, 55 ounces, and with tails averaging 5 ounces, gives a mill head of 60 ounces. To the above production can be added 11,029 ounces from 4.8 tons of high-grade picked from development ore before milling commenced.

Gross mine production for the year is, therefore, 142,782 ounces of silver and 5,565 pounds of cobalt. The average content per ton of material broken as ore was 38.7 ounces.

Production from Mill Rock Dump.—In September an agreement was reached with Castle-Trethewey Mines, Limited, for the treatment (without any financial risk or obligation on the part of your company) of 1,000 tons out of about 3,000 tons of mill ore dump, on the basis of an even division of the profits after deducting a loading, trucking, and milling charge of $4 per ton. Some 974 tons were treated on this basis and yielded 14,892 ounces. The grade being low and with the further drop in silver, the return from this source was negligible and the arrangement was discontinued.

Ore Reserves

Of the new developments referred to above, the winze from the 425-foot level to the 465-foot level and the 130 feet of drifting on the 465-foot level was the most consistent and productive, all the material broken averaging over 50 ounces per ton and mill shipments averaging around 70 ounces per ton. The winze was sunk upon a vein which produced a pocket of high-grade on the 425-foot level and which dipped to the north as against all our other veins dipping to the south. This winze opened up a set of conditions not before encountered and which, in the writer's judgment, from the point of view of ore deposition, are most important. This view has been confirmed by the production of about 50,000 ounces and the development of a further 70,000 ounces (in 50-ounce ore) above the 465-foot level in the small amount of work done to date in this section.

The westerly ore shoots are essentially low-grade and are estimated to contain, as of December 31, 1930, about 7,000 tons of 20-ounce ore, containing 140,000 ounces; and 200 tons of 50-ounce ore, containing 10,000 ounces. The easterly shoots are estimated to contain 1,000 tons of 25-ounce ore, containing 25,000 ounces; and 2,400 tons of 50-ounce ore, containing 120,000 ounces; or a total of 10,600 tons of about 28-ounce grade, containing a total of about 295,000 ounces of silver.

Present Status

The crash in silver, during the closing two weeks of the year, to below 30 cents per ounce, decided a suspension of operations as of December 31.

William Newton

William Newton, of New Liskeard, operated the Silver Queen property in Coleman township, district of Timiskaming, under lease in 1930.

Values of $12 in silver and $39 in cobalt were obtained from a test shipment of one ton.

Nipissing Mining Company, Limited

Nipissing Mines Company, Limited, has a capital of 1,200,000 shares of $5 par value. The directors of the company are: E. P. Earle, president and

treasurer; Alexander Fasken, vice-president and secretary; Richard T. Greene, August Heckscher, C. W. Nichols, Halstead Lindsley, and Hugh Park, directors. The head 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 a capital of 2,500 shares of $100 par value. The officers and directors of the company are: Alexander Fasken, president and secretary; E. P. Earle, vice-president and treasurer; Richard T. Greene, C. W. Nichols, and Hugh Park, directors. The operating officials are: Hugh Park, general manager, and E. V. Neelands, manager.

The net value of Nipissing shipments in 1930 was $790,897.87. During the year $360,000 was paid in dividends.

The property at Cobalt, Coleman township, district of Timiskaming, operated throughout the year 1930, employing an average of 195 men.

The general manager reports as follows for the year 1930:—

Summary of Results

The net result for 1930 was a satisfactory production of silver and a most unsatisfactory market price for the metal.

From an operating standpoint, the year's results were better than anticipated. There was some decrease in tons treated, but the ounces of silver produced were about the same as in 1929, due to a higher average head assay of ore treated at the low-grade mill. The tons of ore treated at the high-grade plant and the ounces of bullion produced at the refinery exceeded the quantities produced in 1929. From a milling and production point of view the results of the year were gratifying.

As in recent years, production was obtained from a number of small low-grade veins, assisted by the removal of several high-grade pillars and the occasional development of high-grade shoots in some of the current work on new veins. None of these operations was extensive at any one place, and the amount of ore now assured is difficult to estimate. Present reserves, as at the end of the year, are estimated at 10,000 tons, containing 300,000 ounces. There is also a reserve, in residue dumps and in a number of veins underground, of material containing cobalt, silver, and associated minerals, which is available for future shipment or treatment. An appreciable income has been derived from this source in past years.

Shipments of bullion contained 1,800,000 fine ounces, part of which was from inventory at the beginning of the year. The total production of silver from the commencement of operations, including inventory at the end of the year, is in excess of 84,000,000 ounces of silver.

The operating results for the year were practically nullified by the extreme decline in the price of silver. The following table is of interest:—

	Average price, cents
1920	100.899
1928	58.176
1929	52.993
1930	38.154
January, 1931	29.423
February, 1931	26.773

The year 1930 started at a price for silver which was within a fraction of the lowest on record up to that time; by the end of the year it had fallen 15⅝ cents, or one-third, to a new low. There were further decreases in the first two months of 1931, a new all-time low of 25¾ cents being recorded on February 16. Operating profits under such conditions are impossible.

The ounces of silver produced in 1929 and 1930 were almost identical. The effect of the 15-cent drop meant $235,000 less valuation for the same number of ounces and directly concerns the items of production, inventory, and surplus. In determining the value of the year's production, the result was adversely affected to a large extent by reason of the fact that the inventory at the beginning of the year was calculated at 46¾ cents per ounce, whereas the inventory at the end of the year was valued at 31⅛ cents per ounce.

The large low-grade occurrence of sulphides on the company's group of claims at Nisto lake, Saskatchewan, was tested at depth by a number of diamond-drill holes. Results indicate a deposit similar in size and grade to the surface exposure. It has no economic value at the present time.

The regular staff of prospectors and engineers were at work in many areas in various parts of the Dominion. Some districts were promising and a number of claims were staked.

Numerous properties were examined, and several options were taken in what may prove to be interesting fields.

The immediate future at the Cobalt property is somewhat in doubt. As advised from time to time in previous reports, the operations are becoming more restricted, even at what may be termed a satisfactory price for silver. No doubt additional ore will be encountered from time to time, but the possibilities for future profits will depend on the successful search for new properties and the price of silver.

PRODUCTION IN 1930

	Silver, fine ounces	Gross value	Net value
Shipments in 1930	1,905,425.01	$796,834.82	$790,897.87
On hand at mine, December 31, 1930	781,197.63	439,679.96	434,443.49
Total	2,686,622.64	$1,236,514.78	$1,225,341.36
On hand at mine, December 31, 1929	1,140,353.11	726,518.58	717,223.06
Nipissing production	1,546,269.53	$509,996.20	$508,118.30

SOURCES OF PRODUCTION

FROM UNDERGROUND:	Tons
Shaft No. 19	22,599
Shaft No. 49	807
Shaft No. 63	5,650
Shaft No. 73	11,300
	40,356
In battery bin, December 31, 1929	650
	41,006
In battery bin, December 31, 1930	600
Total ore milled	40,406

The various products treated in the high-grade plant were:—

HIGH-GRADE ORE TREATMENT

	Tons	Assay	Ounces contained
Concentrate	620	$1,876	1,163,052
By-products	28	3,455	96,745
Total	648	$1,944	1,259,797

The refinery treated precipitate containing 1,553,376 fine ounces. Shipments of bullion amounted to 1,821,643 fine ounces; shipments of residue amounted to 1,205 tons.

LOW-GRADE MILL

	Tons	Assay	Ounces contained
Ore treated	40,406	$40.29	1,628,040
Recovered in products:			
Precipitate	15	25,057	375,851
Coarse concentrate	554	2,002	1,109,219
Fine concentrate	84	711	59,696
Total recovery	.....	.....	1,544,766

Average tailing, 2.09 ounces, recovery 94.89 per cent. Twenty stamps ran 340 days, 3 hours, or 93.19 per cent. of possible running time. They crushed 118.80 tons per day, or 5.94 tons per stamp per day.

SUMMARY OF UNDERGROUND WORK, 1930

Shaft	Drifting	Cross-Cutting	Raising	Total	Stoping
	feet	feet	feet	feet	cu. yds.
No. 19	2,173	1,285	107	3,565	6,266
No. 49	.....	.....	.....	.....	212
No. 63	387	284	44	715	933
No. 73	61	152	.....	213	3,016
No. 127	921	310	11	1,242	45
Cobalt vein	.....	.....	.....	.....	201
Total	3,542	2,031	162	5,735	10,673

M. J. O'Brien, Limited

Miller Lake O'Brien Mine

The Miller Lake O'Brien mine, Nicol township, district of Timiskaming, is owned and operated by M. J. O'Brien, Limited. J. G. Dickenson is general manager, and H. G. Kennedy is manager. One hundred and eight men are employed.

The underground development for the year amounted to 1,283 feet of drifting, 887 feet of crosscutting, 40 feet of raising, 3,696 cubic feet of station-cutting, and 311,323 cubic feet of stoping. Ore hoisted amounted to 25,716 tons, containing 1,264,884 ounces of silver. There were shipped 22.8 tons of high-grade and 337 tons of concentrates.

O'Brien Mine

The O'Brien mine in Coleman township, district of Timiskaming, is owned and operated by M. J. O'Brien, Limited. J. G. Dickenson is general manager, and W. A. O'Flynn is manager. An average of 170 men is employed.

The underground development for the year amounted to 5,456 feet of drifting and crosscutting and 435 feet of raising. Some 60,947 tons of ore were stoped; 56,248 tons of ore, containing 2,287,250 ounces of silver, were hoisted. Of the ore hoisted, 9 tons were high-grade.

Diamond-drilling at the Cross Lake mine amounted to 5,455 feet.

C. W. Price

C. W. Price operated the Foster mine in Coleman township, district of Timiskaming, under lease during 1930, employing three men.

Ore shipped to Deloro produced values in silver and cobalt amounting to $8,528.

C. P. Roper

C. P. Roper operated the Silver Cliff property in Coleman township, district of Timiskaming, under lease from January to July, 1930.

Shipments of ore and bullion having a value of $4,961 were made to the Deloro smelter and the Cobalt Reduction Company.

Sandoe and Moyle

Richard Sandoe and H. Moyle operated the Temiskaming mine in Coleman township, district of Timiskaming, under lease.

Silver and cobalt ores, valued at $6,727, were shipped to Deloro.

A. Sarabura

A. Sarabura leased the Lumsden mine in Coleman township, district of Timiskaming, during 1930.

Cobalt and silver valued at $101 were recovered from a small shipment of ore.

Smith and Laycock

The Hudson Bay mine in Coleman township, district of Timiskaming, was leased to W. H. Smith and Mr. Laycock.

Ore and metallics having a value of $6,624.70 were shipped to Deloro.

Roy Sullivan

Roy Sullivan leased the Provincial mine in Coleman township, district of Timiskaming, during 1930.

Ore containing $2,485 in silver and $2,291 in cobalt was shipped.

F. H. Todd

F. H. Todd, of Cobalt, leased the Victory mine in Coleman township, district of Timiskaming, in 1930.

From a small shipment of ore, values of $13 in silver and $54 in cobalt were obtained.

C. F. Tuer

C. F. Tuer, of Haileybury, operated the Kissinger property in Coleman township, district of Timiskaming.

A small test shipment containing 42 ounces of silver and 240 pounds of cobalt and having a total value of $160 was made.

R. N. Ward

The old Stoneham property in Coleman township, district of Timiskaming, was leased to R. N. Ward.

Cobalt ore having a value of $368.69 was shipped to Deloro.

Yorkshire Cobalt Mining Company

The Yorkshire Cobalt Mining Company operated their property in the township of Bucke, district of Timiskaming, with a force of 7 men. The owners of the property are: W. E. Seed, Chas. P. Roper, Frank H. Todd, and Wm. E. McCready. Wm. E. McCready is manager.

The development work for the year consisted of 150 feet of drifting and 25 feet of raising. A hoist-house, power-house, sleep-camp, and cook-camp were built.

Shipments to Deloro amounted to 6,316 pounds of ore containing 479 pounds of cobalt.

TALC

Canada Talc Company, Limited

The mine and mill of the Canada Talc Company, Limited, in Hastings county, were operated throughout the year.

The shaft was sunk a further 65 feet, and 92 feet of shaft timbering was renewed between the 2nd and 4th levels. The talc was mined from the 3rd and 6th levels. A total of 4,173.27 tons was hoisted and milled.

Roy Taylor, Madoc, was manager, employing 9 men in the mine and 8 in the mill.

Geo. H. Gillespie Company, Limited

The Henderson talc mine and mill, near Madoc, in Hastings county, were operated during 1930 at 70 per cent. capacity.

Some 7,931 tons of talc were mined and milled. A 70-foot shaft was sunk below the 300-foot level. The talc was mined from stopes on the 300-foot level.

Seven men were employed in the mine and 15 at the mill. Geo. H. Gillespie, Madoc, is manager.

METALLURGICAL WORKS

Algoma Steel Corporation, Limited

The blast furnaces of the Algoma Steel Corporation, Limited, at Sault Ste. Marie, were operated as follows during the year 1930:—

Furnace	Days in operation	Product
		tons
No. 1	365	114,788
No. 2	Idle all year	.....
No. 3	Idle all year	.....
No. 4	187	97,240

No new equipment was added to the operating furnaces during the year. No. 3 furnace was completely relined but did not operate.

Jas. H. Bell is blast furnace superintendent.

Canadian Industries, Limited

The company completed the construction of a sulphuric acid plant and a "Nitre cake" plant in July, 1930, to adjoin the International Nickel smelter at Copper Cliff.

The sulphuric acid plant is connected by a 6-foot-diameter gas flue with the smelter, which supplies the sulphur gas necessary for the manufacture of sulphuric acid. The plant consists of three units, each with a capacity of 50 tons of acid a day.

The process used is to clean the gas with dilute acid sprays and a Cottrell plant, then to absorb the water vapour with strong acid. The clean dry sulphur dioxide is converted to sulphur trioxide by the catalytic action of vanadium or platinum. The sulphur trioxide is then dissolved in weak sulphuric acid and becomes commercial acid.

The "Nitre cake" plant was erected to manufacture acid sodium sulphate, which is an essential flux in the separation of nickel and copper. In this plant sodium sulphate from Saskatchewan is mixed with sulphuric acid and fused in an oil-fired furnace. The product is cast in bars and shipped to the International Nickel's Port Colborne refinery. The plant has a rated capacity of 200 tons of "Nitre cake" per day, which will require a consumption of 75 tons of sulphuric acid per day.

Production of acid and "Nitre cake" commenced in August, 1930, and an average of 100 men was employed.

W. H. De Blois is works manager; and G. G. Vincent, assistant works manager.

Deloro Smelting and Refining Company, Limited

The plant at Deloro operated throughout the year. On account of unsatisfactory market conditions, the output of cobalt products was curtailed and a considerable tonnage of cobalt ore was stored for future treatment. Important improvements in metallurgical efficiency and reductions in general costs were secured during the year, as an offset to decreased market prices of products.

The silver output for the year, approximately 6,500,000 ounces, constituted a record for this plant.

The officers of the company are: M. J. O'Brien, president; J. A. O'Brien, vice-president; F. A. Bapty, secretary-treasurer; S. F. Kirkpatrick, managing director. S. B. Wright is general manager, and R. A. Elliott is superintendent.

International Nickel Company of Canada, Limited

The refinery at Port Colborne was operated continuously throughout the year.

Ontario Refining Company, Limited

This company commenced operations at its new electrolytic copper refinery at Copper Cliff on August 1, 1930, sixteen months after construction work was started.

The officers and directors are: H. Steel, president; W. Hochschild, vice-president; H. K. Hochschild, secretary; W. H. Brady, treasurer; Britton Osler, J. E. Warren, John L. Agnew, and R. C. Stanley, directors.

It is owned jointly by the International Nickel Company of Canada, Limited; the American Metal Company, Limited; the Consolidated Mining and Smelting Company of Canada, Limited; and Ventures, Limited.

The plant covers about 12 acres and has an estimated capacity of 20,000,000 pounds of copper per month. Production during the five months of operation in 1930 was at about 50 per cent. of capacity. During this period an average of 367 men was employed on operation.

C. H. Aldrich is general manager. J. K. Bryan was succeeded as superintendent by F. Benard in November.

Steel Company of Canada, Limited

The Steel Company of Canada, Limited, operated "A" furnace at full capacity until September 9, with a production of 71,551 tons; and "B" furnace at full capacity until May 31, then at two-thirds capacity for the remainder of the year, with a production of 187,000 tons.

The average number of men employed during the year was 140. R. A. Gillies is blast furnace superintendent.

The officers of the company are: C. S. Wilcox, chairman of the board; R. H. McMaster, president; H. H. Champ, H. M. Jaquays, R. G. Wells, and H. T. Diplock, vice-presidents; H. S. Alexander, secretary; S. E. Le Brocq, comptroller.

MINING ACCIDENTS IN 1930

Chief Inspector of Mines, D. G. Sinclair, Toronto; Inspectors, R. H. Cleland, Timmins; E. C. Keeley, Kirkland Lake; D. F. Cooper, Sudbury; A. R. Webster, Toronto.

Accidents during 1930

During the year 1930 at the mines, metallurgical works, quarries, clay, sand, and gravel pits regulated by the Mining Act, there were 2,223 accidents to employees reported to the Department of Mines up to January 15, 1931. Fifty-six fatalities, arising out of 54 separate accidents, were recorded.

These returns represent a decrease of 221 in the total number of casualties and an increase of one in the number of men killed over the preceding year.

The report shows a fatality rate of 3.02 per thousand men employed, which is 0.02 per thousand lower than the average for the past twenty-five years.

There were 117 non-fatal accidents per thousand men employed, which shows a decrease of 9 per thousand from the rate in 1929.

The percentage of non-fatal accidents followed by infection decreased from 6.9 per cent. in 1929 to 6.2 per cent. in 1930.

Fatal Accidents

A comparison of fatal accidents for the past five years is given in the following table:—

Distribution	1926	1927	1928	1929	1930
Mines, underground	20	19	31	33	30
Mines, surface	3	4	2	2	3
Metallurgical works	3	3	4	2	11
Quarries	3	4	2	3	4
Clay, sand, and gravel pits	3	3	4	8	6
Total	32	33	43	48	54

By months the fatal accidents occurred as follows:—

Month	No. of accidents	No. of men killed
January	2	2
February	5	6
March	6	6
April	3	3
May	6	6
June	5	5
July	8	9
August	7	7
September	3	3
October	2	2
November	5	5
December	2	2
Total	54	56

Classifying the fatalities according to industries gives the following:—

Gold mines	18
Nickel mines	17
Silver mines	0
Copper-lead-zinc mines	0
Gypsum mines	0
Metallurgical works	11
Quarries	4
Sand, gravel, and clay pits	6
Total	56

ANALYSIS OF FATALITIES AT MINES, 1926–1930

Cause	1926	1927	1928	1929	1930
	per cent.	per cent.	per cent.	per cent.	per cent.
Fall of ground	17.39	26	6.6	14.3	45.6
Run of ore or rock	.....	17.4	5.3	11.9	8.6
Shaft accidents	26.09	21.3	9.3	14.3	8.6
Explosives	43.48	4.3	12	28.6	8.6
Miscellaneous, underground	.....	8.69	64	28.6	20
Surface	13.04	21.7	2.6	2.3	8.6

TABLE OF FATAL ACCIDENTS IN MINES, METALLURGICAL WORKS, QUARRIES, AND GRAVEL, SAND, AND CLAY PITS, 1906–1930

Year	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 1,000 employed
1906	11	5,017	750	5,767	1.9
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	3.6
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	2.1
1919	39	11,926	1,000	12,926	3
1920	29	10,486	1,000	11,486	2.61
1921	24	8,436	1,000	9,436	2.54
1922	30	9,500	1,500	11,000	2.72
1923	30	10,500	1,500	12,000	2.5
1924	40	11,000	1,500	12,500	3.2
1925	42	11,500	1,500	13,000	3.23
1926	32	11,500	1,500	13,000	2.46
1927	33	13,311	2,000	15,311	2.1
1928	85	15,787	2,000	17,787	4.76
1929	55	17,145	1,849	18,994	2.89
1930	56	18,217	317	18,534	3.02

The comparative fatality rate per thousand men employed at mines, metallurgical works, quarries, and clay, sand, and gravel pits is as follows:—

	Men employed	No. killed	Rate per thousand
Mines	11,773	35	2.97
Metallurgical works	4,513	11	2.44
Quarries	1,448	4	2.76
Clay, sand, and gravel pits	800	6	7.5
Total	18,534	56	3.02

The occupation and nationality of the men killed at mines, metallurgical works, quarries, and clay, sand, and gravel pits are set out in the following table:—

Occupation	Finn	Roumanian	British	Jugo-Slav	Hungarian	Austrian	German	Czecho-Slovak	Italian	Pole	American	Total
Miner	4	1	1	1								7
Shaftman	1	1	2									4
Cage tender		1	1									2
Dry man			1									1
Transportation boss			1									1
Skip tender			1									1
Shift boss	1											1
Drill helper			2							1		3
Scaler	1		1	1		1						4
Mucker	1			1					1			3
Scraper runner	1											1
Scraper helper	1											1
Timber helper			1							1		2
Switchman			1									1
Trammer								1				1
Station tender			1									1
Electrician's helper			1									1
Labourer			3	1	1					1		6
Ladle man		1										1
Machinist's helper											1	1
Electrician			1									1
Engineer			1									1
Furnace man									1			1
Farmer			3									3
Locomotive driver			1									1
Sampler			1									1
Crane man			2									2
Fitter			1									1
Feeder										1		1
Machinist							1					1
Total	10	4	27	4	1	1	1	1	2	4	1	56

The ages of the men killed are as follows:—

17–20	21–25	26–30	31–35	36–40	41–45	46–50	Over 50	Unknown	Total
1	12	16	11	6	1	1	7	1	56

Non-Fatal Accidents

The causes of non-fatal accidents at mines are shown in the following table:—

Cause	Surface	Underground	Total
Rock or ore at face	.....	227	227
Fall of persons	58	145	203
Falling objects	53	132	185
Fall of rock or ore from face, wall, or back	.....	143	143
Tramming	4	126	130
Rock or ore at chute	.....	113	113
Flying objects, sledging, etc.	9	100	109
Crushed between two objects	18	81	99
Hand tools	26	52	78
Strain while lifting	20	54	74
Nails or splinters	10	56	66
Drilling machines	.....	63	63
Machinery	28	11	39
Running into or striking against objects	2	31	33
Fall down shaft, winze, raise, or stope	.....	19	19
Explosives	2	13	15
Burns	12	4	16
Cage, skip, or bucket	1	5	6
Electricity	6	.....	6
Explosion of carbide	1	3	4
Gas	.....	4	4
Poisoning from cyanide, mercury, etc.	2	.....	2
Unclassified	4	1	5
Total	256	1,383	1,639

The causes of non-fatal accidents at metallurgical works were:—

Falling objects	71	Burns	9
Fall of persons	51	Cranes, ladles, hooks	8
Burned by slag, matte, or scrap	27	Nails or splinters	7
Crushed between two objects	17	Strain while lifting	5
Flying objects, sledging, etc	17	Burns by acid	5
Transportation	14	Electricity	4
Hand tools	14	Unclassified	2
Machinery	14		
Running into or striking against objects	10	Total	275

The causes of non-fatal accidents at quarries were:—

Handling material	62	Transportation	9
Fall of persons	18	Crushed between two objects	8
Falling objects	16	Hoists, derricks, elevators	4
Flying objects, sledging, etc.	15	Running into or striking against objects	4
Machinery	15	Explosives	3
Strain while lifting	10	Nails or splinters	3
Hand tools	10	Burns	2
Fall of rock	10		
		Total	189

The causes of non-fatal accidents at gravel, sand, and clay pits were:—

Falling objects	13	Strain while lifting	4
Falls of persons	9	Running into or striking against objects	2
Fall of material	9	Flying objects	1
Machinery	7	Nails or splinters	1
Transportation	6	Burns	1
Crushed between two objects	5	Explosives	1
Hand tools	5		
		Total	64

Infection

Records show that infection followed in 134 cases out of 2,167 non-fatal accidents:—

Location	No. of accidents	Accidents followed by infection	Per cent. infection
Mines, underground	1,383	98	7.1
Mines, surface	256	22	8.5
Metallurgical works	275	7	2.5
Quarries	189	6	3.2
Gravel, sand, or clay pits	64	1	1.6
Total	2,167	134	6.2

Accidents from Explosives

Cause	Non-fatal		Fatal		Total	
	No. of accidents	Men injured	No. of accidents	Men killed	No. of accidents	Men killed or injured
Drilled into explosives	4	5	3	3	7	8
Struck by rock from blast	2	2	1	1	3	3
Returned to delayed blast	2	3	.....	.....	2	3
Concussion from blast	2	3	.....	.....	2	3
Handling explosives	2	2	.....	.....	2	2
Premature explosion	1	2	.....	.....	1	2
Explosion while sledging	1	1	.....	.....	1	1
Total	14	18	4	4	18	22

Electric Accidents

The following table shows the fatal accidents due to the use of electricity at mines, metallurgical works, and quarries during the past ten years:—

1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
2	.....	.....	1	3	.....	2	1	.....	6

The following table shows the voltage of the circuits on which the fatal accidents occurred:—

Volts	No. of accidents
110	3
220	1
550	8
2,200	3
Total	15

Classifying the accidents according to the industry shows the following:—

Mines, surface	5
Metallurgical works	6
Quarries	4
Total	15

The number of fatal accidents from electricity in 1930 greatly exceeded that of any previous year.

Three of these occurred on 110-volt circuits. One was caused by the victim not realizing the danger from a low-voltage circuit and deliberately touching the exposed part on a broken light socket. There was no evidence that another accident was caused by electric shock except that the man was holding a 110-volt extension cord in his hand when he collapsed. The third fatal accident on a low-voltage circuit was caused by a mechanic receiving a shock while holding an electric drill, with the result that he fell from a railway bridge. His death was caused by a fractured skull, due to the fall, but the accident might have been prevented had a ground wire been attached to the drill.

The accident on a 550-volt circuit was due to a moment of forgetfulness on the part of an electrician, when he evidently touched a live circuit while waiting for an assistant to open a switch.

One accident on a 2,200-volt line was the result of inexperienced helpers working in the vicinity of a high-voltage circuit without close supervision. The other was due to the failure of workmen to open a disconnecting switch in their haste to make repairs to an electric shovel.

The following table shows the number of non-fatal electric burns during the past ten years:—

1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
6	6	9	9	6	5	10	4	14	10

The causes of non-fatal electric burns in 1930 were:—

Arc when closing switches	6
Arc when opening switches	1
Flash while locating ground	1
Defective insulation	1
Attempting to connect ammeter across line	1
Total	10

Electric Fire

A small fire occurred on the 1,500-foot level of the McIntyre mine, about 3.15 A.M., on June 18, when an electric cable ruptured, either from faulty construction or previous injury, and ignited the insulation.

At the place where the fire broke out three cables were supported by a steel messenger wire supended from the roof of the level.

The cables were: power cable, 3-conductor, No. 10 wire, 550-volt, rubber-covered, with fine steel wire braided armour covered with rubber belting; charging cable, 2-conductor, No. 4 wire, 110-volt, rubber-covered; lighting cable, 2-conductor, No. 12 wire, 110-volt, rubber-covered.

The cables were run from a concrete link-house to apparatus installed in fireproof compartments and were not attached to timbers or other inflammable

material at any point. The installation was such that there was no possibility of the fire spreading beyond the cables themselves.

Prosecutions

Before Magistrate Atkinson at Timmins, on September 24, Peter De Santis, manager of the De Santis Gold Mining Company, Limited, pleaded guilty to a charge of operating a shaft in Ogden township without providing the closely-boarded partition between the hoisting compartment and the ladderway required by section 163, subsection 90, of the Mining Act.

A fine of $100 and costs was imposed.

Before Magistrate McKessock, at Sudbury, on November 17, Vili Luoma, Finn, aged thirty years, single, a raise driller at the Frood mine of the International Nickel Company of Canada, Limited, employed since August 10, 1929, was fined $10 and costs for a contravention of section 163, subsection 52, of the Mining Act. He was charged with having placed explosives in No. 3 shaft cage without supervision of an authorized person, by transporting an electric blasting cap on his person in the cage from the 2,400-foot level to the surface, on November 7.

The electric blasting cap was found in Luoma's underground clothes when his locker was searched by company police looking for stolen explosives. It proved to be a Dupont zero delay cap with enamel wires, a type that had been specially imported by the company and confined entirely to the 2,400-foot level, on which level the accused was working.

A charge was first laid under the Criminal Code but was later changed to the above, together with a charge of committing a careless act with explosives (regulation 42b).

Luoma frankly admitted having brought the cap to surface but maintained that he had done so accidentally through forgetfulness. He told a straightforward story of putting the cap in his pocket while assisting to load a raise round the previous day. He claimed that they were blasting with nine delays and had the caps in a fuse bag. After loading the zero delays he noticed they had requisitioned one too many zero caps, so he put it in his pocket to keep it from becoming mixed up with the remaining caps of different delays, and did not remember having done so until it was found in his clothing the following day.

He also stated that he had been hit on the head and face by falling rock when working in a raise on August 30, and showed a badly scarred face and head.

This accident, he claimed, had impaired his memory. The records showed this to be a compensation case.

The Magistrate held that regulation 52 did not contain the word "wilfully," hence he had no option but to find the defendant guilty, as he had admitted the charge. However, in view of the plausible explanation, he imposed the minimum fine.

The second charge under regulation 42b was withdrawn.

Before Magistrate Atkinson, on January 7, 1931, F. Tomlenson was convicted of drunkenness while underground at the Hollinger Consolidated Gold Mines, Limited, on December 24, 1930. Information was laid under subsection 285, of section 163, of the Mining Act.

Summary of Rope Tests, 1930

During the year, 301 tensile tests were performed in the Rope Testing Laboratory.

Of these, 42 were special tests on wire ropes or other material for different manufacturers and 19 were special tests for mining companies.

In the remaining 240 tests made on hoisting ropes, under the provisions of regulation 135, section 163, of the Mining Act, 25 defective ropes were detected and the removal from hoisting service of these defective ropes was asked for.

It will thus be noted that 10.4 per cent. of the ropes were found to be defective. This closely follows previous experience in the Rope Testing Laboratory. During the preceding five years an average of 10.6 per cent. of the ropes submitted for test had been found defective.

Mine Rescue Stations

Timmins

Following a training course at the Pittsburgh Station of the United States Bureau of Mines, attended by the Inspectors of Mines and Mr. Austin Neame, supervisor of the station, the training of miners in mine rescue and recovery operations was inaugurated at the Timmins Station early in the year.

To facilitate training and to ensure a standardization of the course when the other stations in the province become operative, a fully illustrated handbook of mine rescue and recovery operations has been published. This booklet of 143 pages covers the training course very fully and permits a candidate for training to acquire more detail than can possibly be undertaken in the short periods which are actually spent in the station in undergoing training.

Up to the end of the year, 96 men had been trained at the station. These men represent teams from the Hollinger, McIntyre, Dome, Vipond, and Coniaurum mines.

Weight-pulling devices were installed in the "smoke-room," so that the men in training could be taught the wearing of apparatus while performing strenuous physical labour. When the weather permitted the men were required to shovel rock, screen sand, etc., while wearing apparatus.

In preparation for emergency calls, rugged packing cases have been provided for the immediate boxing and transport of the material and apparatus necessary to meet any situation.

One call was put in for the equipment during the year, when the underground crew of the De Santis Gold Mining Company was overcome by carbon monoxide following a blast. Unfortunately the call was received too late to save the lives of the whole crew, one man dying before he could be rescued. Four days after the accident apparatus was worn in the shaft to sample the air and determine whether it was safe to resume operations. It was found that carbon monoxide was still present in amounts varying from 0.2 per cent. to 1 per cent.

Sudbury

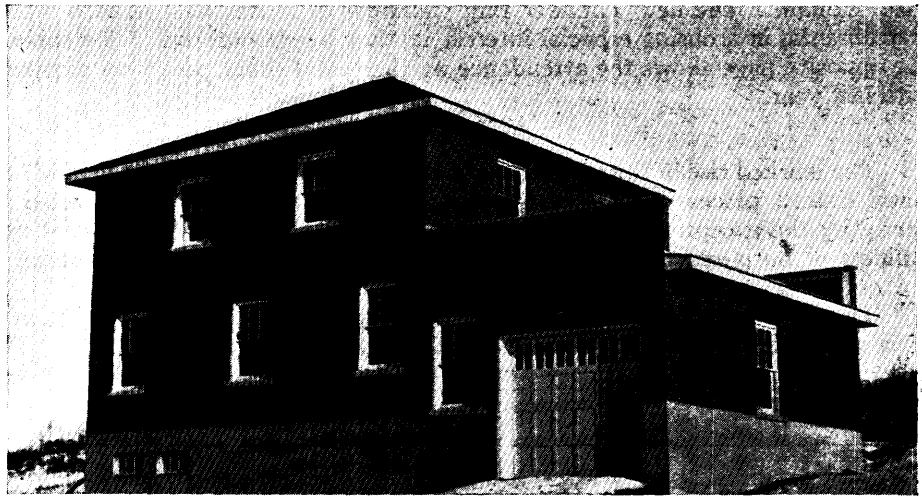
During the year, construction of the Sudbury District Mine Rescue Station was undertaken and at the end of the year the building was complete, with equipment installed and ready for operation.

The station is located on the Sudbury-Frood road quite near the Frood mine. The building is a two-storey, brick-veneer structure, 30 feet 9 inches by

27 feet 6 inches, with an attached brick-veneer garage, 16 feet 3 inches by 27 feet 6 inches.

This arrangement provides living quarters for the supervisor and his family on the second floor, the ground floor being given over to training quarters and storage facilities. The station is steam heated from a boiler installed in basement under the north half of the main portion of the building.

The main training room, 16 feet by 25 feet 6 inches, adjoins the garage, which is intended to serve the double purpose of housing the rescue truck, which it is proposed to install, and to provide a "smoke-room" for carrying on training in irrespirable atmospheres. A long, gas-tight observation window between the main training room and the garage smoke-room permits the supervisor to see and direct the action of the men undergoing training in the smoke-room.



Sudbury Mine Rescue Station

The equipment of the station is similar to that installed at Timmins, consisting mainly of oxygen, self-contained breathing apparatus, gas masks, self rescuers, inhalator, etc., with complete spare and accessory equipment. An ample stock of material is maintained at the station to meet any emergency and provide uninterrupted service over such periods as may be necessary to obtain replenishments by express in the event of a serious disaster.

The main features in which the Sudbury Station differs from the previously installed station at Timmins is in the provision of living quarters for the supervisor and the installation of a truck for the rapid transport of the equipment.

The widely separated locations of the active mines in the Sudbury district make the installation of a truck indispensable. This truck is being designed to accommodate all the apparatus and sufficient supplies for approximately 10 hours continuous operation. This necessary material and equipment will be stored on the truck in order that no unnecessary delay need occur in answering any call in event of an emergency at any of the mines of the district.

CLASSES FOR PROSPECTORS, 1930-31

By E. M. Burwash

Introduction

This work was prosecuted as usual during the past winter. The places where courses were held were the same as in the previous season except that Mine Centre was omitted and the experiment of holding a course in Toronto tried instead. The course in Toronto proved very successful both as to the number enrolled and the percentage of regularity in attendance. Classes were, in general, larger than last year and exceptionally large at Port Arthur and Fort William. The new Thunder Bay Chamber of Mines was perhaps mainly instrumental in arousing especial interest in that neighbourhood. The table on the opposite page shows the attendance at these and other points as compared with last year.

Attendance

The marked rise in the total attendance, approaching the figures for 1927-28, when sixteen places instead of fourteen were visited, may be accounted for partly by the exceptionally large class at Toronto and partly by the prevalent dullness of business conditions, which left many free to attend who ordinarily are otherwise occupied.

The amount of work accomplished is best represented by the total number of student periods, which are as follows:—

	1930	1931
Total student mineralogy periods	1,220	2,189
Total student geology periods	1,520	1,977

Of these periods, the mineralogy periods, of which there are eight in each course, would average nearer two hours than one. The lecture periods in geology, of which there are five in each course, are ordinarily a little over an hour long. Some difficulty is experienced in the mineralogy work when classes over thirty in number have to be dealt with, but this is to some extent overcome by extending the period up to two full hours.

A new printed system of rock study covering the chief common types of rock was introduced, and it is believed that it supplements the tables already in use for instructional purposes and is also useful for determinative work.

During the last season applications for advice on the part of prospectors and promotors were fewer than usual. These form a distinctive feature of the work, which is not easy to deal with satisfactorily owing to the impossibility of going to the properties due both to lack of time and to the winter season. Advice tendered on the basis of information given by the parties interested without seeing the property is apt to be largely inadequate owing to the difficulty of getting a clear understanding of the facts, or to having them presented only in part, or occasionally in a misleading way.

TABLE OF ATTENDANCE

1929–30 and 1930–31

Place	Dates	Minerals and Rocks (8 day classes)				Geology (5 evening lectures)				Total Student Hours (Mineralogy)	
		1929–30		1930–31		1929-30		1930-31			
		Registration	Average attendance	Registration	Average attendance	Total	Average	Total	Average	1929–30	1930–31
	1930		per cent		per cent						
Ottawa	Nov. 11–18	10	51.2	14	60.2	59	11.8	42	8.4	41	59
North Bay	Nov. 20–28	5	62.5	7	41.14	220	44	97	19.4	25	23
Sudbury	Dec. 1– 9	5	47.3	20	70.6	40	8	79	16	19	113
Sault Ste. Marie	Dec. 11–19	24	64.6	24	48.4	69	13.8	48	9.6	124	93
	1931										
Toronto	Jan. 5–13	.....	.....	103	70.27	.....	.....	481	96.2	.....	579
Port Arthur	Jan. 15–23	17	56.6	51	69.8	76	15.2	170	34	77	285
Fort William	Jan. 26–Feb. 3	29	65.1	82	65	160	32	263	52.6	151	375
Mine Centre	.....	16	61.6	.....	.....	146	29.2	.....	.....	69	.....
Fort Frances	Feb. 5–13	19	55.3	18	65.3	72	14.4	61	12.2	84	94
Kenora	Feb. 16–24	15	55.5	30	48.75	61	12.2	101	20.2	75	117
Sioux Lookout	Feb. 26–Mar. 6	21	48.8	11	67	106	21	112	22.4	82	59
Timmins	Mar. 9–17	21	54.17	22	42.5	100	20	88	17.6	91	75
Matheson	Mar. 19–27	11	62.3	27	31.4	105	21	166	33.2	53	85
Kirkland Lake	Mar. 30–Apr. 8	22	62.3	34	31.76	190	38	145	29	96	108
Haileybury	Apr. 9–17	66	43.4	40	38.75	116	23.2	124	24.8	233	124
Total	.....	281	.....	483	.....	1,520	.....	1,977	.....	1,220	2,189
Average	.....	20.07	56.47	34.5	53.37	108.57	21.7	141.2	28.26	87.14	156.35

Acknowledgments

The writer's best thanks are due to the many friends who have invariably assisted in any way in their power to the success of the work. Among these may be mentioned:—

Ottawa.—The Director of the Geological Survey and Dr. E. Poitevin.

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Sudbury.—The Mining Recorder, T. A. McArthur, and the Principals of the Technical and High Schools.

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Toronto.—The Deputy Minister of Public Works, who took some trouble to provide a suitable room for the classes, and the Superintendent of Grounds of the University of Toronto.

Port Arthur.—Mr. Garrison, Mr. King, and Mr. McWilliams, of the Technical School, who took a keen interest in our work, and the municipal authorities, who very kindly allowed us the use of the Council Chamber in the Whalen Block.

Fort William.—An exceptionally large class was promoted by those interested in the newly organized Thunder Bay Chamber of Mines. Among others may be mentioned Norman M. Patterson, Mr. Duncan, and the obliging and able secretary of the institution, where we were well accommodated for both the afternoon and evening classes.

Fort Frances—The Town Council and the Town Clerk supplied us with room in the Municipal Hall.

Kenora.—The Mining Recorder, J. D. C. Smith, who attended to advertising and arrangements, and the Municipal Council, who allowed us the use of the Council Chamber.

Sioux Lookout.—We were again under obligation to the Railway Y.M.C.A. for the use of a room for the course. We missed the active assistance formerly rendered by R. McAlpine MacGregor.

Timmins.—The Oddfellows Order and the School Board again kindly met our requirements for rooms.

Matheson.—More interest was shown than last year, the town authorities assisting as usual.

Kirkland Lake.—Our work was facilitated as often before by George Ginn, Mining Recorder, and by the Township of Teck authorities who allowed us the use of their court room.

Haileybury.—The Mining Recorder, N. J. McAulay, gave us his aid in advertising, and the management of the Hotel Haileybury provided us with rooms for the classes at extremely reasonable rates. We were also indebted, as formerly, to the Principal of the High School for his interest in allowing some of his pupils to attend.

INDEX, PART I.

NOTE.—All places referred to are in Ontario unless otherwise mentioned.

PAGE

A

Abitibi canyon, water power 1
Abitibi r.
  Lignite 55, 104
    analysis; notes 30
Abitibi Coal Field, Ltd 44
Abitibi Power and Paper Co 1
Abrasives, statistics 2, 3
Accidents, mining 127-135
Acknowledgments 138
Acme g. m., dividends 13
Acreage tax 45
Actinolite.
  Industry and statistics 2, 3, 27
  Mine and manager 54
Actinolite, Ont 54
Acton, England 107
Adams, Robt. F 57
Adams, R. S 60
Africa, gold production 14
Agaunico s. m 53, 113
Agnew, John L 107, 126
Ahearn, T. F 119
Aitken, J. M 68, 113
Alabastine. *See* Gypsum, Lime and Alabastine, Canada, Ltd.
Aladdin Cobalt Co., dividends 18
Aldrich, C. H 54, 126
Alexander, H. S 126
Alexander, J. A 47
Alexander Power Development 62
Alfred peat plant 32
Algoma dist.
  Copper mg. *See* White Lake Mines, Ltd.
  Gold mg. *See* Gondreau g. m., Michipicoten area.
  Sales; leases; revenues 45
Algoma Steel Corporation.
  Blast furnaces 25, 26
  Manager and address 54
  Operations 125
  Silica brick producers 33, 56
Allen, Innis P 72
Allen, J. C 64
Allied Metal Products, Ltd 44
Amabel tp., limestone quarry 60
American Cyanamid Co 59
American Metal Co 126
Ames, G. C 116
Amherstburg, salt 33, 56
Ammonium sulphate 26
Analyses.
  Lignite, Abitibi r 30
  Tariff of fees for 50
Ancaster, limestone 59
Anderdon tp.
  Lime kilns 57
  Limestone 59
Anderson, C. F 60
Anderson, Jas. G 55

PAGE

Andrews, G. S 94
Animikie Mines, Ltd.
  Capital, officers, operations 109, 110
  Manager and address 53
Ankerite g. m., production 7, 10
Apatite, production (1927) 3
Argonaut g. m., production 7, 9
Argyle tp., gold 8, 119
Arnold, Thomas 97
Arsenic.
  Industry 27
  Production 2, 3
    from silver mines 15-17
  Refinery and manager 54
Arthur tp., sand and gravel 58
Asbestos production (1926) 3
Asbestos Pulp Co. *See* Canada Talc Co.
Ashley, James L 107
Ashley gold find 8, 119
Ashley Gold Mg. Corpn 116, 117
Assay fees 45
  Free, details 49
Assay office. *See* Provincial Assay office.
Assessment fees 45
Atkinson, Magistrate 133
Atlas Exploration Co 44
Augusta tp., limestone 61
Austin, Louis 56
Australia.
  Gold production 14
  Industrial diamonds, imports 6

B

Bache, Jules S 72
Bad Vermilion l 7
Badeski, F 5
Badger s. m. (Th. B. dist.) 53, 109, 110
Bailey, George 27
Bain Coal Co 43, 44
Bains, J. P 61
Baker, C. M 76
Baker, G. B 76
Baker, John 5
Ball clay, imported 41
Ballast for railways, statistics 40
Bancroft, limestone quarry 60
Bannerman, Geo 51, 69
Bannockburn tp., g. claims 8, 119
Bapty, F. A 126
Barite, industry 27
Barriefield, limestone 61
Barry, E. P 68
Barry, P. A 65
Barry-Hollinger g. m.
  Manager and address 51
  Milling rate, daily 8
  Operations 65-67
  Production 7, 9
Barry-Hollinger Gold Mines, Limited.
  Capital; officers 65

PAGE

Base Metals Mg. Corpn..... 116
Bast, Aaron..... 58
Bathurst feldspar m..... 55
Bawden, W. E..... 53
Bayonne, N. J..... 107
Beachville.
  Lime plant..... 103
  Limestone quarry.....57, 59, 60
Beachville White Lime Co..... 51
Beardmore g. m.
  Manager and address..... 51
  Operations..... 67
Beardmore Gold Mines, Limited.
  Capital; officers..... 67
Beatty, E. W..... 107
Beaver s. m. (Cobalt).....53, 110
Beaver Consolidated Mines, Ltd.
  Dividends..... 18
Beilby, Charles..... 76
Belgium.
  Industrial diamonds, imports..... 6
Bell, Jas. H.....54, 125
Bell, Wilson..... 76
Belleville.
  Assay office..... 49
  Cement plant.....36, 57
Belmont tp., trap rock..... 62
Benard, F..... 126
Bennett-Pacaud Mines, Ltd.
  See also Gondreau g. m.
  Operations.....67, 68
Benny Mines, Ltd..... 43
Benson and Patterson..... 58
Beresford, John..... 61
Bertram, Charles D..... 67
Beryl.
  Industry..... 27
  Production..... 3
Bessemer matte, production..... 21
Bexley tp.
  Lime. *See* Canada Lime Co.
Bickell, John P.....88, 107, 110
Bidgood g. m..... 51
Bidgood Consolidated Mines, Ltd..... 51
Biederman, Albert G..... 57
Big Eddy..... 107
Big Ochig l..... 69
Billings Bridge, limestone..... 59
Birks, R. T..... 79
Birmingham, England..... 107
Bishop, A. L..... 70
Bismuth.
  Statistics.....1-3, 5
  Production from silver mines..... 16
Black, John H.....99, 114
Black Donald Graphite Co.
  Manager and address..... 55
  Officers; operations..... 103
  Production..... 29
Blackburn, R..... 93
Blacksmith rapids, lignite..... 30
Blast furnaces.
  See also Metallurgical works.
  Iron, operating..... 25
Bliss, C. L..... 109
Blue Quartz g. m., production..... 11
Bob, C. V..... 63
Bolender, Chas..... 59
Bolender Bros..... 59
Bonter, J. W..... 59
Bonuses. *See* Dividends.

PAGE

Bore-holes. *See* Diamond-drilling.
Boring permits, revenue..... 45
Boston Creek.
  Gold mg. *See* Barry-Hollinger g. m.
Boston Creek gold area.
  Gold mg. *See* Barry-Hollinger g. m.; Telluride Gold Mines; Tashota Gold Mines.
Botham g. m., production..... 7
Bothwell oil field..... 32
Bourget Springs..... 56
Bourgie, J. B..... 59
Boyd, Barclay..... 56
Bradley, F. W..... 64
Bradley, Ont..... 65
Brady, W. H..... 126
Brantford, sand and gravel..... 58
Brazil, industrial diamonds, imports... 6
Brennan, L. L..... 99
Brick.
  Industry and statistics.....2, 3, 41, 42
Bridgeport, sand and gravel..... 58
Brigham, A. F.....52, 76
British America Nickel Corpn..... 21
British American Oil Co..... 32
British Canadian Mines, Ltd.
  See also Foley g. m.
  Capital; officers..... 68
British South Africa.
  Industrial diamonds..... 6
Brocklebank, Arthur.....53, 110
Brockville, limestone quarry near..... 60
Bronte, limestone..... 61
Brougham tp., graphite.....29, 55
Brown farm, limestone..... 61
Brownell, C..... 61
Brule, E. D..... 59
Brule and Sons, E. D..... 59
Brunner Mond, Canada, Ltd.
  Lime plant..... 57
  Limestone quarry..... 59
  Salt plant.....33, 56
Bryan, J. K..... 126
Buck Lake mica m..... 56
Bucke tp.
  Silver mg. *See* Cobalt Contact Mines; Yorkshire Cobalt Mg. Co.
Buckingham, Que., feldspar mill..... 28
Buffalo Mines, Ltd., dividends..... 18
Building blocks, hollow, production.... 36
Building contracts..... 34
Building materials. *See* Structural materials.
Building permits..... 34
Building sand, consumption..... 39
Building Services, Ltd..... 54
Building stone, statistics..... 40
Building trades, lime consumption..... 37
Bull, F. J. C..... 93
Bullion statistics..... 14
Bunclark, Richard.....53, 110
Bunker Hill Extension Mines, Ltd....51, 68
  See also Tough-Oakes Burnside g. m.
Bunting, R. F.....55, 103
Burlington, calcium chloride in water.. 31
Burpee, F. D..... 94
Burwash, E. M.
  Report by, on Classes for Prospectors.....136-138
Business construction contracts.
  See Construction contracts.

PAGE

Business depression. *See* Depression, business.
Butler, granite quarry 61

C

Cabana, Oliver, Jr 101
Cable testing fees 45
Cadwell Dredging Co 59
Cain, C. E 53, 110
Calcite, industry 27
Calcium carbide, for making cyanamid 37
Calcium chloride, occurrences in springs 31
Caldwell pyrites mine 29, 55
Caledonia. *See* Gypsum.
Caledonia tp., mineral waters 56
Calgary Alta., gypsum plant 103
California, U.S.
  Feldspar production 28
  Gold production 14
Calvin, C. C 72
Cambridge tp., limestone quarry 60
Camden tp., sand and gravel 58
Cameron, W. M 57
Campbell, Angus D 53, 110
Campbellford, limestone 61
Canada.
  Calcite imports (1930) 27
  Gold production 14
Canada Cement Co 36, 57, 59
Canada Crushed Stone Corpn 59, 61
Canada Dry Ginger Ale, Ltd 56
Canada Gypsum and Alabastine Co.
  See Gypsum, Lime and Alabastine, Ltd.
Canada Lime Co 57
Canada Nighthawk Mines, Ltd.
  Barite mill 27
Canada Power and Paper Co 30
Canada Pulp Co 124
Canada Sand-Lime Pressed Brick Co 38
Canada Talc Co., Ltd 34, 57, 124, 125
Canadian Associated Goldfields.
  Gold production 9
Canadian Champion Reef Mg. Co 51, 68
Canadian Copper Co., dividends 23
Canadian Electric Castings Co 25
Canadian Furnace Co 25, 54
Canadian Gowganda Succession Mines, Ltd 44
Canadian Industries, Ltd.
  Acid plants 29, 54, 55, 108, 125
  Nitre cake plant 108, 125
  Operations 125
  Salt plants 33, 56
Canadian Kirkland g. m. *See* next ref.
Canadian Kirkland Mines, Ltd.
  Manager and address 51
  Operations 68
Canadian Oil Refineries, Ltd 32
Canadian Pyrites, Ltd 55
Canadian Salt Co 33
Canham, W. W 68
Canusa Mining and Exploration Co 51, 69
  See also Scottish-Ontario g. m.
Capital of mining companies 43, 44
Capital Engineering Co 5
Capitol s. m. (Gowganda).
  Manager and address 53
  Operations 110-113
Carbon-monoxide accident, De Santis g. m 134

PAGE

Carew, F. J 68
Carleton co.
  Lead mg. *See* Kingdon Mg., Smelting, and Mfg. Co.
  Limestone quarries 60
Carlsbad, Ltd 56
Carlsbad Springs 56
Carroll Bros 58
Carstens, O. G 64
Cartnell, Ellen 59
Cartnell, John 60
Casey tp., silver production 17
Casey Cobalt Silver Mg. Co., dividends 18
Cason, Charles 63
Castle s. m. (Gowganda) 53, 110
  See also Castle-Trethewey Mines, Ltd.
Castle-Trethewey Mines, Ltd.
  Capital; officers 110
  Dividends 18
  Manager and address 53
  Operations 110-113
Cement.
  Industry and statistics 2, 3, 35, 36
  Mines and managers, listed 57
  Stone requirements 40
Central Canada Mines, Ltd.
  Capital; officers; operations 69, 70
  Manager and address 51
Central Oil Co 43
Central Patricia Mines, Ltd 51, 69
Chalmers, M 57
Chalmers and Campbell 57
Champ, H. H 126
Champion Reef g. m 51
  See also Canadian Champion Reef Mg. Co.
Chatham, lime kilns 57
Chatham tp., sand and gravel 58
Cheltonia-Swastika Mines, Ltd 43
Chemical industry.
  Lime consumption 37
  Stone consumption 40
Cherry, W. S 79
China clay. *See* Kaolin.
Chisholm, C. A 52
Chisholm, D. D 5
Christie, Chas. P 57
Chrome. *See* Consolidated Chromium Corpn.
Chukuni r 79
Cinder blocks (Cincrete), statistics 36
City of Cobalt Mg. Co., dividends 18
Clappison cut 60
Clarence tp., limestone 61
Clark, G. M 116
Classes for prospectors, report by Burwash 136-138
Clauson, V. C 51, 65
Clay pits, accidents at 128
Clay products.
  Industry and statistics 1, 3, 41-43
Cleland, R. H 63, 127
Clemens, E. H 53, 113
Clifton g. m., production 11
Climax s. m 53
Clinton tp.
  Limestone. *See* Beachville.
Cloutier and Grenon 59
Clydach, Wales 21, 107
Coal. *See* Lignite.

PAGE

Coal, bituminous.
Imports for coking 26
Cobalt.
See also Silver-cobalt.
Market improves 117
Production 1-3, 5
from silver ores 15, 17
Cobalt, Ont., testing laboratories 48, 49
Cobalt silver field.
See Bucke, Coleman tps.
Production 15, 17
Cobalt Central Mines Co., dividends .. 18
Cobalt Comet Mines, Ltd 18
Cobalt Contact Mines, Ltd.
Manager and address 53
Officers; operations 113
Cobalt Lake Mg. Co., dividend 19
Cobalt Reduction Co 54, 116, 119
Cobalt Silver Queen, Ltd.
See also Silver Queen s. m.
Dividends 18
Cobalt Townsite Mg. Co., dividends ... 19
Coboconk, lime kilns 57
Cochrane dist.
Gold mg. *See* Deloro, Ogden, Tisdale, Whitney tps.
Sales; leases; revenue 45
Cockeram, Alan 69
Code, W. Harry 61
Coghill, J. M 47
Cohen, Louis 69
Coke industry 26
Coldwater Crushed Stone, Ltd 60
Cole, A. A 48
Coleman mg. div 47
See also Timiskaming mg. div.
Coleman tp.
Silver mg. *See* following mines: Badger; Beaver; Coniagas; Kerr Lake; La Rose; Nipissing; O'Brien; Penn-Canadian.
Coles, Walter H 113
Collins, W. H 138
Collins, Ont. *See* Chrome.
Colorado, U.S., feldspar 28
Company incorporations 43, 44
Concord, calcium chloride in water 31
Conderman, B. C 93
Coniagas s. m., leased 53, 113
Coniagas Mines, Ltd.
Dividends 18
Profit tax 48
Coniaurum g. m.
Manager and address 51
Milling rate, daily 8
Operations 70, 71
Production 7, 10
Coniaurum Mines, Ltd.
Capital; officers 70
Coniston.
Smelter 20, 107-109
Sulphuric acid plant 29
Conkey, M. J 65
Conlin, Herbert L 58
Connell, F. M 69
Connell, W. H 69
Connolly talc m 57
See also Canada Talc Co.
Consolidated Chromium Corpn.
Capital; officers; operations 63
Manager and address 51

PAGE

Consolidated Mining and Smelting Co.
Copper refining 20
Part owner, refinery, Copper Cliff ... 126
Consolidated Sand and Gravel, Ltd ... 58
Construction contracts 34
Construction Materials Corpn 59
Cook, J. S 60
Coombs, H. F 68, 113
Cooper, Alfred 60
Cooper, D. F 63, 127
Cooper, Gordon A 60
Cooper, James 51
Cooper Gold Mines, Ltd.
See also Minto g. m.
Mill erected 8
Operations 71
Copings, statistics 2, 3
Copper.
See also Falconbridge Nickel Mines, Ltd.; Internat. Nickel Co. of Canada; Treadwell Yukon Co.; White Lake Mines, Ltd.
Industry and statistics 1-3, 5, 20-24
gold ores 7
low price 109
map showing developments, Sudbury area ..... *frontis.*
silver mines 16
Mines.
accidents 128
managers and addresses 51-53
profit tax 48
Refinery. *See* Ontario Refining Co.
Copper-zinc-lead. *See* Errington m.
Copper Cliff.
Nitre cake plant 108, 125
Refinery 21
Smelter 107-109
Sulphuric acid plant 29, 108, 125
Corey, William E 107
Cornucopia g. m 52
Correspondence, Departmental, details 46
Courtright, salt 33, 56
Cowie, Geo. S 56
Craig, Ernest 53, 56, 105, 107
Craig, R. M 61
Craig, T. H 55
Cranney, Robt 61
Credit Valley Quarries, Ltd 62
Creighton nickel m.
See also International Nickel Co. of Canada.
Manager and address 53
Operations 108, 109
Production 20
Creighton tp. *See* Treadwell Yukon Co.
Crompton s. m 118, 119
Cromwell, Wm. N 107
Crosby, J. W 64
Cross Lake s. m 53, 123
Crow, H. C 65
Crow r 69
Crow River Gold Mines, Ltd 43
Crown Reserve s. m., leased 53, 116
Crown Reserve Mg. Co., dividends 18
Crumb, Phillip 60
Crystallite Products, Ltd 60
Culross tp.
Lime. *See* Gypsum, Lime and Alabastine, Canada, Ltd.
Culvert pipe, statistics 36

PAGE

Cunningham, Lt.-Col. James 119
Curbstone, statistics 40

D

Dalton, J. A 84
Danforth Quarry, Ltd 62
Davidson g. m., production 11
Davis, A. E 76
Davy, R. M 97
Deacon, K. A 52
De Blois, W. H 128
Decewsville Crushed Stone, Ltd., idle .. 60
Deloro tp.
  Gold mg. *See* Ankerite g. m.; Hayden Gold Mines Co.; March g. m.; United Mineral Lands Corpn.
Deloro Smelting and Refining Co.
  Arsenic production 27
  Manager and address 54
  Operations 126
Deneault, F 56
Dent tp.
  Gold. *See* Metals Development, Ltd.
Department of Highways.
  Gravel and sand 39
  Limestone quarries 60
Department of Mines.
  Correspondence 46
  Lignite mg., Abitibi r. 30, 55, 104
  Revenue and expenditure 45-48
Department of Northern Development.
  Gravel and sand 39
De Pencier, H. P 52, 72
Depression, business.
  Effect on mica 30
  nickel-copper 20, 109
  silver 121
Dereham tp., sand and gravel 58
De Santis, Peter 71, 133
De Santis Gold Mg. Co., Ltd.
  Accident (carbon-monoxide) 134
  Manager and address 52
  Operations 71, 72
  Production 11
Deschênes, Que 21
Diamond-Drill Co 5
Diamond-drilling 5
Diamonds, industrial, statistics 6
Diatomite industry 27
Diatomite Products, Ltd 28
Dibblee Construction Co 60
Dickenson, J. G 123
Dickson, George 48
Diplock, H. T 126
Dividends.
  Gold mg 12, 13
  Nickel mg 23, 24
  Silver mg 18, 19
Dobbins, W. J 53, 114
Doghole l 69
Dome g.m.
  See also Dome Mines, Ltd.
  Manager and address 52
  Milling rate, daily 8
  Operations 72-76
  Production 7, 10
Dome tp.
  Gold mg. *See* Howey g. m.
Dome Extension g. m 73, 75
Dome Mines Co 12

PAGE

Dome Mines, Ltd.
  See also Dome g. m.
  Diamond-drilling 5
  Dividends 12, 13
  Officers; financial statement 72
  Profit tax 48
Dominion Concrete Co 58
Dominion Diatomite, Ltd 28
Dominion Foundries and Steel, Ltd ... 25
Dominion Mines and Quarries, Ltd 33, 56
Dominion Pavers and Supplies, Ltd ... 44
Dominion Rock Products, Ltd 57
Dominion Royalty Corpn., Ltd 44
Dominion Salt Co 33, 56
Dominion Steel and Coal Corpn 44
Dominion Sugar Co 57
Donald, Andrew 58
Donaldson, Oliver G 101
Donaldson, Samuel 60
Dorfman, Andre 79, 99, 114
Dover West tp., oil production 32
Downing, C. E 57
Drain pipe, statistics 36
Drain tile, prices and production 41, 42
Draper tp., diatomite 28
Draughting office, North Bay 50
Dredging operations 59
Drummond tp., limestone quarry 60
Dufferin Contracting Co 60
Dufferin Paving and Crushed Stone Co. 60
Dulles, John F 107
Duncan, Mr 138
Dundas, limestone 59
Dunlop, J. M. C 53, 68, 113
Dunwich tp., oil production 32
Durham Stone and Sand Co 58
Durrell, Wm 83
Dye, Robert E 52, 99

E

Eagle l., Kenora dist 34
Ear Falls 83
Earle, E. P 120, 121
East India. *See* India.
East Neebish isld 56
East Zorra tp., limestone quarry 60
Eby-Burt Mines, Ltd 43
Edgar Irvine Co 60
Eganville, lime kilns 57
Eldorado Quarries, Ltd 43, 44
Electricity, accidents due to 128, 130, 131
Electro Metallurgical Co. of Canada, Ltd 25
Ellins Bros 58
Elliott, R. A 126
Elora, lime kilns 57, 103
Elzevir tp. *See* Actinolite.
Embossed brick, prices 41
Emmons, K. P 97
Empire Limestone Co 58
Employees. *See* Labour statistics.
Engineering construction contracts.
  See Construction contracts.
Ennis, R. T 52
Enniskillen tp., oil production 32
Errington, Joseph 65
Errington copper-zinc-lead m.
  See also Treadwell Yukon Co.
  Manager and address 51
  Operations 64, 65

PAGE

Esquesing tp. *See* Milton.
Etobicoke tp., sand and gravel..... 58
Evans, A. B..... 69
Evans, D. Owen..... 107
Evans, W. H..... 55
Exchange. *See* Premium on exchange.
Exolon Co..... 25
Explosives, accidents arising from.....127, 130, 131
Extra-provincial companies licensed... 44
Eyre, Reginald..... 49

F

Face brick. *See* Brick.
Fairbank tp..... 51
Fairlie, M. F..... 116
Falconbridge tp.
  Nickel and copper mg. *See* Falconbridge Nickel Mines.
Falconbridge Nickel Mines, Ltd.
  Blast furnace, manager and address. 54
  Manager of mine and address..... 53
  Officers..... 104
  Operations.....20, 105-107
  Quartz mg. for flux.....33, 56
Falconbridge Nikkleverk..... 20
Fancy, W. F.....55, 104
Fancy brick, statistics.....41, 42
Farley, P. J..... 109
Farr limestone quarry..... 61
Fasken, Alexander.....72, 121
Fatalities, mining.....125-129
Favel..... 79
Fawcett, T. C.....52, 76
Federal Petroleum Royalties, Ltd..... 43
Fees for analyses and assays.....49, 50
Feine, Geo. R..... 93
Feldspar.
  Industry and statistics.....2, 3, 28
  Mines and managers, listed..... 55
Feldspar Glass, Ltd..... 55
Feldspar Quarries, Ltd..... 55
Ferro-alloys..... 26
Fire.
  Levack nickel m..... 108
  McIntyre g. m..... 132
  Wentworth quarries..... 59
Fire-clay, James Bay slope..... 41
Fisher, Norman R..... 93
Fitzgeorge, Sir A. C..... 113
Fitzroy tp.
  Lead mg. *See* Kingdon Mg., Smelting and Mfg. Co.
Flagstone, statistics..... 40
Flamborough E. tp., sand and gravel.. 58
Flower pots, statistics..... 42
Flower Station.....29, 55
Flue-linings, statistics..... 2, 3
Fluorspar.
  Industry and statistics.....2, 3, 29
  Mine and manager..... 55
Flux, stone statistics..... 40
Flynn, W. A. O..... 53
Foley g.m.
  See also British Canadian Mines, Ltd.
  Dewatered..... 68
  Manager and address..... 51
Forbes, D. L. H.....52, 97
Forgue, Samuel..... 60
Fort Frances, classes for prospectors... 137

PAGE

Fort Frances mg. div.
  Assays, free, details..... 49
  Recorder's report..... 47
Fort William.
  Classes for prospectors.....137, 138
  Operating trap quarries..... 62
Foster, R. R.....58, 60
Foster s. m.....53, 123
Foster Cobalt Mining Co., dividends.. 18
France, industrial diamonds, imports.. 6
Fraser, Alistair..... 93
Freeman, Horace..... 29
Fripp, H. D..... 119
Frontenac Floor and Wall Tile Co....28, 55
Frontier s. m.....53, 116, 118, 119
Frood nickel m.
  Manager and address..... 53
  Operations.....108, 109
  Production..... 20
  Rescue station near..... 134
Fryatt, B. J..... 76
Fuller Gravel, Ltd..... 58
Furlong feldspar claim..... 55

G

Gaby, F. A..... 1
Galena. *See* Lead.
Galetta.
  Lead mg. *See* Kingdon Mg., Smelting, Mfg. Co.
Gallagher, Raymond..... 57
Gallagher Lime and Stone Co..... 57
Gananoque, granite quarry near..... 61
Garafraxa W. tp. *See* West Garafraxa tp.
Garrison, Mr..... 138
Garson nickel m.
  Manager and address..... 53
  Operations.....108, 109
  Production..... 20
Garson tp.
  See Falconbridge Nickel Mines; Garson nickel m.
Garvey gold vein..... 119
Gas, natural.
  Industry, notes by Harkness..... 32
  Leases and taxes, revenue..... 45
  Statistics..... 2, 3
Gas and Oil Developers, Ltd..... 43
Gauthier tp.
  Gold mg. *See* Ritchie Gold Mines, Ltd.
Genesee feldspar claim..... 55
Geneva l..... 104
Gilbertson, Gordon..... 59
Gill, J. R.....54, 107
Gillespie, Geo. H., Co., Ltd.....34, 57, 125
Gillies, R. A.....54, 126
Gillies tp.
  Silver mg. *See* Animikie Mines, Ltd.
Gilpin, D. B..... 99
Gilpin, D. M..... 99
Ginn, George..... 138
Ginn, H. G..... 47
Glass industry.
  Lime consumption..... 37
  Stone consumption..... 40
Glendinning, Geo..... 94
Glenelg tp., lime kilns..... 57
Glenwilliams, sandstone..... 62

PAGE

Globe, A. R....51, 64
Gloucester tp.
Limestone quarry.... 61
Sand and gravel.... 58
Goderich, salt....33, 56
Goderich Salt Co.... 56
Goetz, E. P.... 72
Gold.
See also Boston Creek, Kirkland Lake, Michipicoten, Porcupine g. fields.
Industry and statistics.... 1-14
milling, lime consumption.... 37
production from nickel-copper mines 21-24
world production.... 14
Mines.
accidents.... 128
dividends....12, 13
managers and addresses....51, 52
profit tax.... 48
reports....65-103
Mint receipts.... 14
Gold Hill g. m., production.... 9
Gold Reef g. m., production.... 11
Goldbank Syndicate....52, 76
Golden Lake.... 57
Golden Summit Mines, Ltd.... 52
Goldpines.... 79
Goodall tp.
Gold mg. *See* Metals Development, Ltd.
Goodreau, Chas.... 58
Gordon, A. E.... 61
Gordon Crushed Stone Co.... 60
Gordon Granite Co.... 61
Gosfield S. tp., sand and gravel.... 58
Goudreau g. m. (Michipicoten).
See also Bennett-Pacaud Mines, Ltd.
Dewatered.... 8, 67
Manager and address.... 51
Operations....67, 68
Goudreau Gold Mines, Ltd.... 67
Gowdy, Wm.... 57
Gower S. tp., sand and gravel.... 58
Gowganda mg. div.
Assays, free, details.... 49
Recorder's report.... 47
Gowganda silver field.
See also Castle-Trethewey Mines; Morrison Mines; Miller Lake O'Brien s. m.
Production....15, 17
Grace g. m. (Michipicoten).
Manager and address.... 52
Operations suspended.... 94
Production.... 7
Graham, A. R.... 63
Graham, H.... 76
Graham, R.... 84
Graham, T. H.... 109
Graham, Wm. T.... 107
Granite.
Industry and statistics....2, 3, 40, 41
Quarries and owners listed.... 61
Grant, A. J.... 61
Grant, Douglas I.... 76
Grant Bros. Construction Co.... 60
Graphite.
See also Black Donald Graphite Co.
Industry and statistics....2, 3, 29
Graton, L. C.... 70
Gravel. *See* Sand and gravel.

PAGE

Great Britain.
Industrial diamonds, imports.... 6
Great Lakes, sand and gravel.... 39
Great Lakes Dredge and Dock Co.... 59
Green, W. F.... 49
Greenburn Sand and Gravel Co.... 58
Greene, E. H.... 65
Greene, Richard T.... 121
Grenfell tp.
Gold mg. *See* Golden Summit Mines.
Grenville co., limestone quarries.... 60
Grenville Crushed Rock Co....60, 61
Grey, Andrew.... 76
Grit for poultry, statistics.... 40
Guelph.
Lime kilns.... 57
quarry.... 61
Gull Rock l.... 79
Gurd, Chas., and Co.... 56
Gypsum.
Industry and statistics....2, 3, 29
Mines, accidents.... 128
Mining. *See* Gypsum, Lime and Alabastine, Canada, Ltd.
Gypsum, Lime and Alabastine, Canada, Ltd.
Limestone quarries....57, 60
Manager and address.... 55
Operations.... 29
Gypsumville, Man.... 104
Gzowski, C. S.... 93

H

Hadley's Chatham, Ltd.... 59
Hagersville, limestone quarry.... 60
Hagersville Contracting Co.
See Canada Crushed Stone Corpn.
Hagersville Quarries, Ltd.... 60
Haggarty, J. C.... 56
Haight, J. C.... 84
Haileybury.
See also Farr limestone quarry.
Classes for prospectors....137, 138
Haldimand co.
Gypsum. *See* Gypsum.
Limestone quarry.... 59
Haliburton, limestone.... 59
Haliburton Exploration, Ltd.... 43
Hall, Oliver.... 109
Hall, R. Reece.... 61
Halladay, Reg.... 107
Halpenny, Lewis E.... 58
Halstead, A. G.... 68
Halton co., sandstone.... 62
Hamilton.
Blast furnace. *See* Steel Co. of Canada.
By-product coke ovens.... 29
Hamilton, F. H....99, 114
Hamilton By-Products Coke Ovens, Ltd.... 26
Hammersmith, F. A.... 64
Hanna, D. B.... 84
Harbour Brick Co.... 38
Hardy, J. Gordon....70, 104
Harkness, J. G....52, 94
Harkness, R. B.
Notes by, on natural gas and petroleum.... 32
Harris, G. H.... 72
Harvey Kirkland Mines, Ltd....52, 76

PAGE

Hastie, Morris....52, 76
Hastings co., actinolite.... 27
Haultain tp.
Silver mg. *See* Castle-Trethewey Mines, Ltd.
Hawk Lake, granite quarry.... 61
Hayden, Charles.... 107
Hayden Gold Mines Co., Ltd....52, 76
Haydite.
Notes on manufacture of.... 42
Statistics.... 3
Hayne, M.... 69
Heberle, T. W.... 76
Heckscher, August.... 121
Helmrich, G. L.... 109
Hematite, Ont.... 69
Henderson talc m....57, 125
Henniger, M. G.... 60
Henvey tp., feldspar.... 55
Hespeler, lime kiln....57, 103
Hess tp.
Lead-zinc mg. *See* Lake Geneva Mg. Co.
Heyson tp.
Gold mg. *See* Howey g. m.
High Falls, Michipicoten.... 94
High Falls, Spanish r.... 107
Highland Creek, sand and gravel.... 58
Highways Department, sand and gravel 39
Hill, A.... 59
Hill, John D.... 58
Himrod, William C.... 97
Hincks tp., gold claims.... 8
Hinde, Jas. H.... 58
Hinde Bros.... 38
Hogarth, D. M.... 70
Hokanson, Swan.... 61
Holdcroft, W.... 60
Holden, John B.... 76
Holland. *See* Netherlands.
Holland, H. E.... 47
Hollands-Hurst, H....52, 99
Hollinger g. m.
See also Hollinger Consol. Gold Mines.
Manager and address.... 52
Milling rate, daily.... 8
Production.... 7, 10
Operations.... 76-79
Hollinger Consolidated Gold Mines, Ltd.
Capital; officers; financial statement..76, 77
Dividends....12, 13
Profit tax.... 48
Hollinger Gold Mines, Ltd.... 12
Homegardner Sand Co.... 59
Homestead Gas and Oil, Ltd.... 43
Hook, O. M.... 55
Hooker, T.... 60
Horne, Wm.... 61
Hotchkins, F. J....51, 68
Howard, N. H.... 58
Howe, J. P.... 61
Howey g. m.
Manager and address.... 52
Milling rate, daily.... 8
Operations.... 79-84
Howey Gold Mines, Ltd.
Capital; officers.... 79
H.R. 960. *See* De Santis Gold Mg. Co.
H.S. 805, 961-66, g. locs. *See* De Santis Gold Mg. Co.
Huddlestone and Cline.... 11

PAGE

Hudson.... 79
Hudson Bay s. m....54, 124
Hudson Bay Mines, Ltd., dividends... 18
Hudson Bay Mining and Smelting Co. 116
Huffman Construction Co.... 60
Hughes g. m., production.... 11
Humberstone tp.
Limestone quarry.... 60
Sand and gravel.... 58
Huntingdon, W.Va.... 107
Huronian g. m. *See* Moss Mines, Ltd.
Huronian Mining and Finance Co.....83, 99
Notes by, on Howey g. m.... 84
Hurst, S. H.... 62
Hutchinson, William J.... 107
Hutchinson tp.
Gold mg. *See* Central Canada Mines.
Hyde, B. S.... 55
Hydrated lime, statistics.... 37
Hydro-Carbons, Ltd.... 43
Hydro-Electric Power Commission.
Operating trap quarry.... 62
Hyman, Bernard M.... 94

I

Illinois, U.S., feldspar.... 28
Imperial Chemical Industries, Ltd. *See* Canadian Industries, Ltd.
Imperial Oil Refineries, Ltd.... 32
Index map.
Sudbury nickel-copper area.....*frontis.*
India, gold production.... 14
Industrial construction contracts.
See Construction contracts.
Industrial diamonds, statistics.... 6
Infection after accidents.... 131
Ingham, Clark L.... 95
Ingram, J.... 99
Innerkip, lime kilns.... 57
Innerkip Lime and Stone Co.... 57
Innerkip Quarries, Ltd.... 60
Insecticide. *See* Arsenic.
Inspiration g. claims.... 99
Insulex. *See* Gypsum.
Interlake Transportation Co.... 59
International Nickel Co., dividends... 23
International Nickel Co. of Canada, Ltd.
See also Ontario Refining Co., Ltd.
Blast furnaces.... 54
Dividends.... 23
Mine managers and addresses.... 53
Officers; directors; finance.....107, 108
Operations; production.....20, 108, 109
Profit tax.... 48
Quartz mining.... 33
Refinery at Port Colborne.....21-24, 54, 108, 125, 126
Iridium.... 22
Iron and steel industry.
Lime consumption.... 37
Iron ore, production and industry.3, 5, 25, 26
Iron oxide, from pulp mill.... 30
Iron pyrites.
Industry and statistics.....2, 3, 29, 30
Mine and manager, listed.... 55
Irvine Co., Edgar.... 60

J

Jackfish l., Th. B. dist.... 93
Jacks Lake m.... 69

PAGE

Jacques, George ... 76
Jago Concrete Products Co ... 58
James, F. Conway ... 57
James Bay slope, fire clay ... 41
Jamieson, J. A ... 57
Jamieson Lime Co ... 57
Jaquays, H. M ... 126
Jardine, Hugh ... 51, 68
Jemmett, D. L ... 53, 114
Jemmett, Henry ... 53, 113
Jemmett, Ltd., D. L ... 44, 113
Johnson, E. E ... 69
Johnson Bros. Co ... 60
Johnston, Albert W ... 97
Johnston, G. F ... 50
Johnston, Strachan ... 88
Joliette, Que., lime plant ... 103
Jubien, L. P ... 63
Jubilee g. m ... 71
Jupiter g. m ... 91

K

K. 740-43, 867, 1,364-72, 1,397-99, 1,400-6 g. locs. *See* Howey g. m.
Kaolin, Mattagami r ... 41
Kashabowie. *See* Tip Top copper m.
Keast, A. J ... 70
Keeley, E. C ... 63, 127
Keeley s. m.
  See also Keeley Silver Mines, Ltd.
  Manager and address ... 53
  Operations ... 114-116
Keeley Silver Mines, Ltd.
  Capital; officers ... 114
  Dividends ... 18
Keg l ... 79
Kelley Island Lime and Transport Co. 59
Kennedy, A. J ... 57, 59
Kennedy, D. E ... 57
Kennedy, H. G ... 53, 123
Kennedy, Wm., and Sons, Ltd ... 25
Kenora, classes for prospectors ... 137, 138
Kenora dist.
  See also Patricia portion of Kenora.
  Sales; leases; revenue ... 45
Kenora mg. div.
  Assays free, details ... 49
  Recorder's report ... 47
Kenora Prospectors and Miners, Ltd. . 52
Kerr, J. D ... 103
Kerr Lake s. m.
  Manager and address ... 53
  Operations ... 110
Kerr Lake Mines, Ltd.
  Capital returned by ... 18
Kerr Lake Mg. Co., Ltd., dividends ... 18
Key map. *See* Index map.
Keystone s. m ... 53, 109, 110
Kidder, S. J ... 53, 109
Killarney quartz quarry ... 33, 56
Kincardine, salt ... 33
Kincardine Salt Co., Ltd ... 33, 56
King, Mr ... 138
King g. m ... 52
Kingdon Mining, Smelting and Mfg. Co., Ltd ... 52, 104
Kingston, feldspar mill ... 28
Kingston tp., sand and gravel ... 58
Kingston Penitentiary, limestone quarry 60

PAGE

Kingston Sand and Gravel Co ... 58
Kinkel, Edward G ... 93
Kirkfield, limestone quarry ... 60
Kirkfield Crushed Stone, Ltd ... 60
Kirkland Lake.
  See also Kirkland Lake gold field.
  Classes for prospectors ... 137, 138
Kirkland Lake gold field.
  See also Canadian Kirkland Mines; Kirkland Lake, Lake Shore, Sylvanite, Teck-Hughes, Tough-Oakes Burnside, Wright-Hargreaves g. mines.
  Boring operations ... 5
  Dividends ... 15
  Gold production ... 6, 7
  and silver ... 9
  Labour statistics ... 8
  Ore, average grade ... 8
  Premium on exchange ... 9
Kirkland Lake g. m.
  Manager and address ... 52
  Milling rate, daily ... 8
  Operations ... 84-86
  Production ... 7, 9
  Silver percentage ... 85
Kirkland Lake Diamond Drilling Co. . . 5
Kirkland Lake Gold Mining Co.
  See also Kirkland Lake g. m.
  Capital; officers ... 84
Kirkland Securities, Ltd ... 86
Kirkpatrick, S. F ... 126
Kissinger s. m ... 54, 124
Kitley tp., limestone quarry ... 61
Knapp, E. B ... 86
Knox, John, Jr ... 8, 51, 71, 76
Knutson, Martin O ... 52, 93
Kobler, Henry ... 93
Koons, Edward L ... 95
Kowkash mg. div.
  Assays, free, details ... 49
  Recorder's report ... 47
Kremzar Gold Mines, Ltd ... 44
Kuhorski, Mr ... 54

L

Laboratories. *See* Temiskaming testing laboratories.
Labour statistics.
  Cement ... 36
  Cobalt-silver ... 2
  Construction contracts ... 34
  Gold ... 8
    Hollinger ... 78
  Gypsum ... 29
  Lime ... 37, 38
  Nickel-copper ... 2, 21, 24
  Salt ... 33
  Stone ... 40
  Talc and soapstone ... 34
Lac Seul ... 79
Lake Erie, sand and gravel dredging ... 59
Lake Erie Sand Co ... 59
Lake Geneva Mg. Co., Ltd ... 53, 104
Lake Huron, quartz. *See* Killarney.
Lake of the Woods.
  Gold mg. *See* Kenora Prospectors and Miners, Ltd.; Laurentian Mines, Ltd.
Lake Ontario, sand and gravel ... 39

PAGE

Lake Shore g. m.
See also Lake Shore Mines, Ltd.
Manager and address ... 52
Milling rate, daily ... 8
Operations ... 86-88
Production ... 7, 9
Lake Shore Mines, Ltd.
Capital; directors ... 86
Dividends ... 12, 13
Profit tax ... 48
Lake Superior.
Gold, N. shore. *See* Beardmore g. m.
Sand and gravel dredging ... 59
Lacey mica mine ... 56
Lakefield, cement plant ... 36, 57
Lakeland Gold Mines, Ltd ... 52
Lamport, W. A ... 64
Langmuir g. claims. *See* De Santis Gold Mg. Co.
Langton, Thos ... 60
Lapierre, M. C ... 60
Lapish, F. C ... 59
Larder Lake mg. div.
Assays free, details ... 49
Recorder's report ... 47
Lark, Tom ... 93
La Rose s. m., leased ... 54
La Rose Mines, Ltd., dividends ... 18
Lash, John F ... 97
Lauper, R. A ... 57
Laurentian s. m ... 53, 116
Laurentian Mines, Ltd ... 53, 116
Law, R. E ... 61
Law Construction Co ... 60
Laycock. *See* Smith, W. H., and Laycock.
Lead.
See Kingdon Mg., Smelting and Mfg. Co.; Lake Geneva Mg. Co.; Treadwell Yukon Co.
Production ... 2-5
from silver mines ... 16
Leask, J. P ... 67
Lebel tp.
Gold mg. *See* Bidgood g. m.; Harvey Kirkland Mines.
Le Brocq, S. E ... 126
Lee, Dwight B ... 72
Lee, George R ... 138
Lee, W. W ... 56
Leeds tp., granite quarry ... 61
Legate, J. H ... 59
Levack nickel m.
Labour ... 109
Manager and address ... 53
Surface construction ... 20, 108
Ley, William ... 49
Licenses, sand and gravel ... 45
Lignite, Onakawana, Abitibi r ... 30, 55, 104
Lime, hydrated, statistics ... 2, 3
Lime.
Industry ... 37, 38
Statistics ... 2, 3
Lime kilns, owners and locations listed 57
Lime phosphate. *See* Apatite.
Limehouse.
Lime plant ... 57, 103
Sandstone quarry ... 62
Limestone.
Industry and statistics ... 25, 40, 41
Quarries and owners ... 59, 60

PAGE

Limestone Products, Ltd ... 60
Lindsley, Halstead ... 104
Lindsley, Thayer ... 70, 104
Lionite Abrasives, Ltd ... 25
Little, M. C. H ... 114
Little, T. B ... 93
Little Ochig l ... 69
Loesch, Gustave ... 93
Logan, Hugh ... 62
London Rolling Mills Co ... 25
Longbottom claims ... 94
Longford Crushed Stone Co ... 60
Longwell, Alex ... 70
Lonsdale, limestone ... 61
Loring, Frank C ... 113
Lorraine Quartzites, Ltd ... 43
Lorrain Trout Lake Mines, Ltd.
Dividends ... 18
Loughborough tp., mica ... 56
Loughborough Mining Co.
Manager and address ... 56
Profit tax ... 48
Louis, Austin ... 56
Lucky Cross g. m., production ... 9
Lumsden s. m ... 54, 124
Luoma, Vili ... 133
Lynch, E ... 53, 116
Lyndoch tp. *See* Beryl.
Lythmore, gypsum. *See* Gypsum.

M

Mabou, N. S., lime plant ... 104
McArthur, T. A ... 47, 138
McAulay, N. J ... 47, 138
McCallum, W. J ... 55
McCaul tp.
Gold mg. *See* Central Canada Mines.
McClure, J ... 69
McColl Bros., Ltd ... 32
McComb, Robert ... 76
McConnell, J. W ... 107
McCrea l ... 69
McCready, Wm. E ... 54, 124
MacDonald, Ivan ... 61
Macdonald, Peter ... 54, 55
McDougald, W. L ... 76
McDougall, D. H ... 88, 110
McDougall tp., granite quarry ... 61
McElroy tp.
Gold mg. *See* Tashota Gold Mines.
MacEwan, J. A ... 104
McEwen, A. L ... 109
McGinnis and O'Connor ... 61
McGowan, Sir Harry ... 107
McGregor, C. F ... 47
MacGregor, R. McAlpine ... 138
McIntyre Extension g. claims ... 91
McIntyre g. m.
See also McIntyre-Porcupine Mines.
Electric fire ... 132, 133
Manager and address ... 52
Milling rate, daily ... 8
Operations ... 88-93
Production ... 7, 10
McIntyre-Porcupine Mines, Ltd.
Boring operations ... 5
Capital; officers; finances ... 88
Diamond-drilling ... 5
Dividends ... 12, 13
Profit tax ... 48

PAGE

McKay, D. E. 69
McKee, George M 94
McKee, J. E 62
McKee, James 61
McKee Bros 61
McKenzie, D. C 109
McKessock, Magistrate 133
McKim tp.
See also Canadian Industries, Ltd.; Internat. Nickel Co of Canada.
Map showing industrial developments . . . . . *frontis.*
McKinley-Darragh-Savage Mines of Cobalt, Ltd., dividends 18
McLean, A. B., and Sons 59
McLean, B. L 68
McLean Building Review 34
McLennan, Frank 71
McLennan, R. S 63
McMahon, Robt 55
McMartin, Allen A 76
McMartin, Duncan 77
McMaster, R. H 126
McNab tp., lime 57
Macnamara l 56
McNeill, W. K.
Report on Provincial Assay Office . . . 49
MacPhadyen, K. A 69
McPherson, W. B 68
McQueen, A. M 84
McQueen, F 51, 68
McQueen, John 51
McQuigge, J. R 61
McQuoid, H. M 60
McRae, Wm. T 60
McTavish, R 69
McWilliams, Mr 138
Madawaska Syndicate 27
Madoc, talc plant 34, 125
Madoc tp., fluorspar 29
Maine, U.S., feldspar, production 28
Maisonville tp.
Gold mg. *See* Golden Summit Mines.
Manitoba, boring operations 6
Maple, Ont., sand and gravel 58
Maple Mountain s. area, production . . . 17
Maple Sand, Gravel and Brick Co 58
Maps.
Key. *See* Index map.
Sale of 45
March g. m.
Manager and address 52
Milling rate, daily 8
Operations 93
Production 7, 10
March Gold, Ltd., officers 93
Marcus limestone quarry 61
Marcy, William L 95
Mark, Joseph 103
Marmora tp., limestone 59
Martin, Ernest 86
Martin, George 53, 116
Martin's Siding 28
Matheson, classes for prospectors . . . 137, 138
Mattagami r., kaolin 41
Matthews, A. C 84
Maulson, Frank E 72
Medonte tp., limestone quarry 60
Mein, Wm. W 107
Melchett, Lord 20, 107
Merica, Paul D 107

PAGE

Merivale road, limestone quarry 60
Merlo, Merlo and Ray, Ltd 59
Metallic minerals.
Industry and statistics 1-26
Mines listed 51-54
Metallurgical works.
Accidents in 127, 128
Companies engaged in, listed 54
Lime consumption 37
Operators and addresses 25
Metals Development, Ltd 52
Methuen tp., trap rock 62
Mexico, gold production 14
Mica.
Industry and statistics 2, 3, 30, 31
Mines.
managers and addresses 56
profit tax 48
Michie, A 59
Michipicoten gold area.
Gold mg. *See* Cooper Gold Mines; Parkhill Gold Mines.
Mickle, G. R 48
Middleton, J. N 61
Mikado g. m 52
Miles, Chas. W 110
Mill Lake quarry 61
Millar, R. L 61
Mille Roches 60
Millen, M. M 57
Millenback, J. P 51, 70
Miller, D. G 64
Miller, Edwin Lang 101
Miller, George C 72, 97
Miller, Gerald F 101
Miller, W. N 47, 138
Miller Bay Gold Mines, Ltd 43
Miller Lake O'Brien s. m 53, 123
Millerton Gold Mines, Ltd 12
Mills, George 61
Milton, lime kiln 57, 103
Mincor Exploration and Development Co 117
Mine Centre.
Classes for prospectors 137
Gold. *See* Foley g. m.
Mine rentals 45
Mine rescue stations. *See* Rescue stations.
Mineral Resources Finance Co., Ltd 43, 44
Mineral waters.
Industry and statistics 2, 3, 31
Plants and managers, listed 56
Miners' licenses and permits 45, 46
Mines of Ontario.
Report by Chief Inspector *et al* 63-126
Mines Selection, Ltd 44
Mining accidents, report by inspectors 127-135
Mining company incorporations 43, 44
Mining Corporation of Canada, Ltd.
Ashley find drilled by 8
Capital and officers 116
Dividends 18
Mines owned and operated by 18, 53
Operations 116-119
Mining divisions, business statistics 46, 47
Mining land, sold and leased 45
Mining recorders. *See* Recorders' reports.
Mining revenue and expenditures 45-48

PAGE

Mining Tax Act, details of profit tax... 48
Mint. *See* Royal Mint, Ottawa.
Minto g. m. (Michipicoten).
See also Cooper Gold Mines, Ltd.
Manager and address..... 52
Operations..... 71
Production..... 7
Minto Gold Mines, Ltd..... 44
Mississagi Forest Reserve.
See also White Lake Mines, Ltd.
Assays, free, details..... 49
Mitchell, W. J..... 5
M. J. O'Brien, Ltd. *See* O'Brien, M. J., Ltd.
Molybdenite, production..... 5
Mond, Alfred. *See* Melchett, Lord.
Mond, Robert L..... 107
Mond Nickel Co., Ltd.
See also Internat. Nickel Co. of Canada.
Amalgamated with Internat. Nickel Co. of Canada..... 20
Dividends..... 23
Profit tax..... 48
Montgomery, Joseph.....67, 76, 119
Montgomery, R. J..... 62
Montreal, Que.
Calcite plant..... 27
Gypsum plant..... 103
Montreal River mg. div.
Assays, free, details..... 49
Recorder's report..... 47
Montreal River s. area, production... 17
Montrose tp., g. claims..... 8
Moore tp., oil production..... 32
Moot, Welles V..... 95
Morey, Ross..... 55
Morisette, N..... 5
Morlock, W. S..... 104
Morris, G. H..... 65
Morrison, Thomas..... 107
Morrison, Wm..... 61
Morrison s. m. *See* next ref.
Morrison Mines, Ltd.....53, 119, 120
Morrow, R..... 27
Morrow and Beatty..... 83
Morse, Geo. F..... 61
Mosa tp., oil production..... 32
Mosher claims..... 110
Moss tp.
Gold mg. *See* Moss Mines, Ltd.
Moss Mines, Ltd.
Capital; officers..... 93
Manager and address..... 52
Operations..... 8, 94
Moulding sand, consumption and value 39
Moulthrop, C..... 57
Moyle, H.....54, 123
Mumford, W. J.....53, 109
Murdoch, James Y..... 101
Muskoka dist., diatomite..... 28

N

Nairn Falls.....107, 108
Nassagaweya tp., limestone quarry.... 61
National Sand and Material Co..... 59
Natural gas.
Industry, notes by Harkness..... 32
Statistics.....2, 3, 32
Natural Gas Commissioner, permits... 45

PAGE

Neame, Austin..... 134
Neebing tp., limestone quarry..... 60
Neelands, C. F..... 61
Neelands, E. V..... 121
Neelon tp.
See also Canadian Industries, Ltd.; Internat. Nickel Co. of Canada.
Map showing industrial developments.....*frontis.*
Neilly, Balmer.....88, 110
Nelson, J. C..... 52
Nelson tp., limestone..... 61
Nelson Crushed Stone Co..... 61
Nepean tp., sand and gravel..... 58
Netherlands, industrial diamonds, imports..... 6
New Algoma District Power Co..... 94
New Hampshire, U.S., feldspar production..... 28
New Jersey, U.S., feldspar production. 28
New York state, U.S., feldspar production..... 28
New Zealand, gold production..... 14
Newray g. m., production..... 10
Newton, William.....53, 120
Niagara tp., limestone quarry..... 59
Niagara Falls. *See* American Cyanamid Co.
Nichol tp.
Lime kilns. *See* Elora.
Nichols, C. W..... 121
Nickel.
See also Falconbridge Nickel Mines; Internat. Nickel Co.
Consumption, world's..... 107
Industry and statistics.....1-3, 5, 20-24
Map showing developments in Sudbury area.....*frontis.*
Market for, notes on..... 109
Mines.
accidents..... 128
dividends..... 23
managers and addresses..... 53
profit tax..... 48
reports.....104-109
Production from silver mines..... 16
Nickel-copper matte, gold from..... 7
Nickel Hill Syndicate..... 17
Nickel Holdings Corpn..... 23
Nicol tp.
Silver mg. *See* Miller Lake O'Brien s. m.; Morrison Mines.
Night Hawk Peninsular g. m.
Production..... 10
Nill, F.....57, 59
Nipigon Forest Reserve.
Gold mg. *See* Beardmore g. m.
Nipissing s. m.
See also next two refs.
Future of, discussed..... 122
Manager and address..... 53
Operations.....121-123
Nipissing Mines Co., Ltd.
Capital and officers..... 120
Dividends..... 19
Nipissing Mining Co., Ltd.
Capital and officers..... 121
Dividends..... 19
Profit tax..... 48
Nisto l., Sask..... 121
"Nitre cake" plant.....108, 125

PAGE

Non-metallic minerals.
Industry and statistics.....1-4, 27-62
Mines, quarries, and works, listed...54-57
Noranda Mines, Ltd., limestone quarry 61
Norrie and McHardy..... 62
North Bay.
Classes for prospectors.....137, 138
Draughting office..... 50
North Carolina, U.S., feldspar production..... 28
North Star Oil Co..... 44
Northcrown g. m., production..... 10
Northern Development Dept.
Gravel and sand worked by..... 39
Northern Ontario Lands Corpn., Ltd.. 44
Northway, John A..... 79
Northwest Territories, boring operations..... 6
Northwestern Ontario.
See also Patricia portion of Kenora.
Gold production..... 7
Labour statistics..... 8
Norton, A. W..... 62
Norway, nickel smelter..... 20
Nottawasaga tp., limestone..... 61
Nova Scotia, boring operations..... 6
Novar, diatomite..... 28

O

Oakes, Harry..... 86
Oakes, Louis..... 86
Obonga l., chrome..... 51
O'Brien, J. A..... 126
O'Brien, M. J..... 126
O'Brien, M. J., Ltd.
See also O'Brien s. m.
Mines listed..... 53
Operations..... 123
Profit tax..... 48
O'Brien s. m.
Diamond-drilling..... 5
Manager and address..... 53
Operations..... 123
Oceania, gold production..... 14
Ochig lakes..... 69
O'Connor, W. J..... 56
O'Flynn, W. A..... 123
Ogden, P. W..... 97
Ogden tp.
Gold mg. *See* De Santis Gold Mg. Co.; Hayden Gold Mines Co.
Ohio, U.S., feldspar production..... 28
Oil. *See* Petroleum.
Oil Springs, oil production..... 32
Oliver, R..... 107
Onakawana lignite field.
See also Ont. Dept. of Mines.
Notes and analysis..... 30
Oneida tp.
Gypsum. *See* Gypsum.
Onondaga tp., oil production..... 32
Ontario Department of Mines.
Lignite mg., Abitibi r.....30, 55, 104
Ontario Diamond-Drilling Co..... 5
Ontario Gravel Freighting Co..... 59
Ontario-Kirkland g. m., production... 9
Ontario Power Service Co..... 1
Ontario Refining Co.
Capital and date of license..... 44
Copper refinery, Copper Cliff.....24, 54

PAGE

Ontario Refining Co.—*Continued*
Operations.....108, 126
Owners named..... 20
Ontario Reformatory, limestone quarry 61
Ontario Rock Co..... 62
Orillia tp. *See* Limestone Products, Ltd.
Ornamental brick. *See* Brick.
Ornamental stone, statistics..... 40
O'Rourke, M. F..... 47
Osburn, D. F..... 109
Osler, Britton.....107, 126
Osmium..... 22
O'Sullivan, C. D..... 64
Ottawa, classes for prospectors.....137, 138
Ottawa r., sand and gravel..... 39
Owen Sound.
Lime kiln..... 57
Limestone quarry worked by..... 61
Metallurgical plant..... 25
Oxford tp.
Limestone quarry. *See* Beachville.
Sand and gravel..... 58
Oxford W. tp. *See* West Oxford tp.

P

P. 6,132. *See* De Santis Gold Mg. Co.
Pacaud tp.
Gold mg. *See* Barry-Hollinger g. m.
Pakenham tp., mineral waters..... 56
Pakwash l..... 79
Palladium.....21, 22
Paris.
Alabastine plant..... 103
Sand and gravel..... 58
Park, Hugh.....53, 121
Park Mining Co.....43, 44
Parker, R. D.....53, 109
Parkes, J. C..... 63
Parkhill Gold Mines, Ltd.
Capital; officers; operations..... 94
Contract for mill..... 8
Manager and address..... 52
Parkinson, N. F..... 104
Pascalis dist., Que..... 117
Paterson, J. D..... 93
Paterson, W. L..... 57
Patno, J. D..... 103
Patricia portion of Kenora.
See also Red Lake mg. div.
Assays, free, details..... 49
Gold mg. *See* Central Patricia Mines; Howey g. m.
Sales; leases; revenue..... 45
Patterson, Norman M..... 138
Paving blocks, statistics..... 40
Paymaster g. m.
See also United Mineral Lands Corpn.
Manager and address..... 52
Production..... 10
Paymaster Consolidated Mines, Ltd...43, 99
Peat.
Industry..... 32
Statistics..... 2, 3
Pembroke, limestone quarry..... 61
Peninsula Granite Quarries, Ltd..... 61
Penn-Canadian s. m., leased 53, 110
Penn-Canadian Mines, Ltd., dividends. 19
Permits. *See* Boring permits; Miners' licenses and permits.

PAGE

Peterborough.
Sand and gravel operators 58
Peterson Lake s. m. 53, 116
Peterson Lake Silver-Cobalt Mg. Co.
Dividends 19
Petroleum.
Industry, notes by Harkness 31, 32
Statistics 2, 3, 32
Petrolia, oil production 32
Phlogopite. *See* Mica.
Phosphate of lime. *See* Apatite.
Pickering tp., sand and gravel 58
Pickle I 69
Pierce, Jas. S 76
Pig iron.
Production nil 3, 5
Statistics 25
Pine Ridge 79
Pirson, John 61
Plaster. *See* Gypsum.
Platinum metals.
Fall in price 107
Statistics 1-3, 5, 21-24
Plenaurum g. claims 91
Plympton tp., oil production 32
Poitevin, E 138
Pomeroy, Robt. W 97
Pontardawe, Wales 107
Porcupine g. field.
See also Coniaurum, Dome, Hayden, Hollinger, March, McIntyre, Rochester, Vipond, West Dome g. mines; United Mineral Lands Corpn.
Barite 27
Boring operations 5
Dividends 13
Gold production 6, 7
and silver 10, 11
Labour statistics 8
Ore, average grade 8
Premium on exchange 11
Porcupine g. m., development 94
Porcupine mg. div.
Assays free, details 49
Recorder's report 47
Porcupine s. m. 53, 109, 110
Porcupine Crown s. m., production 10
Porcupine Crown Mines, Ltd.
Dividends 12, 13
Porcupine Pet g. m., production 11
Porcupine United Gold Mines, Ltd.
See also Rochester g. m.
Capital; officers; operations 94
Production 7, 11
Porphyry, Kirkland Lake g. m. 86
Porphyry Hill g. m., production 11
Port Arthur, classes for prospectors .. 137, 138
Port Arthur mg. div.
Assays, free, details 49
Recorder's report 47
Port Colborne.
See also Canadian Furnace Co.
Cement plant 35, 57
Refinery 21-24, 54, 108, 125, 126
Port Maitland 58
Porter, J. Bonsall 97
Portland cement. *See* Cement.
Portsmouth, limestone quarry 60
Potter-Doal g. m., production 7
Pottery, statistics 2, 3, 42

PAGE

Poultry grit, statistics 40
Power and Mines Corpn 94
See also Grace g. m.
Prather, V. R 64
Premium on exchange.
Kirkland Lake area 9
Porcupine area 11
Hollinger g. m. 77
McIntyre g. m. 89
Preston, Wesley 110
Preston g. m., production 11
Price, C. W 53, 123
Pritchard, O. L 76
Profit tax 45, 48
Proprietary Mines, Ltd 44
Prosecutions. *See* Accidents.
Prospectors, classes for 136-138
Prosser, Seward 107
Provincial s. m. 54, 124
Provincial Assay office 49
Pulp and paper industry.
Lime consumption 37
Pyrites for 30
Stone statistics 40
Puslinch, lime plant 103
Puslinch Quarry, Ltd. *See* Canada Crushed Stone Corpn.
Pyke Salvage Co 59
Pyrite. *See* Iron pyrites.

Q

Quartz and Quartzite.
Industry 32, 33
Quarries.
accidents 127, 128
listed 56
Statistics 2, 3
Quartz porphyry 84
Quartzite. *See* Quartz and Quartzite.
Quebec prov., boring operations 6
Queenston Quarries, Ltd *See* Canada Crushed Stone Corpn.
Quemont Mining Corpn 116
Quicklime, statistics 2, 3, 37
Quigleys 58
Quinn Stone and Ore Co 62
Quinton, W. Y 61

R

Radio-active deposits near Wilberforce. 31
Railway ballast, statistics 40
Rainy River dist.
Gold mg. *See* Central Canada Mines; Foley g. m.
Sales; leases; revenue 45
Raleigh tp., oil production 32
Rama tp., limestone 61
Ramsay tp., lime kiln 57
Ray, S. W 53, 109
Rayner, Geo 61
Rayner Construction Co 61
Rea, T. H 70
Rea g. m.
Dividends 12, 13
Production 10
Read, E. R 97
Record books, sale of 45
Recorders' reports 47
Recording fees 45

PAGE

Red l. *See* Central Patricia Mines; Howey g. m.
Red Lake mg. div.
See also Central Patricia Mines; Howey g. m.
Assays, free, details 49
Recorder's report 47
Red Lake Tiger Gold Mines, Ltd 44
Redington, John 51, 70
Redvers, Dixon 47
Reece-Hall, R 61
Refineries. *See* Metallurgical works.
Reilley, W. W 97
Reinold, C. B 63
Renfrew, lime kilns 57
Renfrew co., beryl 27
Rescue stations 134, 135
Research Service, Ltd 44
Residential construction.
See Construction contracts.
Revenue. *See* Mining revenue.
Reynolds, E. G 61
Rhodesia.
Copper 109
Gold 14
Rhodium 22
Richardson, J. A 107
Richardson feldspar claim 55
Ridgeley g. claims 99
Ridgeway, limestone 61
Right of Way Mines, Ltd.
Dividends 19
Right of Way Mining Co., Ltd.
Dividends 19
Ritchie Gold Mines, Ltd 52
River Sand Brick Co 38
Road metal, statistics 40
Roberts, W. A 51, 67
Roberts, W. H 60
Robillard, B. E 61
Robillard and Son, H 61
Robinson, E. W 109
Robinson, J. H 57
Robinson, John B 72
Robinson, L. V 55, 103
Robinson, T. F 57, 60
Rochester g. m 7, 52
See also Porcupine United Gold Mines, Ltd.
Manager and address 52
Production 7
Rockingham ware 41
Roddy, J. M 61
Rodgers, C. E 52, 95
Rogers, Frank 62
Rogers, Geo. W 99
Rogers, W. R.
Report by, on Statistical Review of Mineral Industry 1-62
Ronaghan, James P 63
Roofing material. *See* Actinolite.
Rope tests 134
Roper, C. P 53, 123, 124
Rose, E. H 116
Rose, R. R 52, 104
Ross, F. M 93
Rothwell, T. E 49
Roussac, J. A. S 52, 94
Routly, H. T 61
Royal Mint, Ottawa.
Bullion statistics 14

PAGE

Royalties, sand and gravel 45
Russell, D. J 51, 64
Russell, F. C 63
Russell tp., limestone 59
Russia, gold production 14
Ruthenium 22
Rutherford, C 64
Ryan Diamond-Drilling Co 5

S

St. Anthony g. m., production 7
St. Charles, W. P 86
St. Clair r.
Sand and gravel 39
dredging 59
St. Joseph l 69
St. Lawrence r.
Sand and gravel 39
dredging 59
St. Mark, Que., lime plant 103
St. Marys r.
Sand and gravel 39
dredging 59
St. Marys Cement Co 36, 57
St. Marys Crushed Stone, Ltd 60
Salmon, H. H 60
Salmon River, B.C 104
Salt.
Industry and statistics 2, 3, 33
Wells or works and address, listed 33, 56
Saltfleet tp.
Limestone quarry 59
Sand and gravel 58
Sand and gravel.
Accidents in pits 127
Industry 38, 39
Operators, listed 58, 59
Revenue from 45
Statistics 2, 3
Sand-lime brick.
Industry and statistics 2, 3, 38
Lime consumption 37
Sandoe, Richard 54, 123
Sandstone.
Operators and quarries, listed 62
Production 40, 41
Sandwich, salt 33, 56
Sanitaris, Ltd 56
Sapawe lake, gold mg 69
Sarabura, A 54, 124
Sarnia, salt 33, 56
Sarnia tp., oil production 32
Saskatchewan.
See also Ball clay; Sodium sulphate.
Boring operations 6
Sault Ste. Marie.
See also Algoma Steel Corpn.
Blast furnace 25
Coking plant 26
Prospectors' classes 137, 138
Sault Ste. Marie mg. div.
Assays, free, details 49
Recorder's report 47
Schmidt, Charles J 93
Schumacher g. m.
Dividends 12
Production 10
Schwingel, Jacob 93
Scott, H. L 62
Scott, T. G 59

PAGE

Scottish-Ontario g. m.
See also Canusa Mg. and Exploration Co.
Manager and address 51
Operations 69
Production 11
Seaman, A. G 69
Seed, W. E 124
Select Mineral Properties, Ltd 43
Seller, George 54
Seneca tp.
Gypsum. *See* Gypsum.
Seneca-Superior Silver Mines, Ltd.
Dividends 19
Sewer-brick, prices 41, 42
See also Brick.
Sewer-pipe, statistics 2, 3, 36, 40
Shaft accidents 128
Shane, Geo. R 57
Shane Lime Co 57
Sharman, J. H 76
Sharp, A. L 53, 109
Sharpe, Alfred H 95
Sheppard, W. J 88, 110
Sherman and Hubbell 58
Sherkston, sand and gravel 58
Shield Development Co., Ltd 51
Shillington, R. T 99, 114
Shipley, Grant B 107
Shorey, F. C 97
Silica brick.
Industry 33
Quarries listed 56
Statistics 2, 3
Silver.
See also Cobalt, Gowganda s. fields; South Lorrain tp.
Fall in price 121
Industry and statistics 1-3, 5, 15-19
amount in gold ores 7, 9, 85
nickel ores 21, 22
Mines.
accidents 128
dividends 18, 19
managers and addresses 53, 54
profit tax 48
reports 109-124
Refineries. *See* Cobalt Reduction Co.; Deloro Smelting and Refining Co.
Silver-cobalt, statistics and industry ... 15-19
Silver islet 17
Silver Cliff s. m 53, 123
Silver Queen s. m 53, 120
See also Cobalt Silver Queen, Ltd.
Simpson, Wm. J 52
Sinclair, D. G 63, 127
Sin-Mac Lines, Ltd 59
Sioux Lookout.
Base for airplanes 79
Classes for prospectors 137, 138
Sixt, W. M 52, 84
Skead tp.
Gold mg. *See* Telluride Gold Mines of Canada.
Smeaton, R. C 62
Smelters. *See* Metallurgical works.
Smith, Arnold 53
Smith, J. D. C 47, 138
Smith, Oscar R 5

PAGE

Smith, R. Home 79, 99, 114
Smith, R. M 60
Smith, W. H., and Laycock 54, 124
Smith and Travers 5
Smythe, Ltd 58
Snider tp. *See* Copper Cliff.
Soapstone, industry and statistics 2, 3
See also Talc.
Sodium sulphate from Saskatchewan ... 125
Soliaque, L 97
South Africa. *See* British South Africa; Rhodesia.
South Dakota, U.S., feldspar production 28
South Dumfries tp. *See* Paris.
South Lorrain tp.
Silver.
mg. *See* Frontier s. m.; Keeley s. m.
production 8, 11, 15, 17
tons treated 117
Soviet Republic. *See* Russia.
Springer, D 60
Springs. *See* Mineral waters.
Stafford, W. H 99, 114
Stamford tp.
Limestone quarry 61
Sand and gravel 58
Standard White Lime Co 57
Stanley, J. N 62
Stanley, Robt. C 107, 126
Statistical review, mineral industry 1-62
Steatite. *See* Soapstone.
Steel, H 126
Steel, statistics 25
Steel Company of Canada, Ltd.
Blast furnace 25, 26
Manager and address 54
Operations 126
Stephens, J 59
Stern, Morton F 72
Stewart, James A 113
Stikine River area, B.C 117
Stodart, A. B 116
Stoklosar, Chas. A 55
Stone.
Industry and statistics 2, 3, 40
Quarries and managers, listed 59-62
Stoneham s. m 54, 124
Stout, Andrew V 107
Stovel, J. H 72
Stringer, P. J 60
Strong, Horace F 53, 119
Structural materials.
Industry and statistics 1-3, 34
Quarries or works, listed 57-62
Stucco dash, statistics 40
Sturgeon l., Th. B. d.
Gold. *See* St. Anthony g. m.
Sudbury.
See also Sudbury dist.
Classes for prospectors 137, 138
Mine rescue station, notes and photo 134
Sudbury dist.
Boring operations 5
Copper-zinc-lead mg. *See* Treadwell Yukon Co.
Gold in nickel ores 21-24
Gold mg. *See* Canadian Champion Reef Mg. Co.
Lead and zinc mg. *See* Lake Geneva Mg. Co.

PAGE

Sudbury dist.—*Continued*
Nickel-copper mg. *See* Falconbridge Nickel Mines; Internat. Nickel Co. of Canada.
Sales; leases; revenue 45
Sudbury mg. div.
Assays, free, details 49
Recorder's report 47
Sudbury Basin Mines, Ltd 51
Sudbury Diamond-Drilling Co 5
Sudbury Patricia Mines, Ltd 43
Sullivan, Roy 54, 124
Sulphur, statistics 2, 3
Sulphur fumes arbitrator, damages collected 45
Sulphuric acid.
See also Canadian Industries, Ltd.
Amount used in coking industry 26
From sulphur fumes 29
Industry and statistics 2, 3, 29, 30
Plants for making 55, 125
Summer, O. W 76
Summerhays, M. W 52, 101
Summerville, sand and gravel 58
Sunstrum 79
Superior Alloys, Ltd 25
Superior Explorations, Ltd 43
Superior Zinc Corporation of Canada .. 44
Sutherland, F. C 67
Sutherland, Hugh A 54, 58
Swastika g. m., production 9
Sydenham tp. *See* Owen Sound.
Sylvanite g. m.
See also Sylvanite Gold Mines, Ltd.
Manager and address 52
Milling rate, daily 8
Operations 94-97
Production 7, 9
Sylvanite Gold Mines, Ltd.
Capital; officers 94, 95
Dividends 12, 13
Symes, C. B 62

T

Tait, Sir Thomas 94
Talc.
Industry and statistics 2, 3, 34
Mining. *See* Canada Talc. Co.; Gillespie, Geo. H., Co.
Tar, statistics 26
Tariff of fees for analyses and assays .. 50
Tashota Gold Mines, Ltd 52, 97
Taxes, revenue 45
Taylor, Roy 57, 125
Taylor, W. D 110
T.B. 8,422, 8,814. *See* Consol. Chromium Corpn.
Teck tp.
See also Canadian Kirkland g. m.; Goldbank Synd.; Kirkland Lake g. m.; Lake Shore g. m.; Sylvanite g. m., Teck-Hughes g. m.; Wright-Hargreaves g. m.
Gold mg 76, 84
Teck-Hughes g. m.
See also Teck-Hughes Gold Mines.
Manager and address 52
Milling rate, daily 8
Operations 97, 98
Production 7, 9

PAGE

Teck-Hughes Gold Mines, Ltd.
Capital; officers 97
Dividends 12, 13
Profit tax 48
Telfer, R. A 103
Telluride Gold Mines of Canada, Ltd 52, 98, 99
Temiskaming s. m.
Manager and address 54
Output 123
Temiskaming and Hudson Bay Mg. Co., Ltd., dividends 19
Temiskaming and Northern Ontario ry.
Extended to lignite field 30
Temiskaming Mg. Co., dividends 18
Temiskaming Testing Laboratories. 45, 48, 49
Tennessee, U.S., feldspar production ... 28
Terazzo flooring 39, 40
Testing laboratories 45, 48, 49
Thames r.
Sand and gravel 39
dredging 59
Thamesville oil field, production 32
Thompson, Charles 67
Thompson, F 62
Thompson, John F 97, 107
Thomson, R. G. O 84
Thorold.
Limestone quarry 60
Metallurgical plant 25
Three Rivers, Que 30
Thunder Bay dist.
Chrome mg. *See* Consol. Chromium Corpn.
Gold mg. *See* Beardmore g. m.; Central Canada Mines; Moss g. m.; Tashota Gold Mines.
Sales; leases; revenue 45
Thurlow tp., limestone quarry 59
Tice, E. M 65
Tiedt, Henry 93
Tilbury East tp., oil 32
Tile 2, 3
Tillsonburg Oil and Gas Co 43
Timagami reserve.
Assays, free, details 49
Timiskaming dist.
Gold mg. *See* Argyle, Bannockburn, Lebel, McElroy, Pacaud, Skead, Teck tps.
Sales; leases; revenue 45
Silver mg. *See* Bucke, Coleman, Haultain, Nicol, South Lorrain tps.
Timiskaming mg. div.
Assays, free, details 49
Recorder's report 47
Timmins, Jules R 76
Timmins, Leo H 76, 77
Timmins, Noah A 76
Timmins, Ont.
Classes for prospectors 137, 138
Gold mg. *See* Hollinger g. m.
Mine rescue station 134
Tip Top copper m.
Manager and address 51
Tisdale tp.
Gold mg. *See* Coniaurum, Hollinger, Dome, McIntyre-Porcupine, Vipond, West Dome g. mines; Porcupine United Gold Mines.
Todd, E. W 85

PAGE

Todd, F. H....54, 124
Tolman, J. D....52, 94
Tomlenson, F.... 133
Tommy Burns g. m., production.... 11
Toronto.
Building permits, value.... 34
Classes for prospectors....136-138
Toronto tp., sand and gravel.... 58
Toronto Brick Co....38, 57
Tough, George.... 68
Tough-Oakes Burnside g. m.
See also Bunker Hill Extension Mines, Ltd.
Dividends....12, 13
Manager and address.... 51
Operations.... 68
Production.... 9
Townsend, Everett.... 55
Trafford, C. E.... 116
Transvaal, gold production.... 14
Trap rock.
Quarry operators listed.... 62
Statistics....2, 3, 40
Travers, J. T.... 51
Travers and Smith.... 5
Treadwell Yukon Co., Ltd.
See also Errington copper-zinc-lead m.
Gold in exports.... 7
Officers.... 64
Trethewey Silver Cobalt Mines, Ltd.
Dividends.... 19
Tudhope, J. B....88, 110
Tuer, C. F....54, 124
Turk, E....99, 114
Turnbull g. claims.... 72
Turner, E. S.... 94
Tyendinaga tp., limestone.... 61
Tyrrell, J. B.... 84
Tyrrell tp., g. claims....117, 119

U

Uhthoff, limestone.... 61
Union Carbide Co. of Canada, Ltd.... 25
United Kingdom, industrial diamonds, imports.... 6
United Mineral Lands Corpn....99, 101
See also Paymaster g. m.
United States.
Feldspar industry, notes.... 28
Gold, production.... 14
Industrial diamonds, imports.... 6
Tariff high on barite and feldspar... 28
Unwrought Metal Sales Act.... 45
Uraninite near Wilberforce.... 31

V

Vallery, Frank.... 58
Vancouver, B.C., gypsum plant.... 103
Van der Voort, M. P.... 88
Vaughan, H. H.... 97
Vaughan tp., sand and gravel.... 58
Vermilion l.... 51
Ventures, Ltd.
See also Coniaurum g. m.
Copper refining.... 20
Part owner Ontario Refining Co.... 126
Verona feldspar claim.... 55
Victory s. m....54, 124

PAGE

Vincent, G. G.... 125
Vipond g. m.
See also Vipond Consolidated Mines.
Manager and address.... 52
Milling rate, daily.... 8
Operations....99-101
Production.... 7, 10
Vipond Consolidated Mines Ltd.
Capital; officers; finance.... 99
Dividends....12, 13
Profit tax.... 48
Virginia, U.S., feldspar production.... 28

W

Wabageshik....107, 108
Wages. *See* Labour statistics.
Waite, J. H. C.... 69
Waldman s. m....53, 114
Walker, David.... 61
Walker Bros.... 61
Wall board. *See* Gypsum.
Wallace, R. R.... 61
Wallace and Sons, R.... 61
Wallaceburg, lime plant.... 57
Wallaceburg Sand and Gravel Co.... 59
Wallder, W. B.... 63
Walpole tp., limestone quarry....59, 60
Walsh g. claims.... 69
Walter, H. W.... 54
Walton, W. S.... 95
Ward, R. N....54, 124
Warren, J. E.... 126
Waters, mineral. *See* Mineral waters.
Water power. *See* Abitibi canyon.
Waterdown.... 58
Waterford Sand and Gravel Co.... 58
Waterloo tp.
Sand and gravel.... 58
Lime. *See* Hespeler.
Watson, C. G.... 50
Watson, J. C.... 116
Watson, J. P.... 116
Wawa, gold near. *See* Cooper Gold Mines, Ltd.
Webster, A. R....63, 127
Wehman, John.... 61
Weir, Rt. Hon. Lord.... 107
Welch, John.... 60
Welland, metallurgical plants.... 25
Welland co. *See* Niagara Falls; Stamford tp.
Welland Ship Canal, limestone quarrying.... 61
Welland Steel Castings, Ltd.... 25
Wells, R. G.... 126
Wentworth Quarries, Ltd. *See* Canada Crushed Stone Corpn.
Weppler, Henry.... 57
West Australia, gold production.... 14
West Dome g. m.
See also West Dome Lake Gold Mines, Ltd.
Manager and address.... 52
Production.... 7, 10
West Dome Lake Gold Mines, Ltd...99, 101
West Garafraxa tp.
Limestone.... 61
Sand and gravel.... 58
West Oxford tp.... 58
Sand and gravel operators.... 58

PAGE

West Shiningtree area 68
West Zorra tp., sand and gravel..... 58
Western Canada Airways..... 79
Western Canada Flour Mills Co.....53, 56
Western Salt Co.....33, 56
Westminster tp., sand and gravel..... 58
Wettlaufer, Conrad E..... 97
Wettlaufer Lorrain Silver Mines, Ltd.
Dividends 19
White arsenic. *See* Arsenic.
White Lake Mines, Ltd.
Capital; officers; operations..... 64
Manager and address..... 51
White Reserve s. m..... 54
Whiting.
See also Calcite.
Stone statistics..... 40
Whitney tp.
Gold mg. *See* Scottish-Ontario g. m.
Wickett, S. R..... 110
Widdifield tp. *See* North Bay.
Whittingham, H..... 70
Wilberforce, mineral waters 31
Wilcox, C. S..... 126
Wilford and Co., F. R..... 61
Wilkie Mines, Ltd..... 44
William Kennedy & Sons, Ltd..... 25
Williams, B. J..... 60
Wilson, M..... 58
Wilson, W. P..... 61
Windmill Point Crushed Stone Co.... 61
Windsor Sand and Gravel Co..... 58
Winnipeg, Man., gypsum plant..... 103
Wishart, J. A..... 109
Wolford tp., limestone quarry..... 61
Woodland, C. M..... 60
Woodstock, sand and gravel..... 58

PAGE

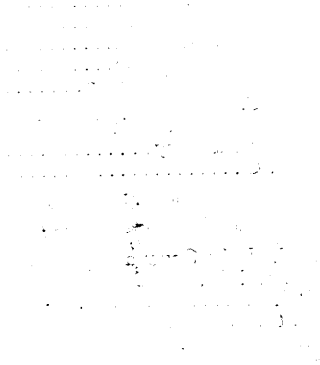
World.
Gold production..... 14
Nickel consumption..... 107
Wright, S. B.....54, 126
Wright, W. H.....86, 101
Wright and Co.....33, 56
Wright-Hargreaves g. m.
See also Wright-Hargreaves Mines.
Manager and address..... 52
Milling rate, daily..... 8
Operations.....101-103
Production..... 7, 9
Wright-Hargreaves Mines, Ltd.
Capital; officers..... 101
Diamond-drilling..... 5
Dividends.....12, 13
Profit tax..... 48

Y

Yates, Harry..... 95
Yates, Richard C..... 54
York tp., sand and gravel..... 58
York Sandstone Brick Co..... 38
Yorkshire Cobalt Mining Co.....54, 124
Young, A. C.
Report by, on Statistical Review of Mineral Industry..... 1-62
Young, H. G.....52, 79

Z

Zinc.
Mg. *See* Lake Geneva Mg. Co.; Treadwell Yukon Co.
Statistics.....2, 3, 5
Zorra E. tp. *See* East Zorra tp.
Zorra W. tp. *See* West Zorra tp.





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DEPARTMENT OF MINES

HON. CHAS. MCCREA, *Minister of Mines* THOS. W. GIBSON, *Deputy Minister*

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Geology of the Ontario-Manitoba Boundary (12th Base Line to Latitude 54), by D. R. Derry and G. S. MacKenzie - 1-20

Geology of the Heron Bay Area, District of Thunder Bay, by J. E. Thomson - - - - - - - - - - - 21-39

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TABLE OF CONTENTS

Vol. XL, Part II

GEOLOGY OF THE ONTARIO-MANITOBA BOUNDARY

PAGE

Introduction 1
Acknowledgments 1
Routes Followed 2
Previous Work 3
Topography 3
Drainage 4
Elevation 4
Timber 4
Fish and Game 5
General Geology 5
Keewatin (?) 6
Azure Lake Belt 6
Tuff 6
Greywacké 7
Iron Formation 7
Quartz-Mica Schist and Paragneiss 7
Volcanics 7
Basic Intrusives 8
Carbonate Replacement 8
Greenstone Area at Mile 64 8
Other Small Greenstone Areas 9
Island Lake Belt 10
Sediments 10
Pyroclastic Rocks 10
Volcanic Rocks 11
Basic Intrusives 11
Structure and Age Relations 12
Intrusive Series (Algoman?) 12
Diorite 12
Granodiorite 13
Grey Hornblende Granite 13
Biotite Granite 13
Granite Gneisses 13
Feldspar Porphyry 13
Quartz Porphyry 14
Pegmatite and Aplite Dikes 14
General Relations of the Intrusives 15
General Correlation 15
Pleistocene 16
Economic Geology 18
Agricultural Possibilities of the Clay Belt 19

GEOLOGY OF THE HERON BAY AREA

Introduction 21
Acknowledgments 22
Access 23
Previous Work 23
Topography and Drainage 23
Natural Resources 25
Timber 25
Game and Fish 25
Agriculture 25
Inhabitants 25
Economic Geology 25
General Geology 26
Keewatin 27
Algoman 29
Red and Augite Syenite 29
Granites and Gneisses 30
Granite and Feldspar Porphyry 30
Keweenawan 31
Pleistocene and Recent 31
Geologic Structures 32
Economic Geology 32
Gold 32
Johnston Claims 32
Claims S. S. M. 6,533 and 6,534 32
Heron Cove Mine 32
Beaumont and Davidson Claims ... 33
Copper-Nickel 33
Iron 33
Pebbles and Cobble Stones 35
Granite 35
Peninsula Granite Quarries, Limited 35
Black Granite 35
Red Granite 37
England Claims 38

ILLUSTRATIONS

PAGE

Aerial photograph looking southwest along the boundary towards Hilton lake.....*frontispiece*
View of interprovincial boundary Monument No. 289 south of Hayward lake..... 1
Stone mound No. 242 on the interprovincial boundary..... 3
Greywacké showing uneven weathering due to carbonate replacement, Azure lake..... 9
Banded epidote rock, probably an altered pyroclastic deposit, mile 87..... 11
Tongue of grey granite intruding andesite, both being cut by a dike of aplite..... 14
Pleistocene varved clay, Varveclay lake..... 17
Typical topography of the clay belt. looking across the boundary towards Manitoba, mile 64 19
View across the valley of the Pic river from the C.P.R..... 21
View along the main line of the C.P.R. at Heron Bay, Lake Superior..... 24
Exposure of agglomerate on an island north of Ogilvy point, Lake Superior..... 28
Typical view along the shore of Bamoos lake, showing a ridge of augite syenite..... 29
Glacial varved clays overlain by sands exposed along the banks of the Pic river..... 31
Quarrying of red granite at Peninsula..... 38

SKETCH MAPS AND SECTIONS

PAGE

Key map showing location of Ontario-Manitoba boundary from the 12th base line to latitude 54..... 2
Structure section across the belt of sediments at Azure lake..... 6
Diagrammatic vertical section to show the relationships of the intrusive series..... 15
Section along the 4-mile portage north from Opasquia lake, showing the transition from varved clay to coarse morainic material..... 16
Key map showing location of the Heron Bay area..... 22
Geological sketch map of the properties of Peninsula Granite Quarries, Limited, Peninsula. 34

COLOURED GEOLOGICAL MAPS

(In pocket at back of report)

Map No. 40*a*—Ontario–Manitoba boundary from the Angle at the Twelfth Base Line, Manitoba, Northeast to Island Lake. Scale, 4 miles to the inch.
Map No. 40*d*—Heron Bay Area, District of Thunder Bay, Ontario. Scale, 1½ miles to the inch.

Courtesy Royal Canadian Air Force



Aerial photograph looking southwest along the boundary towards Hilton lake. The boundary line was not cut out at the time the photograph was taken, but its position is here drawn in.

Geology of the Ontario-Manitoba Boundary

(12th Base Line to Latitude 54)

By D. R. Derry and G. S. MacKenzie

INTRODUCTION

The writers, for the Ontario and Manitoba Departments of Mines, respectively, were instructed to make a reconnaissance geological survey of the area along and adjacent to the Ontario-Manitoba boundary from the point where it crosses the 12th base line and is deflected from due north to N. 44° 25′ 50″ E. up to the point where it touches the east end of Sagawitchewan bay of Island lake. The examination was made in co-operation with a party of the Topographical Survey of Canada under J. W. Pierce, D.L.S. The previous year Mr. Pierce had run a trial line from the latitude of the 12th base line to the east end of Sagawitchewan bay, a distance of 87 miles. During the summer



View of interprovincial boundary monument No. 289 south of Hayward lake. These monuments of cement are placed approximately 6 miles apart.

of 1930 this line was widened and accurately surveyed to make it the final boundary line. In addition, a new trial line was started from the northeastern end of this section in a direction N. 38° 50′ 52″ E. Thirty miles of this trial line was completed, along 15 miles of which the geological features were examined.

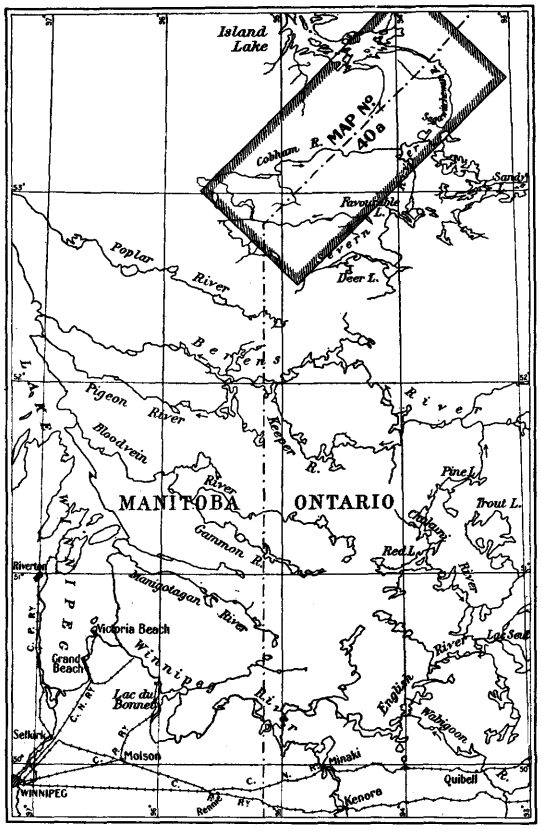
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The writers are indebted to J. W. Pierce, D.L.S., and other members of the Topographical Survey party for their generous help and co-operation throughout the season. Mr. Pierce provided maps and information which proved invaluable and afforded the writers every facility for carrying out their work.

Thanks are due also to C. Chatterway and A. Martin, members of the party, for voluntary assistance in collecting rock samples at localities that the writers had not time to visit.

Routes Followed

The party left Selkirk, Manitoba, on May 26, 1930, on *S.S. Wolverine* of the Northern Fish Company, and reached George Island, 180 miles up Lake Winnipeg, two days later. A launch provided transportation to the mouth of the Poplar river, from which point travel was by canoe. The route followed to the boundary was up the Poplar river to its junction with the Assapan river north of Lewis lake, up the Assapan river, and thence via the Meandering river eastwards for four miles. From here four portages lead over the height of land into the waters



Key map showing location of Ontario-Manitoba boundary from the 12th base line to latitude 54. Scale, 70 miles to the inch.

running into Charron lake. The Palsen river, which drains Charron lake, was followed down to Elliot lake, the southeastern arm of which leads to the boundary at a point one and a half miles northeast of the point where the boundary crosses the 12th base line (unsurveyed). The total distance of this route is judged to be about 170 miles; and 36 portages are necessary, the greater number being short.

In addition to examining the geological features in the immediate vicinity of the boundary line, canoe routes were followed into Ontario and Manitoba, and along these the geology was mapped. These routes included the Cobham river, which crosses the boundary twice, the route from the Severn river north to Sagawitchewan bay of Island lake, and the Banksian river to Island lake.

The return journey was made across Island lake to its west end and along the well-travelled route through Stevenson lake, over the Ponask portages into Ponask creek, and thence down the McLaughlin river. This stream is a tributary of the Gunisao river, which empties into the Nelson river at Norway House. The distance from the boundary to Norway House by this route is approximately 225 miles, and 32 portages are encountered.

At Norway House a launch was taken to Warrens Landing where the *S.S. Wolverine* was again boarded for Selkirk.

Previous Work

The geology along the boundary line had previously been examined as far north as the 12th base line. This examination was completed in two sections. The southern section, from the Winnipeg river northwards for 100 miles, was



Stone mound No. 242 on the interprovincial boundary. Such monuments are placed about 1¼ miles apart.

examined by E. M. Burwash[1] in 1921. From the end of this section to the 12th base line, the geology was described by H. C. Rickaby[2] in 1922. North of the 12th base line no geological work had been done on the boundary except where it strikes Sagawitchewan bay of Island lake; this part was mapped in 1926 by J. F. Wright,[3] of the Geological Survey of Canada.

Dr. Wright followed a belt of sediments and volcanics from Manitoba for a short distance into Ontario.

To the east of the boundary, the geology around Favourable and Sandy lakes and along that part of the Severn river connecting the two lakes was examined by M. E. Hurst[4] in 1928.

Topography

For the first 25 miles the boundary crosses rough, rocky country, consisting of rather sharp ridges, alternating with lakes and muskegs. Ridges and hollows

[1]Ont. Dept. Mines, Vol. XXXII, pt. 2, 1923, pp. 1-48.
[2]Ibid, pp. 49-59.
[3]Geol. Surv. Can., Sum. Rept., pt. B, 1927.
[4]M. E. Hurst, Ont. Dept. Mines, Vol. XXXVIII, pt. 2, 1929, pp. 49-84.

here have a decided east-west trend, parallel to the axes of major folds. East of this part of the boundary, however, lakes and rivers indicate two other structural directions, one northeast and the other northwest.

After mile 20,[1] areas of clay are encountered, covering an increasing proportion of the rock as one goes north. Ultimately, between mile 55 and mile 70, rock outcrops occur only as isolated "islands," projecting from level, almost prairie-like country.

At about mile 70, the clay gives way to ridges of coarse sand and gravel, after which the boundary line, as far as it was examined, crosses the rocky type of country again (see frontispiece).

The topography north of Island lake for the first 15 miles is characterized by rather flat, low rock ridges interspersed with muskegs.

Drainage

In the rocky type of country, lakes are very numerous and the rivers are erratic in course and flow. In the clay country, on the other hand, lakes are comparatively rare and are usually rounded and shallow. The rivers and streams are sinuous in their course and smoother running than in the rocky country. They often have steep banks due to the rapid erosion of the clay. This difference is well seen when following the Cobham river. This stream, a tributary of the Severn river, which empties into Hudson bay, drains all the southern part of the area up to mile 41 on the boundary. It rises in Cobham lake, 20 miles east of the boundary, and crosses the line first at mile 1½. To this point and westward for 25 miles it runs through rocky country with rapids and irregular lakes. It then runs into the clay belt and turns north and east, recrossing the boundary line at mile 37. In this portion the banks are largely clay and rapids are few, which condition persists till it joins the Severn.

North of mile 41, the area is drained to the west by the Banksian river, which flows through clay till just before it enters Island lake at Benson bay. To the northeast the drainage is also to Island lake by the Sagawitchewan river and its tributaries.

Elevation

For the first 45 miles, the elevation is about 1,000 feet above sea-level, the highest point being at mile 3 where it reaches a maximum of 1,096 feet.

From mile 45 to mile 62, the general level drops to about 800 feet, but again rises to about 900 feet at mile 70. This depression is occupied by the main part of the clay belt. After mile 70, the elevation rises to a maximum of 996 feet before dropping to the Island lake level of 756 feet.

Timber

Very little timber of commercial size for lumber was seen in the area. Much of the country has been swept by fire during the last 15 years. The common trees are jackpine on the ridges and spruce on the lower-lying ground; the clay country is covered largely by small poplar and willow. In many of the swamps there is a considerable regrowth of tamarac, some trees attaining a height of twenty-five feet. Along the river banks poplar groves are prominent and a few remaining big spruce, up to 2 feet in diameter, are still to be seen. Fairly extensive groves of birch occur, mainly on the ridges of sand and gravel. The best timber noted was along Gorman creek east from Azure lake, where

[1]Mileages given indicate the distance northeast along the boundary from the point of deflection at the 12th base line.

spruce and jackpine are of an average diameter of 8 inches. A similar growth was noted along the Banksian river.

Fish and Game

The larger lakes are fairly well stocked with such fish as pickerel, jackfish, and suckers. Gold-eyes were caught in the Cobham river and whitefish in Island lake. Ling were noted in the Sagawitchewan river.

Game is not abundant in the area. A few moose and an occasional deer were seen along the Cobham river. North of the river they seem to be scarce, although tracks were sometimes noted. North of Island lake caribou tracks were quite numerous in the muskegs. Trapping is said by the Indians to be good, particularly in the heavier timber around Azure lake and along the Cobham river.

The spruce partridge is the commonest of game birds, but the ruffed grouse is also found. The sharptail variety of the prairie chicken is common in the open, burned clay country. Mallard, teal, and wood-ducks were seen quite frequently, being especially abundant on Gorman and Oasis lakes.

GENERAL GEOLOGY

The consolidated rocks of the area are all pre-Cambrian and consist of two series, the older comprising sedimentary and volcanic material, and the younger intrusive rocks.

The only remnants of the sedimentary-volcanic series are several long narrow belts, apparently the lowest portions of long synclinal folds. The intrusive rocks constitute fully 85 per cent. of the area and represent an immense batholith exposed by erosion.

Much of the consolidated rock is covered by much younger unconsolidated material. This consists of stratified clays, boulder clays, and sand of Pleistocene age, and some river and bog material deposited in Recent time.

Table of Geological Formations

RECENT:	River silts, beach deposits, peat.
PLEISTOCENE:	Boulder clay, varved clay, stratified clay, sand and gravel moraines.
	Great unconformity
PRE-CAMBRIAN	
ALGOMAN (?):	Pegmatite and aplite. Quartz porphyry and feldspar porphyry. Red biotite granite. Grey biotite granite. Grey hornblende granite. Granodiorite. Diorite.
	Intrusive contact
KEEWATIN (?):	INTRUSIVE: Gabbro and diorite. VOLCANIC: Andesite and basalt. SEDIMENTARY: Quartzite, greywacké, conglomerate, iron formation, tuff, quartz-biotite schist, paragneiss.

Keewatin(?)

The sedimentary-volcanic series was found to occupy three separate areas. The southernmost of these is first encountered on the boundary at mile 22½, running east and west; the second, an area of undetermined extent, at mile 64; and the third, the continuation of the Island Lake belt, at Sagawitchewan bay. Several other smaller occurrences were also seen.

It is thought most convenient to describe the extent and rock types of these three areas separately, as the rocks are not connected at the present surface, although probably all of one age.

AZURE LAKE BELT

The southern contact of this belt with the intrusives crosses the boundary at mile 22½ and the northern contact at mile 25. The general strike is east and west, and the dip steep to the south. When traced into Manitoba the belt was found to be covered largely by clay, the most westerly outcrop seen being near the junction of the Warrington and Cobham rivers, 12 miles from the boundary. On the Ontario side good outcrops were found all around Azure lake and for 5 miles eastward along Gorman creek. The belt was again picked up in Ontario southeast of Varveclay lake at a point 25 miles east of its occurrence

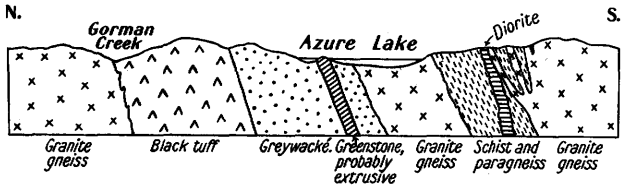


Fig. 1—Structure section (12 miles long) across the belt of sediments at Azure lake.

on the boundary. Twelve miles southeast of this outcrop is the most westerly mapped portion of the Favourable Lake belt of sediments and volcanics described by M. E. Hurst.[1]

As the strike here is roughly northwest it seems quite probable that the two areas are part of the same belt; this conclusion is borne out by the lithology. The dip is almost always to the south, approaching vertical near the northern contact with the granite. A long strip of granite gneiss divides the belt into two parts along the strike between Gorman and Azure lakes and possibly farther to the east and west. This strip of granite gneiss has been intruded parallel to the strike of the sediments, and the well-marked gneissic banding has assumed the same strike and dip. The sediments to the south of this strip of granite are more highly altered than those to the north, the former being composed largely of mica schist and paragneiss as described below (see Fig. 1).

Tuff

In the field this type is hard to recognize as a tuff and looks more like a black chert. It is a dense, black, fine-grained rock, with a distinctly cherty appearance and an almost conchoidal fracture. It is resistant to erosion and forms a pronounced ridge along the northern edge of the belt on the Ontario side. It is well exposed on the north shore of Azure lake at the east end. It

[1]M. E. Hurst, op. cit.

was seen to extend only a short distance into Manitoba, but scarcity of outcrops makes it difficult to say how far it runs. Under the microscope the rock was found to have the characters of a tuff. Siliceous fragments, varying from fine to medium in texture, and irregular in shape and size, are embedded in a very fine grained brownish groundmass. The fineness of this groundmass makes difficult the determination of its exact composition, but it appears to contain silica, epidote, and possibly biotite. The material was probably originally volcanic dust. The siliceous fragments make up a high percentage of the rock in some patches, and it seems probable that the conchoidal fracture is due to these patches.

Greywacké

This rock occurs in a band immediately south of the last type and is well shown along the north shore of the western half of Azure lake. In the field its grain appears to be rather coarser than that of the tuff and its colour dark to light grey. Thin sections from specimens from several parts of this member show it to vary considerably in texture, and to carry quartz, biotite, and some feldspar as the main constituents. Some specimens contain sufficient feldspar to suggest that they were originally arkose. Outcrops on the Manitoba side showed a similar greywacké, but more markedly banded.

Iron Formation

North of Gorman creek, 7 miles east of the boundary, a fine-grained, red and black banded rock was found. Marked deflection of the compass occurred as this outcrop was approached. Under the microscope the rock is seen to consist of fine-grained quartz, green biotite, and a varying proportion of magnetite in very small grains. Some bands are almost pure magnetite, while in others the magnetite is present in disseminated grains throughout the quartz. The small size of grain and the concentration in bands of the magnetite strongly suggests a sedimentary origin. The iron was probably deposited as hematite or limonite and recrystallized to magnetite when the sediments were metamorphosed.

Quartz-Mica Schist and Paragneiss

Coarse schist and paragneiss occur on the southern side of the belt between Gorman and Azure lakes. They may be seen on the boundary line at mile 22½, on the middle of the north shore of Gorman lake, and on the south shore of Azure lake. At their southern contact with the granite, *lit par lit* pegmatitic injections are developed. The schists grade into the greywacké type of sediment on the south shore of Azure lake and may represent a more altered stage of that rock. The schists contain rather coarse quartz, muscovite, and biotite, with a little feldspar. By an increase in feldspar content, they grade into paragneiss.

A light-coloured, fine-grained schist on the north shore of the small lake northeast of Gorman lake was found to be a kyanite schist. A thin section showed kyanite forming 40 per cent. of the rock; quartz, feldspar, and diopside make up the rest.

Volcanics

A few occurrences of greenstone were found on Azure lake and on the boundary. Owing to the crushed and metamorphosed state of these rocks it was almost impossible to determine with certainty whether they are of intrusive or extrusive origin. One occurrence is on an island opposite the portage at the

west end of Azure lake. A specimen from here in thin section shows augite forming about 30 per cent. of the rock, hornblende about 30 per cent., and quartz and albite the remainder. The quartz and albite may both be secondary, replacing an original more basic plagioclase. The texture is fine, and in general the rock resembles more the volcanic types seen elsewhere in the area than the basic intrusions of corresponding composition.

At a point north of Gorman creek, 5½ miles east of the boundary, a curious rock association was found. In the field this assemblage was seen to be made up of alternate bands, about an inch wide, of fine-grained light and dark material, fingering out into each other. Under the microscope the dark bands are seen to consist of much hornblende, quartz, and a little feldspar, with some secondary chlorite and leucoxene, the whole having a foliated appearance. The light bands consist of quartz and cloudy feldspar, with a little muscovite, biotite, and pyrite. From a consideration of the appearance in the field and under the microscope, it would seem that the dark bands represent the original rock, possibly an andesite, while the light bands are parallel acid injections associated with the granite intrusives.

Basic Intrusives

A few hundred yards south of the middle of Azure lake a decomposed basic intrusive rock occurs. This rock is cut by the granite and a greater age is suggested by its highly altered state. In thin section it shows the following mineral content by the Rosiwal method.

	Per cent.
Quartz	11
Albite to oligoclase	29
Hornblende	58
Pyrite and pyrrhotite	2
Total	100

It is probable that this rock was originally a gabbro and represents the older basic intrusives as described by M. E. Hurst in the Favourable Lake area. No other occurrence was found by the writers in this belt.

Carbonate Replacement

Replacement by carbonate, chiefly calcite, was seen in several places along the belt, especially in the greywacké member. On the north shore of the small lake northeast of Gorman lake, a lens of pure crystalline calcite was found replacing the banded greywacké. Less complete replacement has occurred in other parts of the same outcrop. On the north shore of Azure lake (see photograph on page 9), it takes the form of irregular patches, leaving a network of unreplaced greywacké, which on weathering stands out, giving a pitted appearance to the surface. Carbonatization was also seen in the sediments at the easternmost point in the course of Gorman creek.

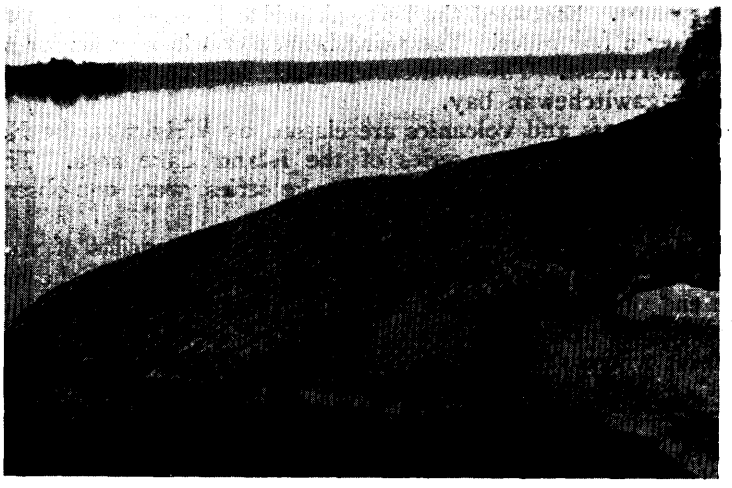
GREENSTONE AREA AT MILE 64

An area of basic volcanic rocks was found just east of the boundary at mile 64, but not outcropping on the boundary, nor on the Manitoba side, owing to the thick covering of clay. An arm of the greenstone runs westward and probably crosses the boundary under the clay, but the most westerly outcrop seen was half a mile east of the line. Eastward this outcrop seemed to continue for several miles, but time did not permit following it far. Another ridge of the same rock was encountered 4 miles east of mile 60. This outcrop is

three-quarters of a mile across the strike, which is here N. 60°-75° E. The width of the belt is not known, as to the southeast the rock is obscured by clay. It is probable that this belt is continuous with the outcrops east of mile 64.

The greenstone may form a considerable area east of where it was seen, but no indication of its eastern continuation was observed on the route from the Severn river to Sagawitchewan bay. On the Manitoba side, no sign of the belt was found on the Banksian river, although a few greenstone inclusions were noted on the approximate continuation of its strike. The volcanics are cut by numerous dikes of red and grey granite, pegmatite, and aplite.

The greenstone appears to be all of volcanic origin, hand specimens being dark-green to black and fine-grained. In some places two varieties were noted, one black and massive, probably a basalt, and the other green and less basic. Pillow structure was seen in the green type, but not in the black. A thin



Greywacké showing uneven weathering due to carbonate replacement, Azure lake.

section of the green variety shows the following mineral composition by the Rosiwal method:—

	Per cent.
Hornblende	32
Feldspar (untwinned)	40
Quartz (probably secondary)	10
Biotite (probably secondary)	16
Magnetite, apatite, pyrite, and pyrrhotite	2
Total	100

This analysis suggests a somewhat altered andesite.

OTHER SMALL GREENSTONE AREAS

A few other small outcrops of basic volcanic rocks, similar to those just described, occur along the Banksian creek near the boundary. In one of these outcrops, a ridge a quarter of a mile east of the boundary at mile 50, thin bands of dark sediments were seen interbedded with the volcanics. It is possible that all these outcrops belong to one narrow, curving belt running nearly parallel to the boundary, but the scarcity of outcrops does not permit a definite statement on this point.

The northernmost of these outcrops, 100 yards west of the boundary at mile 51, consists of inclusions of talc schist in the granite. The schist is cut by dikes of hard, cream-coloured aplite. Banksian creek has cut its way through the soft talc schist, but the aplite dikes stand out, forming waterfalls. Some very perfect pot-holes have been formed in the talc schist by these falls; they measure from a few inches to one foot in diameter and as much as two feet in depth.

ISLAND LAKE BELT

A continuation of the sedimentary-volcanic area of Island lake, as mapped by J. F. Wright, crosses the boundary at Sagawitchewan bay. The southern contact with the granite crosses the boundary at mile 86½, or slightly less than a mile and a half south of the point of deflection of the line at the east end of Sagawitchewan bay. The northern contact is found about half a mile north of the same point. Eastward the belt splits into three branches, two of which pinch out after a few miles. The third branch continues east for 6 miles and then swings northeast. This branch was last seen 10 miles east-northeast of the end of Sagawitchewan bay.

These sediments and volcanics are classed by Wright as the Hayes River series, the older of the two series of the Island Lake area. The younger sediments, called by Wright the Island Lake series, were not observed in the area examined by the present writers.

At the boundary, the northern part of the belt consists of volcanics and the southern of sediments, the contact between them crossing the line where it meets the end of Sagawitchewan bay. The volcanics, however, thin out and disappear within 5 miles to the east. Some greenstone does occur at the most easterly point where the belt was examined, but this rock may be intrusive.

Sediments

Quartzite.—Dark-grey, fine-grained, close-banded quartzite forms a considerable proportion of the sediments south and east of the Sagawitchewan river. Under the microscope this rock is seen to consist almost entirely of fine-grained quartz, with a few flakes of biotite and occasional crystals of albite.

Greywacké.—The greywacké is rather similar in appearance to the quartzite, but is darker and has more marked banding. A thin section shows it to differ only in a larger proportion of biotite and a little more feldspar and muscovite.

Conglomerate.—Only one exposure of conglomerate was found in this area. This occurs on the Sagawitchewan river on the north side of the falls a mile east of the boundary. The pebbles are highly squeezed and elongated and consist mainly of granite, but occasionally of quartz. The cementing material is fine-grained and siliceous in appearance.

Mica Schist.—Soft mica schist was found at two places along the Sagawitchewan river. The rock has a very limited extent, so far as seen, and probably represents the muddy facies of the sediments.

Pyroclastic Rocks

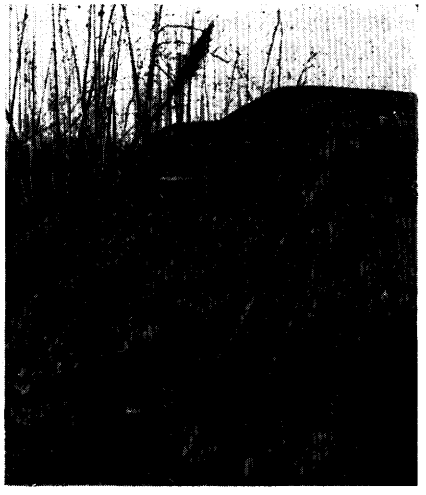
A dark, fine-grained rock with a greenish colour and close banding occurs on the south bank of the Sagawitchewan river not far from its mouth. The same type was also encountered half a mile to the southwest on the boundary line. Seen under the microscope, it consists of quartz, hornblende, and biotite,

with a little orthoclase and albite. The hornblende occurs in parallel bands and makes up about 30 per cent. of the rock. Epidote is always present in some quantity and in certain parts forms bands up to three-quarters of an inch wide, parallel to the bedding. These epidote bands weather to a reddish-brown colour, giving the rock a striped appearance on the surface (see photograph below).

The high hornblende content suggests a volcanic origin for the rock-forming material, and the close bedding indicates deposition in water. These characters suggest that the rock represents a pyroclastic deposit.

Volcanic Rocks

Rocks of volcanic origin occupy the northern part of the belt in the region of the boundary; these are andesites, dark-green to black in colour and fine to medium in texture. They are continuous with the volcanics described by J. F. Wright on the shore and islands of Island lake, and are similar to them lithologically. Rather distorted pillow structure was seen just east of the



Banded epidote rock, probably an altered pyroclastic deposit, mile 87.

boundary on a ridge a quarter of a mile north of Sagawitchewan bay. Marked schisting and distortion of the strike occur on parts of the same ridge.

At a point 650 feet north of Sagawitchewan bay on the boundary, a narrow strip of greywacké, 80 feet across the strike, is interbedded with the lava. The southern edge of this bed of sediments is separated from the lava by a narrow band of volcanic agglomerate.

Basic Intrusives

Intruding both the sediments south of the Sagawitchewan river and the volcanics north of it are several lens-shaped masses of altered gabbro or diorite. The rock is medium to coarse in texture and dark-green in colour. In the field the finer-grained varieties are distinguished with difficulty from the volcanic andesites. The intrusive contacts, also, though clear in some cases, are often blurred by later effects of folding and crushing. Thin sections from several specimens from these intrusive masses show a much altered, fairly coarse grained

mixture of secondary uralitic hornblende and saussuritized feldspar. In some cases the feldspar has been completely replaced by zoisite and epidote.

The similarity in composition between the basic intrusives and the volcanic andesites, together with their close areal association, suggests that they were both derived from the same magma. The intrusives probably represent a slightly later phase of the igneous activity of this period. It is not probable that the basic intrusives have any genetic connection with the granite intrusives of the later period mentioned below. That they are more or less contemporaneous with the earlier series is suggested by the fact that they have undergone the same chemical and physical alteration as the volcanics and do not occur outside the sedimentary-volcanic belts.

STRUCTURE AND AGE RELATIONS

It seems probable that the rocks of the three sedimentary-volcanic areas are of the same general age. The sediments and volcanics on Sagawitchewan bay are continuous with those on the main part of Island lake, called by J. F. Wright the Hayes River series and classed by him as the older of the two series occurring there. Lithologically the sediments of the Azure Lake belt resemble those of Island lake. The volcanics at mile 64 are also similar in composition to the Island Lake volcanics. All have undergone the same degree of metamorphism and dynamic stresses.

Concerning the volcanic-sedimentary age relations, the best evidence is found in the Island Lake belt. The gabbro, shown above to be probably the intrusive phase of the magma that gave rise to the volcanics, cuts the sediments. It is probable, therefore, that the greater part of the sediments had been laid down before the main outburst of volcanic products. However, no unconformity occurs between the two, and the periods of sedimentation and extrusion seem to have overlapped to some extent.

The predominating trend of the belts and the strike of the schistosity is east and west. The greatest variation occurring over any appreciable length is between miles 40 and 60 on the boundary, where a narrow belt was found with a strike nearer northeast-southwest. The whole series dips almost everywhere steeply to the south, very few northward dips being found. This indicates that the movement responsible for the major folding was a predominant thrust from south to north, as far as this area is concerned.

Intrusive Series (Algoman?)

All the above types have been intruded and metamorphosed by a series of plutonic rocks which now underlie the greater part of the area along the boundary. They range in composition from diorite to very acid dikes, but grey and red granites predominate. These will be described as nearly as possible in chronological order.

Diorite

Diorite occurs generally in small masses but becomes quite extensive in some places, as in the eastern part of Hilton lake, west of mile 73 on the boundary, and east of mile 66. In the field it appears as a dark-grey, medium-grained, massive rock cut by numerous dikes of granodiorite and more acid types. A thin section from a specimen from Hilton lake showed it to consist of predominant plagioclase, some orthoclase, a small percentage of quartz, primary hornblende (forming about 35 per cent. of the whole), and a little biotite. Minor constituents are apatite, magnetite, and pyrite.

There is sufficient quartz to class this rock as a quartz diorite, but at least some and possibly all of the quartz may be of secondary origin.

Granodiorite

The granodiorite is closely akin to the diorite described above and grades into it in some places, although in others it intrudes it in clear-cut dikes. It is characterized by grey colour and coarse texture. Pink aplitic injections are typically associated with this granodiorite. It forms prominent ridges along the Sagawitchewan river south of Cocos lake and also occurs in smaller masses in other parts of the area.

Grey Hornblende Granite

Grey hornblende granite is one of the most abundant types in the area. It grades into the granodiorite on one hand and into the biotite granite on the other, though in places it clearly intrudes the former and is intruded by the latter. In the hand specimen it is generally coarse grained and grey in colour, sometimes having a porphyritic appearance due to large feldspar crystals. Under the microscope, hornblende, plagioclase, and quartz are seen to make up most of the rock, with orthoclase and biotite as less abundant constituents. It differs from the granodiorite mainly in having more quartz and less hornblende.

Biotite Granite

There are two types of biotite granite, one pale-grey and the other pink or red. In the former most of the feldspar is white albite with subordinate microcline and orthoclase. Quartz is abundant, and ferromagnesian material is scantily represented by biotite with a little hornblende. The red granite contains mainly red potash feldspar, both microcline and orthoclase, with a small proportion of albite, a varying quantity of quartz, and some biotite. Gradational types carrying equal quantities of red and white feldspar also occur in places. In spite of the gradation the red type is in general a slightly later phase, since it often cuts the grey biotite granite in sharp dikes. This feature is well seen in the vicinity of Hilton lake and on the boundary near Elliot lake. Both the red and grey granites form dikes cutting the grey hornblende granite. Here again, however, gradational types do occur showing their close relationship. With all the more basic types the contact of the biotite granite is sharp.

Granite Gneisses

Granite gneisses are not so common in the area as might be expected with such large granitic masses. Both the hornblende and the grey biotite granites, however, do sometimes take on a markedly gneissic character in the region of the sedimentary-volcanic belts. The most acid red granite was never seen to be gneissic even at its contact with the sediments or volcanics.

The granite gneisses contain quartz and albite and a smaller proportion of microcline with either hornblende or biotite or both as the ferromagnesian constituent. The gneissic structure in the grey granites seems to indicate the proximity, in a lateral direction, of an area of sediments or volcanics or a high spot in a batholith from which the overlying formations have been very recently removed.

Feldspar Porphyry

A number of narrow dikes of very light weathering material cut the greenstone north of Sagawitchewan bay. The rock proved under the microscope

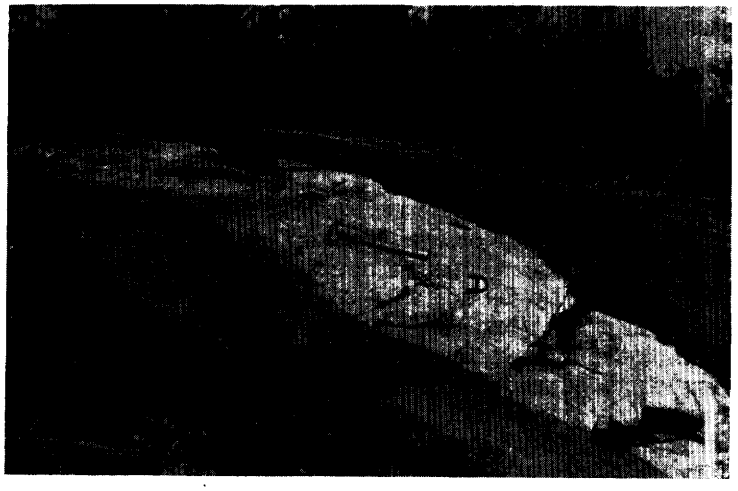
to be feldspar porphyry. Fairly fresh phenocrysts of albite and smaller ones of quartz are embedded in a medium-grained groundmass, consisting of quartz and feldspar with smaller quantities of muscovite and biotite. These dikes cut tongues of grey biotite granite and so must be a fairly late stage in the intrusive sequence.

Quartz Porphyry

A few dikes of quartz porphyry were found at the east end of Hilton lake. They strike east and west and cut the grey biotite granite and its inclusions of more basic intrusives. They thus seem to have about the same time sequence as the feldspar porphyry described above.

Pegmatite and Aplite Dikes

Dikes and sometimes sills of red pegmatite and aplite are common throughout the area. They cut all the other rocks with the exception of the feldspar porphyry



Tongue of grey granite (G) intruding andesite (A), both being cut by a dike of aplite (D).

and quartz porphyry, with which they were not seen in contact. In the most acid red granite they did not occur as clear-cut dikes but only in irregular segregations and border phases. It is probable that they are most closely connected in age and composition with the red granite. The pegmatites were nearly all made up of quartz and red microcline with subordinate quantities of muscovite, biotite, and magnetite. White pegmatites in which the feldspar is albite occurred in one or two places. One of these was on the boundary on the north shore of Warrington lake. Another pegmatite on the north shore of Gorman lake, intruding paragneiss, carries besides white albite and quartz, tourmaline, molybdenite, tantalite, pyrite, and chalcopyrite.

The aplites consist essentially of red feldspar and quartz with only a small quantity of mica. As a general rule in the area the pegmatite dikes cut those of aplite.

Veins of glassy quartz often cut the pegmatites, representing the last stages of intrusive activity.

General Relations of the Intrusives

A study of the field relations of the intrusives described shows that these form a series, intruded in order of decreasing basicity as a result of the differentiation of one parent magma. Each member is more acid than the previous one but may grade into the type on either side of it in the series. Thus in some places the granodiorite on the one hand grades into the more basic diorite and on the other into the more acid hornblende granite, while other localities may be found where it is intrusive into the former and is intruded by the latter (see Fig. 2).

The earlier phases of the series have contacts with the sedimentary-volcanic belts, which conform with the major folding and have few irregularities. The gneissic structure where it occurs is parallel to those contacts and is restricted to the vicinity of the sediments and volcanics, or to a region in line with the strike of such belts, from which the sediments themselves have been eroded. For example, the Island Lake belt just east of the boundary gives off two branches. Although both of these pinch out before striking Joint lake, their course is continued by two markedly gneissic bands, which the two eastern arms of the

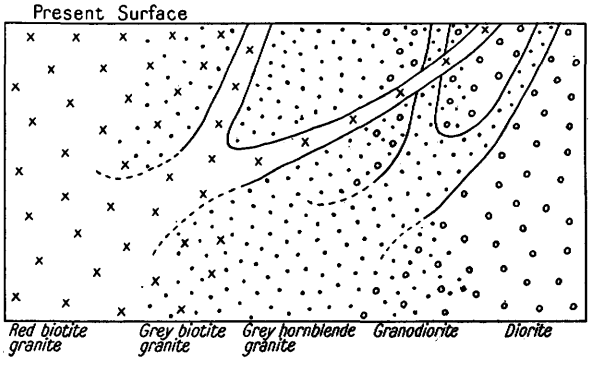


Fig. 2—Diagrammatic vertical section to show the relationships of the intrusive series.

lake follow. As opposed to the grey granite, the red acid granite often breaks the continuity of the earlier lines of contact. A good example of this is seen in the boss of acid granite between a mile and four miles east of the boundary at Sagawitchewan bay. The regular east and west strike and southerly dip has been distorted, and the sediments now dip away from the boss on all sides.

There is naturally some difficulty in mapping such an intrusive series where gradations often occur and where time permitted little detailed work. However, it is thought that some attempt at indicating the differentiation has a certain value. In the accompanying map the intrusives have been differentiated into three groups, viz., the diorite, the granodiorite and hornblende granite, and the later acid types. In the case of gradations the line of contact is somewhat arbitrary.

General Correlation

The association of predominating granitic rocks with a few remnants of highly folded volcanics and sediments occurs the whole way south from this area to the Lake of the Woods 220 miles to the south. It seems reasonable to assume that these granitic areas belong to the same great period of batholithic intrusion.

The sedimentary volcanic series in the area under discussion bears the same relation to these intrusives as does the Keewatin of the type locality at the Lake of the Woods. For this reason a Keewatin age is tentatively ascribed to the sedimentary volcanic series in the region of this part of the boundary.

Pleistocene

In Pleistocene times the whole area was swept by ice-sheets. Evidences of at least two advances are to be found. One of these moved in a west-southwest direction, leaving striae orientated S. 50°–70° W., over all the southern part of the area. The other set of striae, S. 13° W. and S. 31° W., are found only in the northern part of the area. In one place only, on the south shore of Hilton lake, were both sets of striae found on one outcrop. On the west side of the outcrop were striations S. 78° W. and on the north side striations S. 29° W. The latter set were somewhat deeper and appeared to be superimposed on the

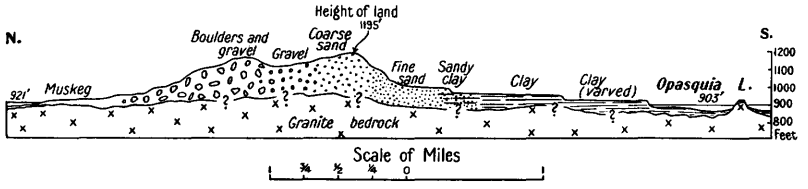


Fig. 3—Section along the 4-mile portage north from Opasquia lake, Ontario, showing the transition from varved clay to coarse morainic material.

former where they met on the top of the outcrop. This suggests that the ice coming from the more northerly direction was the later advance and removed most of the earlier set of striations. Below are listed some directions of glacial striae observed in the area:—

S. 67° W.	West end of lake 8 miles east of mile 10 on boundary.
S. 61° W.	Warrington lake, south shore.
S. 76° W.	Lake on Ontario side of boundary at mile 30.
S. 65° W.	Gorman lake.
S. 62° W.	Angekum lake, Severn river.
S. 16° W.	Fourth lake north of Opasquia lake, Sagawitchewan river.
S. 14° W.	" " " " " " "
S. 16° W.	Fifth lake " " " " " "
S. 17° W.	Sagawitchewan river, south of Cocos lake.
S. 14°–24° W.	Cocos lake.
S. 31° W.	East of Hilton lake.
S. 72° W. S. 29° W.	On same outcrop, Hilton lake, south shore.
S. 26° W.	Hilton lake, near boundary.
S. 16° W.	Lake on boundary at mile 70.
S. 29° W.	First lake north of Sagawitchewan bay on boundary.

Deposits of boulder clay are nowhere very thick, though boulder beds and large erratics are common. Such deposits occur mainly south of mile 25 and north of Sagawitchewan bay.

A belt of bedded clay crosses the border between mile 27 and mile 71. At its southern limit it is thin and rather indefinite. The northern limit is much sharper and marked by ridges of sand, gravel, and boulders, north of which bedded clay is not found. About mile 50 it attains a thickness of 80 feet or more. Outcrops are scarce in the clay belt and stand out as isolated knobs and ridges. East of the boundary along the Cobham river excellent varved clay occurs,

being particularly well shown on Varveclay lake (see photograph below). Thin dark bands, a fifth of an inch in thickness, alternate with light bands up to half an inch thick, but there is much variation in these dimensions in the different horizons. In the region of the boundary itself no good sections were found, as where creeks had cut into the clay, the banks had slumped. In the survey pits on the boundary, rough bedding, distorted by weathering, and vegetation were found which, though it could not be proved to be varving, was suggestive of it, as some light and dark alternating bands were found.

All these factors strongly suggest that the clay was laid down by a lake bounded on its northern side by an ice front. Further evidence for this theory is the presence of ridges of coarse morainic and outwash material along the northern edge of the clay, marking the position of the ice front at the time this lake was formed. The clay lies on top of the first set of striae, running west-southwest. The second set, running S. 14°–31° W., were only found north



Pleistocene varved clay, Varveclay lake, Ontario.

of the clay belt, where the other set was not seen except in the occurrence mentioned above where both occurred on one outcrop. It seems reasonable to conclude, therefore, that the first ice-sheet swept completely over the area towards the west-southwest, and after its retreat the second sheet advanced to a line now marked by the ridges of morainic material, and pausing there dammed back the water to form the lake which deposited the clay. The 4-mile portage from Opasquia lake to the headwaters of the Sagawitchewan river crosses the northern limit of the clay and the terminal moraine (see Fig. 3). Proceeding from south to north, one passes over clay for the first two miles, after which the soil becomes gradually lighter and gives place to fine sand. The latter passes over to coarse sand and gravel, until at the 3-mile mark a ridge is crossed made up entirely of boulders and some gravel. This ridge slopes down into muskeg for the last half mile.

The position of the ice front on the boundary is not so clearly shown but occurs at about mile 71. Sand, gravel, and boulder ridges are abundant here. Some roughly bedded gravel probably represents outwash deposits.

On the Banksian river on the Manitoba side there is a rather sudden transition from the clay country to boulder runs and bare rock within 2 miles of Island lake.

A line joining these three points would give the direction along the ice front here as northwest-southeast. West of the Banksian river it must swing to about due west, as no bedded clay is found on Island lake. J. F. Wright noted terminal moraines near the southwest corner of Island lake, so it is possible that these represent another point on the westerly continuation of the ice front. In general these points suggest that the line of the ice front was about at right angles to the direction of the movement of the ice-sheet as shown by the second set of striations.

It seems probable that this lake was an arm of glacial Lake Agassiz. Measurements of the elevations of the beaches of the lake on the west side of Lake Winnipeg indicate that at one time the lake-level was over 1,100 feet above present sea-level. This was in the earlier stages of the lake and at a time when the area under discussion was covered over with ice. When the ice retreated enough to let the level fall below 1,000 feet above the present sea-level, the drainage of Lake Agassiz, instead of being south to the Mississippi basin, changed to north towards Hudson bay. W. Upham[1] has suggested that it may have flowed over the height of land between the Poplar and Severn rivers. If this was true, the ice-sheet must have retreated from the southern part of the present area. This retreating ice was probably the sheet that left the west-southwest striations in the southern part of the area. Its retreat may have followed or accompanied the advance of the second ice-sheet moving south-southwest as far as mile 71 on the boundary.

The fact that the clay belt in the present area narrows towards the east and widens towards the west is additional evidence for its connection with Lake Agassiz. It remains to be proved whether the clay is continuous from the boundary westwards to the mapped extent of Lake Agassiz on the east shore of Lake Winnipeg.

ECONOMIC GEOLOGY

No mineral deposits have as yet been discovered in the immediate area. Some prospecting was carried on along the sedimentary-volcanic belt from Island lake for a few miles into Ontario at the time when there was considerable interest in the Island Lake area, where a number of claims were staked.

The Azure Lake belt, as far as is known, has not been prospected, though on its possible continuation at Favourable lake, a considerable number of claims were staked in 1927 and 1928.

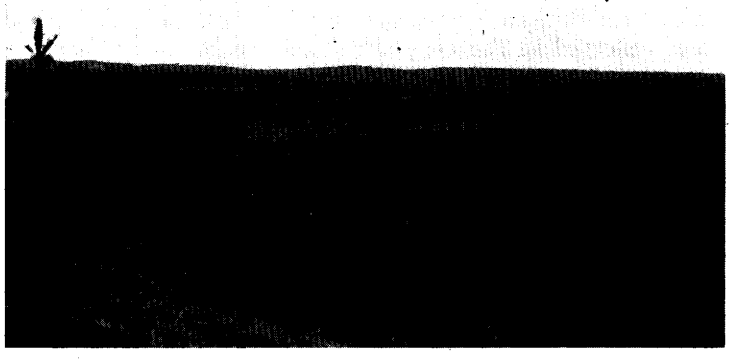
Where crossed by the boundary, both of these belts are narrow, about two miles. Such narrow belts are not generally considered favourable for the deposition of ore deposits on an economic scale. Within these belts the volcanics seem more susceptible than the sediments to shearing and mineralization. Although very little evidence of mineralization was found in the Azure Lake belt, the sediments are much replaced by carbonate, a feature often accompanying metalliferous deposits. Very few quartz veins were noted in this belt. In the area of volcanics east of the boundary at miles 60 to 64, evidence of shearing and sulphide mineralization are much more abundant than elsewhere. Two sets of minor faults were noted, one parallel to the strike of the schistosity,

[1] "Report of Exploration of the Glacial Lake Agassiz in Manitoba," Geol. Surv. Can., Vol. IV, pt. D, 1888-89.

often mineralized with pyrite and chalcopyrite; the other at right angles and never mineralized. Although no deposits of value were found, very little time was available for more than the briefest examination. This area is fairly accessible from Island lake. The route is up the Banksian river and east along the creek that crosses the boundary at mile 62½ and is navigable to the east for several miles at least.

In the Island Lake belt adjacent to the boundary, the most favourable part seemed to be in the volcanics north of Sagawitchewan bay. Here pyrite and chalcopyrite were found mineralizing small fracture zones.

No deposits of any value were found in the pegmatites of the present area. However, pegmatites rich in albite were found intruding the paragneiss and greywacké in the vicinities of Warrington, Gorman, and Azure lakes. It is the pegmatites rich in albite which usually carry the minerals of economic value in other areas, as in the Winnipeg River district.



Typical topography of the clay belt, looking across the boundary towards Manitoba, mile 64.

On Red Sucker lake, Manitoba, thirty miles north of Sagawitchewan bay, a recent find of cassiterite was made. This was not reached by the writers but specimens seen showed cassiterite embedded in a fine-grained rock consisting mainly of albite and quartz.

Agricultural Possibilities of the Clay Belt

The clay-covered regions form regular, gently rolling country (see photograph above), covered with poplar groves on the higher ground and spruce muskeg on the lower. Where fires have swept the country, rather sparse scrub jackpine and poplar have grown up, which would not be hard to clear. In such areas there is little humus soil, and the surface is hard compact clay supporting very little grass or other small plants.

Within a few miles of the northern limit the clay is lighter and less compact, yielding a better soil and more abundant vegetation. A sample taken from here was submitted to the Soil Survey Branch of the Ontario Agricultural College, Guelph, for examination and analysis. This was performed by G. N. Ruhnke, M.S.A., whose report is as follows:—

Analysis of Sample of Clay Soil, No. 7,496	Per cent.
Hygroscopic moisture	3.79
Loss on ignition	8.30
Organic matter	2.75
Nitrogen	.12
Total phosphoric acid (P_2O_5)	.09
Total calcium (CaO)	3.04
Reaction	pH6.75

This sample is not far below the average southern Ontario soil in its content of nitrogen and organic matter. These are not high, however, and the probabilities are that under cultivation the problem of maintaining soil organic matter and nitrogen would be one of primary importance. This would depend, of course, on topographical variations, height of water table, nature of subsoil, etc.

Compared with the average southern Ontario soil this sample contains only half the total amount of phosphorus, and this is very significant from an agricultural standpoint.

Although no satisfactory measure of "available" phosphorus can be made, we may assume that a low total content in this case means a phosphate deficiency problem soon after the land is brought into cultivation.

Fortunately, the lime content is very satisfactory, and this is a good feature. This is further reflected in the very slight acid reaction, as shown by the pH determination.

On the whole, the soil is better supplied with primary fertility nutrients than might be expected of a northern timbered soil which, under conditions of good drainage, would be expected to be well podsolized.

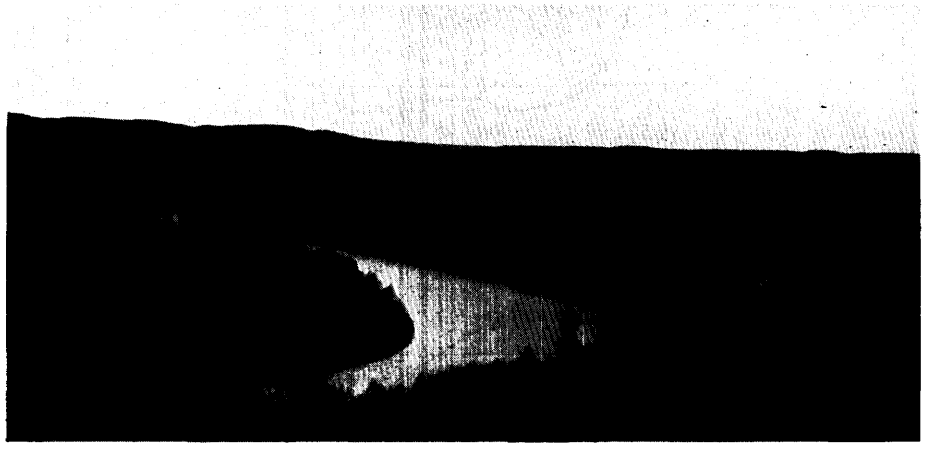
From a standpoint of fertility, then, this soil is suitable for agriculture, and the dominant limiting factors will be climatic, i.e. temperature and precipitation.

Geology of the Heron Bay Area, District of Thunder Bay

By J. E. Thomson

INTRODUCTION

In the vicinity of Heron bay, on the northeastern shore of Lake Superior, there is an area of early pre-Cambrian rocks that was roughly outlined many years ago, but never thoroughly examined. During the summer of 1930, the western part of this area was investigated and mapped in considerably more detail than had previously been attempted. The area included in this report extends along the main line of the Canadian Pacific railway from Hemlo to a point near Peninsula and from Playter harbour on Lake Superior to a point on the Pic river 21 miles due north of the C.P.R. bridge. The area includes



View across the valley of the Pic river from the C.P.R.

the township of Pic and certain territory referred to as townships 74, 75, and 76, the boundaries of which have been outlined but never completely surveyed. Heron Bay station, the most favourable point of departure from the railway, is approximately 55 miles west of White River, the nearest divisional point.

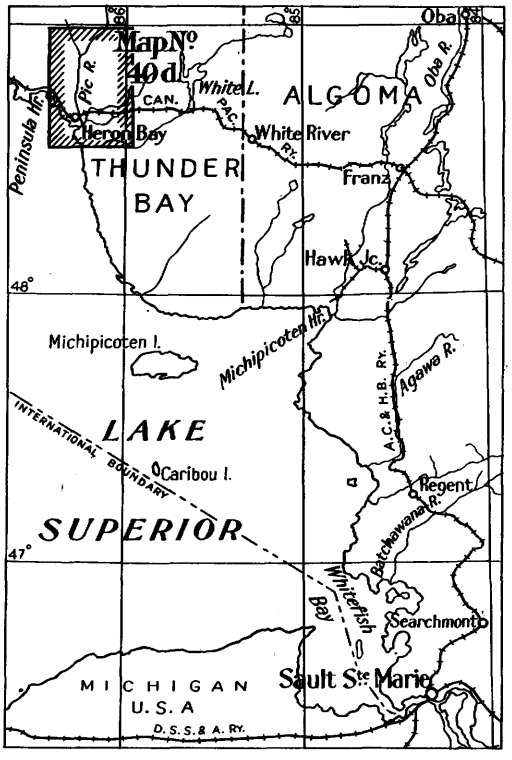
Small gold prospects in the vicinity of Heron bay were described as early as 1872 by Robert Bell.[1] Since that time only a few geological reconnaissance trips have been made into the area, chiefly along the Pic river and the C.P.R. The fact that so far no major mineral discoveries have been made in this area has led to neglect of both prospecting interest and detailed geological investigation. In recent years a few groups of claims have been staked in the more accessible regions along the Pic river and the shore of Lake Superior. The recent development of granite for building stone at Peninsula has led to some exploration in that vicinity.

The accompanying geological map embraces an area of approximately 300 square miles. On the west it overlaps the Port Coldwell map area,

[1]Robt. Bell, Geol. Surv. Can., Rept. of Progress for 1872-73, p. 110.

which was outlined in 1910 by H. L. Kerr. The eastern and northern limit. represent the extent of territory that could be covered during the field seasons Field mapping is admittedly incomplete; if continued eastward, there is a strong possibility that a much larger greenstone belt could be outlined.

The principal water routes north of the C.P.R. were surveyed by micrometer and prismatic compass and tied, as far as possible, to previously surveyed lines or the C.P.R. A number of the numerous lakes in the neighbourhood of Pukatawagan lake were also surveyed, as well as the canoe route from Angler



Key map showing location of the Heron Bay area.
Scale, 50 miles to the inch.

to the Pic river. Pace-and-compass traverses made across country were tied to previously established points. The few original surveys in the area have been almost entirely obliterated either by fire or forest growth. None of the concession lines of Pic township could be located.

Acknowledgments

Many courtesies were extended during the summer by various individuals, to whom the writer wishes to express his appreciation. Much assistance and information were obtained from F. Currie, of Toronto; H. England, of Port Coldwell; T. J. Beggs, of Heron Bay; R. Coveney, of Peninsula; and Wm. Morrison, manager of the Peninsula Granite Quarries. A recent geological map of the property of the Peninsula Granite Quarries, made by John Dawson, mining engineer, was supplied by Mr. Morrison.

In the field most able assistance was rendered by Wilfred Tansley, E. P. Thompson, and A. P. Addison. Assays and chemical analyses were made by the staff of the Provincial Assay Office.

Access

The districts north and south of the C.P.R. can be most easily reached by way of the Pic and Black rivers. The Pic is 250 feet in width at the C.P.R. bridge near Heron Bay station. It can be navigated from its mouth for a distance of approximately 50 miles northward without a portage. About 8 miles upstream from the bridge there are 3 shallow rapids during the low-water season, but these offer little difficulty. The banks of the Pic river are very precipitous, averaging 50 to 75 feet in height over most of its course. For this reason, the location of camp sites is generally quite difficult and trails starting from the river are hard to find. An alternative canoe route to the upper part of the Pic river is offered by a series of portages and lakes starting near Angler siding. From the river, twenty miles north of the C.P.R., a portage leads to Lake Pukatawagan and a series of small lakes, a number of which have been mapped.

The Black river drains a series of lakes situated about 40 miles north of Hemlo station, the largest of which is Lake Manitouwadge. A short cut to the upper part of the river is afforded by a portage from Rous lake, near Pringle siding on the C.P.R. Lake Manitouwadge may be reached by way of the Black river, there being 14 portages en route from the C.P.R. at Rous lake.

Previous Work

As early as 1872 Robert Bell reported on activity at the Heron Cove mine, located near Heron bay. Reconnaissance trips have been made along the Pic river by Bell, Parsons, and Coleman. Coleman, also, on various occasions, reported on prospects and mineral occurrences in the vicinity of Heron Bay and Peninsula for the Ontario Bureau of Mines.

The area is included on map No. 964 of the Canadian Geological Survey, which accompanies Collins' report on the region lying north of Lake Superior between the Pic and Nipigon rivers. The Port Coldwell batholith, which is partly included in the map area, has been described by A. P. Coleman and H. L. Kerr. A bibliography of the principal references to the area is given below.

ROBT. BELL, Geol. Surv. Can., Rept. of Progress for 1870-71, pp. 327-331; Geol. Surv. Can., Rept. of Progress for 1872-73, pp. 110-111.

A. P. COLEMAN, Ont. Bur. Mines, Vol. VII, 1897, pp. 83, 133; Vol. VIII, pt. 2, 1899, pp. 135, 167; Vol. IX, 1900, pp. 186-191; Vol. XI, 1902, pp. 208-213; Vol. XVIII, pt. 1, 1909, pp. 149-153; Vol. XXIII, 1914, p. 231.
Jour. Geol., Vol. VII, 1899, p. 431.
Glacial and Post-Glacial Lakes in Ontario, University of Toronto Studies, Biological Series, No. 21, 1922.

W. H. COLLINS, Report on the Region Lying North of Lake Superior between the Pic and Nipigon Rivers, Geol. Surv. Can., Pub. No. 1081, 1909.

H. L. KERR, Nepheline Syenites of Port Coldwell, Ont. Bur. Mines, Vol. XIX, pt. 1, 1910, pp. 194-232.

A. L. PARSONS, Ont. Bur. Mines, Vol. XVII, 1908, pp. 130-134; Vol. XXII, pt. 1, 1913, p. 231.

Topography and Drainage

The area is predominantly covered by rock outcrop. Along the shores of Lake Superior, hills rise abruptly 200 to 400 feet above the lake, and in the

vicinity of Peninsula attain an elevation of 1,300 feet above sea-level. The view over the lake from some of these hills is of unusual beauty. Immediately south of Pic township and extending inland from Playter harbour, there are a series of ridges trending east-west and separated by deep depressions, which usually provide channels for small streams. One of these depressions is responsible for the long narrow indentation of the coast line at Playter harbour. Their linear arrangement and parallelism suggest ancient faults or easy erosion of fissile schist zones in the direction of schistosity.

Viewed from the summit of one of the numerous hills in the vicinity of Heron Bay station or Peninsula, Pic township represents a rugged appearance. A succession of rounded hills interrupted in places by vertical cliffs and narrow valleys continues northward for many miles. North of the township they increase in elevation, and in places east of the Pic river attain an altitude of almost 1,800 feet (aneroid).

A pronounced topographic feature is the valley of the Pic river, which follows a straight well-marked depression for many miles. The valley averages



View along the main line of the C.P.R. at Heron Bay, Lake Superior.

a mile in width and is almost completely covered with bedded sands and clay. Through this overburden, the river has cut a deep channel with steep and precipitous banks, averaging 50 to 75 feet in height. Owing to continuous slumping of these banks, the river has a characteristic muddy appearance, from which it has derived its name, Pic meaning "muddy" in Ojibwayan. It would appear that the Pic has selected a channel through the valley of an earlier river, formed in pre-glacial time, which was partially filled by glacial-lake deposits.

Glacial deposits are found in the neighbourhood of Peninsula. They also cover considerable territory along the C.P.R. from the Pic river to a point near Pringle siding. Here they appear as level sand plains or are covered by swamp.

The greater part of the area is drained by the Pic and Black rivers and their tributaries. The Pic river originates from a series of lakes and streams in the vicinity of the C.N.R. and flows southward for approximately 60 miles to Lake Superior. Its upper stretches have been described by Parsons.[1] At the northern extremity of the area it has a width of 100 feet. The Black river originates in the unexplored territory north of Hemlo. From a point near the junction of Cedar creek it flows westward and cuts a tortuous course through

[1]A. L. Parsons, Ont. Bur. Mines, Vol. XVII, 1908, pp. 130-134.

glacial clays and sands. Here it resembles the Pic in that the banks are sometimes precipitous. About 2 miles south of the C.P.R. the river drops 100 feet through a narrow gorge in two series of cascades. South of these falls it is joined by Little Black river, which drains a series of small lakes to the east. Little Black river is navigable for 2 miles up to the junction of a creek from the south.

Natural Resources

Timber

The area is well timbered with spruce, balsam, birch, and poplar, with a little cedar along the Black river and jackpine on the high ground. The best stands of spruce and balsam are confined to the depressions, and the uplands are crowned with birches, sometimes 2 feet in diameter, and poplars. No large forest fires have occurred in recent years, but a few small patches of brulé show the effect of fires in the past. Pulpwood is being cut annually along the Pic river and floated down to Lake Superior, where it is either loaded on boats or rafted along the lake.

Game and Fish

Moose are abundant in the vicinity of the small lakes in the northern part of the area and may be observed occasionally elsewhere. A few red deer were seen. Muskrat, fox, marten, and fisher are trapped by the Indians. Beaver seem to have been exterminated. An occasional black bear may be seen, also a few porcupines.

Excellent speckled trout may be caught in some of the smaller streams, especially those near Lake Superior. Pike and pickerel are numerous in the smaller lakes. Lake trout of great size and whitefish are obtained along the shores of Lake Superior and shipped to the larger centres from Peninsula and Port Coldwell. Herring are also caught, especially by the Indians.

Agriculture

Agriculture can be carried on only with difficulty, and gardens are kept chiefly for growing potatoes. Blueberries of excellent quality grow in profusion on the sand terraces near Heron Bay and Peninsula and are picked in the fall by Indians. Large shipments are made annually from these two places.

Inhabitants

The inhabitants of the area are chiefly railway employees, who live at scattered intervals along the C.P.R., and the Pic River Indians. Some 20 people are located at Heron Bay station and probably an equal number at Peninsula. Both stations have a general store, post office, and telegraph service.

About 30 families of Ojibwayan Indians live on the Pic River Reserve, which is located at the junction of the Pic and Black rivers. They are provided with church and school.

Economic Geology

No mineral deposits of major economic interest have been located within the Heron Bay area. As previously mentioned, prospecting activity in the past seems to have been rather limited. A few groups of claims have been staked. These properties are held for their content of either gold, iron, nickel-copper, building stone, gravel, or cobble stone.

Gold has been reported to occur in the area but was not observed by the writer, nor was it obtained by assays of a few samples taken from the most promising showings. In certain parts, there are mineralized shear zones, mineralized quartz veins, and rusty schists, all of which are favourable for the occurrence of gold. Whether a more intensive examination will reveal deposits of gold is entirely a matter for speculation, but there are at least reasonable possibilities of success for the investigator.

Iron, in the form of magnetite, occurs disseminated throughout the augite syenite, which extends from Peninsula to the Pic river. East of Bamoos lake a concentration of this magnetite carries 40 per cent. iron. The deposit is small, irregular in distribution, and highly titaniferous. While this is economically unimportant, so far as the iron content is concerned, it is interesting to note that a trace of vanadium has been found. Copper and nickel are obtained from a sulphide deposit north of Louis lake.

Quarrying of syenite (commercially known as granite) in the vicinity of Peninsula for building and monumental stone has, at present, the greatest possibility of becoming a stable industry in the area. Red and black granite quarries are being opened up in such positions that transportation facilities either by water or rail could scarcely be improved. The extent of the commercial deposits guarantees a future supply for generations. Both granites possess the physical characteristics necesssary for a good building stone. The beauty of the black granite of this locality and its resemblance to the famous laurvikite of Norway has long been recognized. Present demands for these granites seem to indicate that they will have a ready market.

GENERAL GEOLOGY

The consolidated rocks of the area are practically all of the igneous type and are pre-Cambrian in age. The oldest formation is the Keewatin, which consists chiefly of metamorphosed lavas and volcanic fragmental eruptives. The Keewatin rocks have been intruded by five rock types: (1) Scattered and irregular intrusives, ranging in composition from lamprophyre to gabbro. These are highly altered and are pre-granite in age. (2) Granite and granite gneiss, which in places grades into syenite. (3) Augite syenite of the Port Coldwell batholith. (4) Sheared feldspar porphyry. (5) Quartz and olivine diabase dikes. These also cut the granite and are the latest intrusives of the area.

Out of the above group of intrusives only the diabase may be placed definitely as to age. In appearance, composition, and relation to other intrusives, it corresponds to the Keweenawan diabase described so frequently in other areas near Lake Superior. The age of the granitic intrusives can only be postulated within certain limits, and they may best be assigned, at least tentatively, to the Algoman period of plutonic intrusion. The porphyry intrusives are genetically related to the granite masses.

There remains to be considered the stratigraphic position of the red and augite syenites. These form part of the nepheline syenite series of Port Coldwell, which has been described in detail by Kerr.[1] Regarding the relationship of these syenites to the granite area north of Port Coldwell, Kerr concludes as follows:[2]—

> The evidence collected appears to support the theory that the syenite massif fades into the more acid rocks [granite] to the north without any sharp line of demarcation . . . there is reason to think that the whole syenite massif merely represents a peripheral differentiation phase of the fundamental gneiss found to the north.

[1]H. L. Kerr, Ont. Bur. Mines, Vol. XIX, pt. 1, 1910, pp. 194-232.
[2]Ibid, p. 230.

Kerr observes in the preface that the data for this assumption are rather incomplete. In the Heron Bay area the writer was unable to find the syenite series in contact with the granite. Areal mapping has yet to show that the granite north of Port Coldwell is a continuation of that traced out in the Heron Bay area; neverthless, there is a strong probability that this is the case.

It is also significant that Keweenawan diabase dikes cut the various syenites as well as the granites. It thus appears to the writer that the syenite series should be regarded tentatively as belonging to the same general period of intrusion as the granite.

The various formations may be classified as follows, the oldest being placed at the bottom:—

QUATERNARY	
PLEISTOCENE and RECENT:	Bedded clays (varved), sand, and gravel.
PRE-CAMBRIAN	
KEWEENAWAN:	Olivine diabase and quartz diabase dikes.
ALGOMAN (?):	Granite and feldspar porphyry, syenite. Hornblende and biotite granite and gneiss. Red syenite.[1] Augite syenite (laurvikite).[1]
KEEWATIN:	Rhyolite, agglomerate, and volcanic tuff. Iron formation. Andesite, basalt, amphibolite, amygdaloidal lava, chlorite schist; subordinate areas of intrusive gabbro, diorite, and lamprophyre.

Keewatin

Keewatin rocks occupy a considerable portion of the map area. They present a variation from acid to basic types and are metamorphosed and altered to typical greenstones. They are interesting from an economic point of view as they offer suitable conditions for deposition from circulating ore-bearing solutions.

Keewatin rocks can be traced along the shore of Lake Superior from a point near Peninsula to Playter harbour. They extend inland and are divided into three distinct belts east of the Pic river, being separated by intrusive masses of granite and granite gneiss. The two southern belts trend eastward and have an average width of about three miles. The more northerly of these two belts has been traced as far east as Hemlo station, where it shows a tendency to broaden. A map[2] published by the Geological Survey of Canada shows a continuation of these rocks along the C.P.R. to a point near King station. The eastern limits of the more southerly belt are unknown. The greenstone area which extends north of Pic township is the largest and least definitely outlined. It has been traced for a distance of 14 miles along the Pic river and has a width of four miles at the northern extremity of the map area. On the west it is bounded by the granite and augite syenite of the Port Coldwell batholith. The Indians report its easterly extension for several miles beyond the limits of the accompanying map.

The main portion of the Keewatin is lava of intermediate to basic composition. South of the railway it is altered and sheared to form local areas of chlorite schist. Along the upper stretches of the Pic river massive andesite of a rather coarse texture predominates. Part of this appears to be "tight"

[1]Tentatively classified as equivalent in age to the granite.
[2]Map No. 964, Geol. Surv. Can., 1907.

and rather unpromising from a prospecting standpoint. A few localities, however, were noted in which the andesite was schisted and impregnated with sulphides, chiefly pyrite.

Subordinate areas of acidic lavas, associated in part with agglomerates and volcanic tuffs, are to be seen throughout the region. Three of the most distinctive belts have been mapped in separate colour, but there are smaller ones which have not been differentiated from the Keewatin complex. Excellent exposures of agglomerate may be seen on the water-worn islands and along the shore of Lake Superior between Ogilvy point and Heron bay. Here it contains fragmental inclusions of all sizes up to blocks over two feet in length. They have a pronounced elongation parallel to the schistosity, but many still show evidence of original angularity. They can readily be distinguished by their pinkish colour in contrast to the dark-green chloritic matrix. The fragments are felsitic to porphyritic in texture, and eyes of quartz and feldspar can often be distinguished. Small areas of volcanic tuff are interbedded with the



Exposure of agglomerate on a small water-worn island north of Ogilvy point, Lake Superior.

agglomerate; both appear to grade into rhyolite, which is felsitic in texture and often slightly reddish in colour. The general relationship of the acidic rock types to the chloritic schists and basic lavas is rather obscure but appears to be a gradation from one to the other. This can best be observed along the railway west of Heron Bay station.

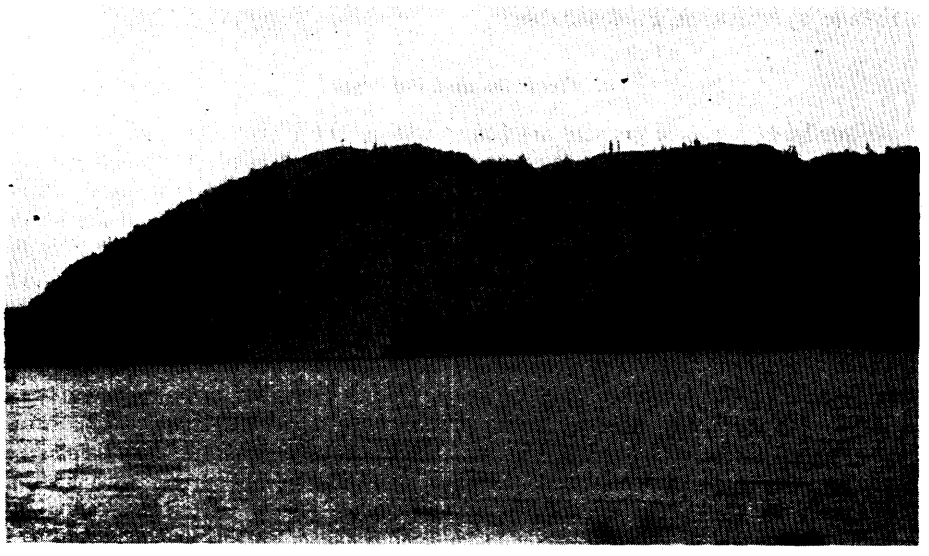
Amygdaloidal bands of lava, one to two feet in width, are to be observed at various places along the C.P.R. west of Heron Bay station. These have been noted by Collins.[1] They are also found south of Roccian lake, where narrow zones of small oval-shaped amygdules can be seen, which in thin section are found to be composed of chalcedony with an enclosing rim of dense siliceous material in which there is a suggestion of radiating structure.

Traces of iron formation may be seen along the Pic river near the northern boundary of Pic township and occasionally elsewhere. The iron formation shows a preponderance of banded black chert and contains only a trace of iron. The bands are narrow and of very small extent.

[1]W. H. Collins, Geol. Surv. Can., Pub. No. 1,081, 1909, p. 14.

Isolated patches of basalt occur within the augite syenite in the vicinity of Bamoos lake. These correspond to part of a basic eruptive series described by Kerr,[1] especially that part which is found in the neighbourhood of Port Munroe. Kerr[2] has shown that the basic eruptives are the oldest members of the Port Coldwell massif. In the Heron Bay area it seems impossible to differentiate these isolated areas from the Keewatin greenstones. They probably represent infolded areas of lava which have escaped erosion and remain as roof pendants in the syenite batholith.

Scattered irregular intrusive masses and dikes of gabbro, quartz diorite, and lamprophyre cut the lavas. These are undifferentiated from the Keewatin rocks on the accompanying map. Along the indented shoreline of Lake Superior immediately south of Mud bay (the long inlet between the mouth of the Pic



Typical view along the shore of Bamoos lake, showing a ridge of augite syenite.

river and Playter harbour), gabbro and amphibolite may be observed intruding chlorite schist. The gabbro grades into a coarsely textured amphibolite, which is easily recognized by the development of lath-shaped hornblende crystals up to an inch in length. Thin sections of the gabbro show that it is considerably altered. It contains a preponderance of hornblende, completely kaolinized feldspars, and magnetite, with subordinate amounts of chlorite, zoisite, leucoxene, epidote, and pyrite. Secondary quartz and carbonate have been introduced.

Algoman

Red and Augite Syenite

These two rock types have been described by Kerr,[3] to whose report the reader is referred for a detailed description of their physical and petrological characteristics. The augite syenite has been traced eastward from Peninsula to the Pic river and then northwestward to Bamoos lake and beyond. The

[1]H. L. Kerr, op. cit.
[2]Ibid, p. 225.
[3]Ibid, pp, 211-220.

contact phase of the augite syenite with Keewatin greenstones is characterized in places by the development of porphyritic phases containing large and abundant magnetite crystals. Pegmatite dikes, which are composed of essentially the same minerals as the invaded rock, cut the augite syenite.

Kerr[1] believes that the red and augite syenites are differentiates of a common magma, which was probably granitic in composition. As observed in the rock cuts north of Peninsula, the transition from augite to red syenite is of an oscillatory nature with decreasing recurrences of augite syenite as the red syenite is approached until only the latter type can be seen.

A few dikes of analcite rock have been found near mile-post 56 on the C.P.R. by Coleman.[2] The rock approaches analcite tinguaite in composition and was given the name heronite. Their presence suggested to Dr. Coleman that nepheline rocks might occur in the region. These were later found in the nepheline syenites of Port Coldwell.

Granites and Gneisses

Four large areas of granite are found within the Heron Bay map area. The rock varies in colour from grey to salmon-pink and reddish varieties and in texture from medium-grained granitic to coarsely porphyritic and gneissic types. Hornblende and biotite are the chief ferromagnesian constituents. The larger granitic areas, with one exception, are gneissic in structure. The exception is an area extending eastward from the junction of the Pic and Black rivers, which contains granitic rocks different, both in structure and contact phenomena, from the others. The rock is chiefly a massive grey granite, which grades into a syenite porphyry near the greenstone boundaries. At the falls on the Black river typical contact effects may be seen. Here marginal apophyses of syenite porphyry are intruded into the green schists parallel to the schistosity, forming a complex with a *lit par lit* arrangement. Xenoliths of greenstone may be observed in the granite near the contact. Similar phenomena are to be seen at many places around the periphery of the granite area.

Thin sections of granite made from specimens collected in various parts of the area show great uniformity of mineral content. They exhibit a predominance of hornblende, orthoclase, and quartz, with lesser amounts of biotite, plagioclase, epidote, titanite, and apatite. Chlorite, sericite, and kaolin are secondary minerals.

Granite and Feldspar Porphyry

Dikes and irregular intrusive masses of granite and feldspar prophyry may be observed throughout the area. The porphyry generally has a pinkish to greyish colour and is sometimes characterized by distinct crystals of feldspar. It shows considerable alteration and is usually schisted. Microscopic examination of a typical specimen from a point near the Pic river immediately south of the C.P.R. reveals a porphyritic texture with parallel arrangement of micas due to rock flow. Orthoclase and a subordinate amount of acid andesine are the dominant euhedral minerals. The groundmass is a fine aggregation of feldspar, quartz, chlorite, muscovite, magnetite, and carbonate.

Many quartz veins and stringers of varying size are to be observed in close proximity to porphyry dikes. These are generally small and irregular. A few contain a small amount of sulphides.

[1]H. L. Kerr, op. cit., p. 212.
[2]A. P. Coleman, Ont. Bur. Mines, Vol. IX, 1900, p. 186.

Keweenawan

Diabase dikes up to 200 feet in width are widespread in occurrence. Along the shore of Lake Superior differential erosion reveals great numbers of these dikes and causes them to stand out prominently. Most of the dikes strike within 20 degrees of north; the dip is generally vertical.

Both quartz and olivine diabase occur. The former is considerably altered in contrast to the fresh appearance of the olivine type and is probably of earlier age. When examined microscopically this difference is even more apparent. The quartz diabase shows an ophitic intergrowth of augite, plagioclase, and quartz, with lesser amounts of magnetite, apatite, hornblende, biotite, and chlorite. The fresher type is characterized by labradorite and olivine.



Glacial varved clays overlain by sands exposed along the banks of the Pic river.

Pleistocene and Recent

The larger areas covered by sand and clay are indicated on the accompanying map. The incision of the Pic river into these sediments has revealed good sections of varved clays overlain by bedded sands. Raised beaches, formed by glacial lakes, are to be seen along the Pic river and at Peninsula. Coleman[1] has recorded six beach levels at Peninsula, the upper three of which come within the limits of Lake Algonquin. Sand terraces along the Pic show the advance of this lake up the river valley at least 35 miles above the C.P.R. at Heron Bay. At this distance from the lake, Coleman found fossil remains of genera now living in Lake Superior. Beaches of Lake Nipissing, which followed Lake Algonquin, have been found at Peninsula harbour 108 feet (aneroid) above the present lake level. It is probable that the lower terraces along the Pic also represent a portion of the Lake Nipissing shore.

Glacial striae, chatter marks, and ice grooving can be seen everywhere. Glacial striae show the direction of ice movement to have been S. 20°–45° W.

[1]A. P. Coleman, Glacial and Post-Glacial Lakes in Ontario, University of Toronto Studies, Biological Series No. 21.

Geologic Structures

The structures of the different igneous formations, which are generally of the massive type, have to be inferred from meagre field data. The Keewatin rocks in Pic township are intensely metamorphosed and show evidence of folding roughly parallel to an axis trending in an east-west direction. The strike of the schists in the southern part of the area is, in general, east-west, but local variations from this regional pattern are numerous. The schists dip north except near the northern boundary of Pic township where a southerly dip is often exhibited. North of Pic township the greenstones are of the massive type, but local shear zones trend from N. 20°–30° E. Quartz veins and porphyry dikes tend to be oriented parallel to the schistosity.

Local evidence of faulting can be seen in the offset of small diabase dikes. The great variation in strike of the schists south of Heron Bay station suggests either faulting or intricate folding, probably the former.

ECONOMIC GEOLOGY

Claims have been staked in various parts of the area for their content of gold, nickel-copper, iron, granite, and cobble stone. Little development work has been done on any of these properties beyond surface-trenching and test-pitting.

Gold

Johnston Claims

This group is located immediately east of Playter harbour on Lake Superior. It was staked by H. J. Johnston, of Pearl, Ont. On claim S.S.M. 6,302, a lenticular vein of milky quartz has been uncovered for a distance of 140 feet by a series of trenches. The average width of exposed quartz is 27 feet, but the total width may be greater as the south contact is covered. The maximum observed width was 37 feet. The vein strikes due east-west and disappears under a thick mantle of drift in either direction along the strike. The north wall is fissile chlorite schist impregnated with pyrite.

The greater part of the vein is glassy quartz, devoid of sulphides. Mineralization is confined largely to the vicinity of the vein wall and narrow mica schist bands included in the quartz. Galena, pyrite, and chalcopyrite may be observed in small amounts. Gold and silver have been reported from this vein. A channel sample taken by the writer across 37 feet of quartz in the second trench from the east end showed, on assay, no gold or silver. Another channel sample, taken across 2½ feet of the most promising mineralized zone in the trench immediately to the west, also gave negative results.

Claims S.S.M. 6,533 and 6,534

An island in the first bay north of Playter harbour is traversed by a quartz vein ranging from 9 inches to 2½ feet in width. The wall rock is a fine-grained amphibolite and green schist. Traces of pyrite, galena, and chalcopyrite are to be seen associated with the quartz.

Heron Cove Mine

This property is located at Heron Bay station, and has long been abandoned. Dr. Bell[1] reported activity there in 1872. Specimens of the ore taken by him

[1]Robt. Bell, Geol. Surv. Can., Rept. of Progress for 1872-73, p. 110.

assayed 0.058 ounces gold and 7.03 ounces silver per ton. Three old pits, sunk on a sheared zone in the acid volcanics, are still to be seen near the station. The dump is composed of chlorite and sericite schist impregnated with quartz and ankerite. Traces of pyrite and chalcopyrite may be seen.

Beaumont and Davidson Claims

This group is composed of 36 claims comprising the east half of the larger block located northeast of Louis lake. The property is held by J. Davidson and J. Beaumont. Gold is reported to have been found on these claims. A trench on claim T.B. 9,079 exposes a sheared zone in massive andesite, which strikes north-south and dips steeply to the west. Irregular bands of limonitic gouge form an intricate pattern across a width of 14 feet. The zone has not been traced any distance along the strike. Small amounts of pyrite and chalcopyrite may be seen in irregular stringers and disseminated throughout the sheared zone. A grab sample gave no gold values when assayed.

Copper-Nickel

A block of claims northwest of the Beaumont and Davidson property and extending to within a short distance of Louis lake is held by T. J. Beggs and F. Currie. The principal showing is on the side of a low ridge immediately north of post No. 1 of claim T.B. 7,278. Work done on the property consists of a series of trenches and a shallow test pit. These reveal an irregular area, approximately 200 feet in its greatest dimension, of massive diorite, which shows rusty weathering. Disseminated sulphides are observed in small amounts through this oxidized zone, but their distribution is patchy and connected with no particular geological structure. Pyrrhotite, pyrite, and chalcopyrite are the sulphides present. In thin sections, these show evidence of having replaced the altered diorite.

A grab sample of sulphides from the main showing, collected by the writer, assayed 0.66 per cent. copper and 0.31 per cent. nickel. Better assay values than these have been reported from this occurrence.

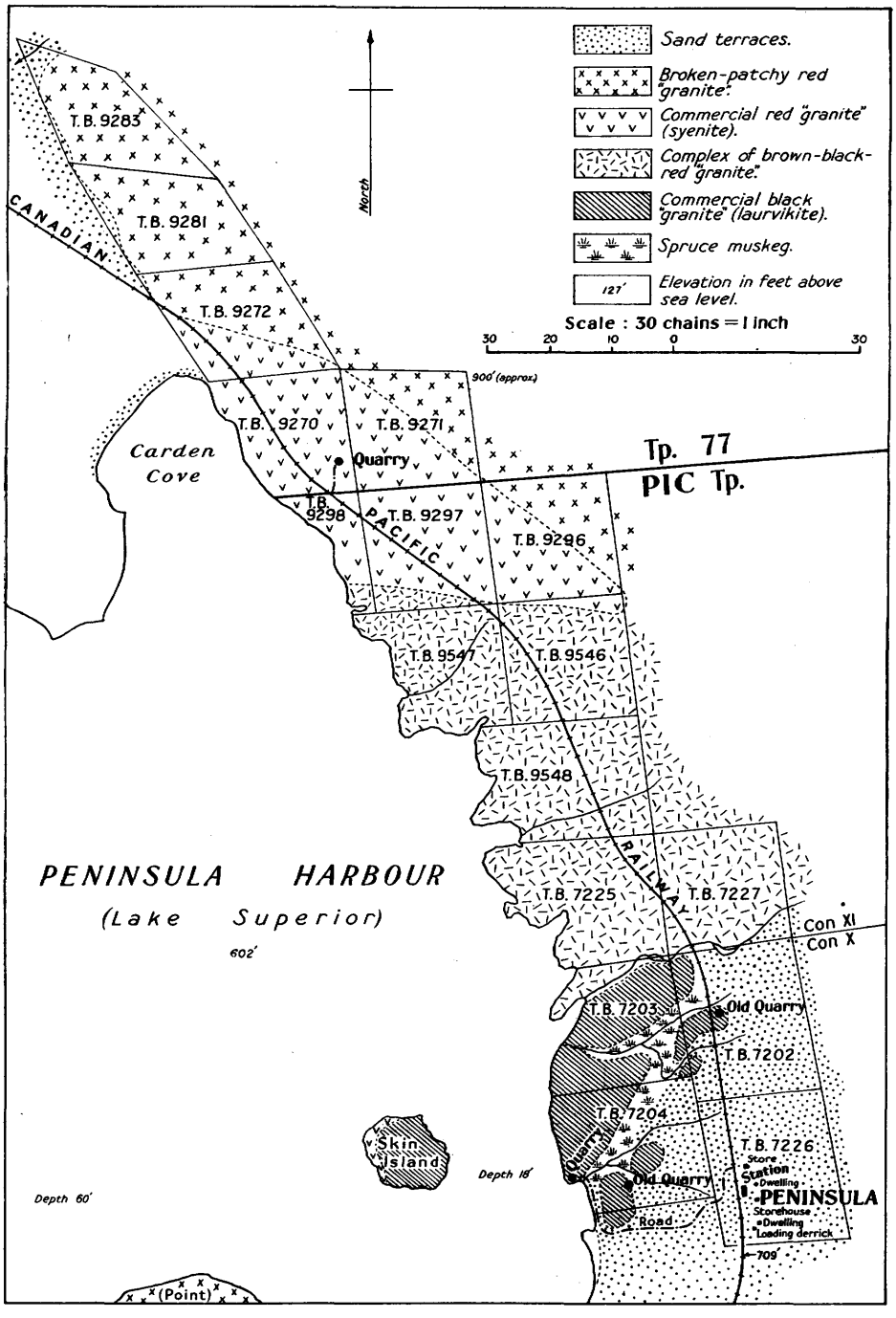
Iron

A group of claims owned by H. England, of Port Coldwell, extends southeastward from Bamoos lake. Stripping has located a few showings of magnetite, the largest of which is found on claim T.B. 7,796. At this place, a trench 125 feet in length reveals a concentration of magnetite, which grades imperceptibly into augite syenite containing only a small amount of disseminated magnetite. The magnetite is concentrated on either side of a pegmatite dike 10 feet in width. The magnetite ore contains a trace of pyrite and chalcopyrite.

Analysis of a chip sample taken along the total length of the trench showed the following content:—

	Per cent.
Iron	40.0
Titanium oxide	7.35
Sulphur	.56
Phosphorus	.33

Vanadium was reported by Mr. England from an occurrence of magnetite on a small island in the lake east of Bamoos lake (southwest corner of claim T.B. 7,797). A grab sample of magnetite ore from this place, obtained by the



Geological sketch map of the properties of Peninsula Granite Quarries, Limited, Peninsula, Ont.

writer, assayed 0.48 per cent. vanadium. The vanadium mineral that occurs here has not been determined definitely. Dr. T. L. Walker,[1] who has examined specimens from this location, suggests that the film of sage-green mineral occurring on the joints of some specimens may be pintadoite.

Pebbles and Cobble Stones

A few claims have been staked along the lake shore near Peninsula for their content of pebbles and cobble stones which might be used in ball mills. Craig's gravel pit, south of Peninsula, contains a good supply of pebbles that are satisfactory for this purpose, but no shipments have been made. Granite, gneiss, diorite, pegmatite, limestone, and many other varieties of pebbles are found. The cost of shipping from this point would be very little, since there is a railway spur-line passing alongside the pit.

Granite

It has been known for many years that the syenites in the vicinity of Peninsula and Port Coldwell are adaptable for building stone. Black granite[2] was first quarried at Peninsula about 50 years ago by the Canadian Pacific Railway for the construction of bridges over the Pic and Little Pic rivers. Since 1927, this rock has been quarried on a small scale by the Peninsula Granite Quarries, Limited, under the management of Wm. Morrison. Shipments were first made early in 1928, and have continued steadily ever since. Trial shipments of a red granite have also been made.

PENINSULA GRANITE QUARRIES, LIMITED (3)

The property consists of a group of 17 claims extending from Peninsula station for 2½ miles north along both sides of the C.P.R. To the west the claims border the shores of Peninsula harbour. Quarrying operations have been carried on at two different locations for the purpose of simultaneously developing red and black granite.

During fourteen months of operation in 1929 and 1930, 24 carloads of black and 2 carloads of red granite have been shipped from Peninsula. At present the company proposes to build a plant capable of producing 30,000 cubic feet of black granite and 15,000 cubic feet of red granite annually. The location of the property is such that shipments may be made by rail or boat at slight expense. Peninsula harbour is well protected and of sufficient depth to allow a dock to be easily constructed to afford shipping facilities over the Great Lakes. The granite is sold at $2.50 per cubic foot, f.o.b. Peninsula.

Peninsula black granite has been used in the construction of several buildings in Canada and the United States. In Toronto, it can be seen in the new building of the T. Eaton Company, McConkey's restaurant, the Creed Building, and the Woolnough Building. Numerous buildings in Chicago, Detroit, and other midwestern cities of the United States contain this granite. A market has also been established in western Canada. Both red and black granites are being sold for monumental purposes.

Black Granite

Commercial black granite outcrops along the lake shore near the southwest corner of claim T.B. 7,204 and is exposed continuously for 30 chains north along

[1]Personal communication.

[2]The syenite is known commercially as granite.

[3]Since this report was written, the black granite quarry has been sold to the Cold Spring Granite Company, Cold Spring, Minn., one of the largest granite operators in the United States.

the waterfront. Beyond this point it merges into a complex of red-brown-black granite. From the shore the limit of commercial material runs eastward to the railway. To the east and south the rock disappears beneath an extensive sand plain. Sixty acres of the property are estimated to be covered with a good grade of black granite.

The black granite quarry is located 30 feet from the shore of Peninsula harbour and about 1,800 feet west of Peninsula station. The working face runs at right angles to the shore line; it is 70 feet in length and has at present a maximum height of 14 feet. Blocks 10 feet in length and weighing up to 3 tons are quarried. These are hauled by team to the railway.

Two sets of joints are seen in the quarry. The most prominent strikes almost due north and varies in dip from vertical to 70° W. The cross-jointing strikes east-west and is nearly vertical. At the quarry the north-south joints are 70 feet apart and run parallel for at least 500 feet. Rectangular blocks of a size limited only by plant capacity can be quarried. The sheets lie horizontally and exhibit an even and well-defined floor. The first sheet quarried had a maximum thickness of 14 feet. Drilling in the next sheet below to a depth of 10 feet did not reach another sheeting plane. The rift is roughly parallel to the sheeting planes.

The granite, as a whole, is a dense, medium-textured rock uniform throughout the quarry. Surface weathering has penetrated the massive rock to a depth of one to two inches. The colour, when closely observed, is dark greenish-brown but at a short distance is black. A striking feature is the development of plate-like or lath-shaped feldspars, which exhibit shining cleavage planes on freshly broken surfaces. The feldspars attain a length of one-quarter to one-half inch and are the predominant mineral constituent. They generally exhibit well-developed Carlsbad twins. The chief ferromagnesian mineral is black augite. Finely crystalline magnetite is disseminated uniformly throughout the rock; traces of pyrite may be seen. At the quarry the granite shows a marked uniformity of colour. Segregations and hair lines are absent. Pegmatite dikes a few inches in width occur at wide intervals.

Examination of a dressed and polished specimen of the black granite shows that it is suitable for fine types of finished work. Owing to the large size of individual crystals, the rock breaks with a somewhat uneven surface. The colour of the hammered face is bluish-grey with a dark-green mottling. The polished surface is of pleasing appearance, the colour being much livelier than that of the rock face. Much of the charm of the rock is due to the light-blue iridescence of the feldspars. In this respect it bears a resemblance to the beautiful monumental laurvikite of Norway. A detailed examination of the surface shows a pronounced greenish-brown shade speckled throughout by irregularly shaped shining black minerals. The surface is also dotted with small grains of magnetite made noticeable by their metallic lustre. The polished rock, viewed at the distance of a few feet, exhibits a bright lustrous black colour enhanced by the delicate sheen of the feldspars. The beauty of this unique type of black granite should assure it a ready market as an ornamental stone.

The rock may be technically termed an augite syenite. Both in chemical and mineralogical composition it is similar to a Norwegian variety of augite syenite which Brögger[1] has named laurvikite. In thin section the rock shows a holocrystalline, coarsely granitic texture. The chief mineral constituents are augite and a feldspar that has been described as a "microperthitic intergrowth

[1]Zeitschrift für Krystallographie, Band. 16, 1890.

of albite and orthoclase."[1] Subordinate amounts of hornblende, olivine, biotite, apatite, and magnetite may be seen. The rock shows very little alteration. A detailed petrological description is given by Kerr.[2]

Available analyses show the augite syenite to have the following composition:—

	No. 1	No. 2	No. 3
	per cent.	per cent.	per cent.
SiO_2	58.37	58.81	57.36
TiO_2	.97	.70	.96
Al_2O_3	15.11	13.37	15.18
Fe_2O_3	1.91	3.88	1.51
FeO	8.99	6.97	8.88
CaO	3.32	3.89	4.16
MgO	.57	.51	.40
NaO_2	3.76	4.96	4.59
K_2O	4.09	5.42	4.90
MnO	.48	.20	.21
P_2O_5	.21	.31	.15
FeS_2	.....	.....	.26
Moisture	2.25	1.04	.....
H_2O (−100)	.....	.....	.14
H_2O (+100)	.....	.....	.85
CO_2	.....	.....	.49
Total	100.03	100.06	100.04
Specific gravity	.....	2.75	2.834

No. 1—Analysis of a laurvikite from a point near Peninsula, by F. A. Ghent, Philadelphia.[3]
No. 2—Analysis of a similar rock from a point near Peninsula, by A. H. A. Robinson.[4]
No. 3—Analysis of augite syenite from black granite quarry, Peninsula, by Provincial Assay Office, Toronto, 1930.

Red Granite

A red granite of commercial grade is located on the northern claims of the group and is estimated to cover an area of 150 acres, which extends from the lake shore across the railway and about half way up the side of the ridge to the east. Beyond this limit the red granite merges into a complex of black and red types. The entire area is practically devoid of overburden.

A red granite quarry is to be opened near the southeast corner of claim T.B. 9,270, about 200 feet east of the railway on the side of a ridge, which at its summit reaches an elevation of 700 feet above Lake Superior. At this place a large quarry face can be maintained. When visited by the writer, shipments of red granite were being obtained from surface blocks cut on the east side of the C.P.R. right-of-way. These were hoisted directly to freight cars.

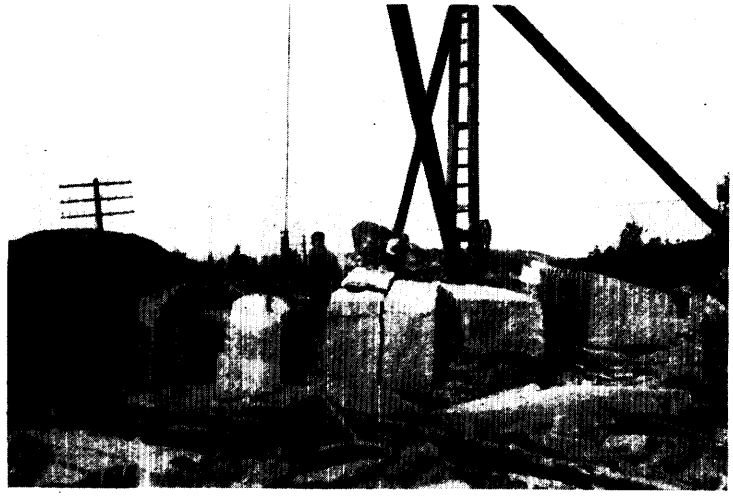
The most prominent joints strike east and north of east; the other system strikes S. 20°–30° E. Joints are so widely spaced that the largest blocks in commercial demand can be obtained. The sheets slope at an angle of 5° S.W. The rock quarries quite readily into rectangular blocks.

The granite is a medium-textured rock of a dull old-rose colour variegated with considerable amount of black material. Lath-shaped crystals of reddish orthoclase up to one-third of an inch in length are prominently exhibited. As

[1]H. L. Kerr, op. cit., p. 214.
[2]Ibid.
[3]Ont. Bur. Mines, Vol. XIX, pt. 1, 1910, p. 220.
[4]Ont. Bur. Mines, Vol. XI, 1902, p. 211.

observed at the quarry, the rock is of uniform colour and segregations are rarely of consequence. Hair lines and weathering stains were not noticed.

The sawn surface of the red granite exhibits a light-pink matrix mottled with fine, irregular anhedra of blue-green hornblende. The rock takes a good polish and exhibits a uniform granular pattern. Orthoclase, hornblende, and scattered grains of magnetite are the most prominent minerals.



Quarrying of red granite at Peninsula. This is obtained from surface blocks on the C. P. R. right-of-way.

Microscopic examination shows the rock to be an alkali syenite. Kerr[1] has named it "red syenite" and gives a complete petrological description.

An analysis of a sample obtained at the red granite quarry was made by the Provincial Assay Office and shows the following composition:—

	Per cent.
SiO_2	57.58
Al_2O_3	14.91
Fe_2O_3	2.47
FeO	7 79
CaO	3.21
MgO	1.14
Na_2O	4.45
K_2O	4.75
H_2O (−100)	.34
H_2O (+100)	1.31
CO_2	.66
TiO_2	.81
P_2O_5	.16
MnO	.23
FeS_2	.28
Total	100.09
Specific gravity	2.763

ENGLAND CLAIMS

At Angler, a group of 11 claims, containing both black and red granite, have been staked by H. England, of Port Coldwell. Blocks of black granite

[1]H. L. Kerr, op. cit., pp. 210-213.

have been taken from a rock cut on the east side of the C.P.R. right-of-way on claim T.B. 9,885. No shipments have been made from this location. The black granite is of a good grade but the area of commercial material is small and the rock is cut by numerous pegmatite dikes.

INDEX, PART II

PAGE

A

Access to areas reported on.
  Heron Bay area 23
  Ontario-Manitoba boundary 2
Acknowledgments 1, 22, 23
Addison, A. P. 23
Agassiz l. (glacial) 18
Agglomerate, photo 28
Agriculture.
  Clay belt, possibilities 19, 20
  Heron Bay area 25
Albite in pegmatites 14, 19
Algoman.
  Heron Bay area 29-31
  Ontario-Manitoba boundary 5
Algonquin l. (glacial) 31
Alkali syenite, analysis 38
Altitudes.
  Heron Bay area 23, 24
  Ontario-Manitoba boundary 4
Amphibolite 27, 29
Amygdaloidal lava 27
Amygdules 28
Analcite rock 30
Analyses.
  Augite syenite 37
  Clay soil 20
  Greenstone 9
  Iron ore 33
  Syenite 38
Andesite.
  Heron Bay area 27, 28
  Ontario-Manitoba boundary 5
    photo 14
Angekum l. 16
Angler, Ont 22, 38
Aplite 5, 9
  Photo 14
Assapan r. 2
Augite syenite 26, 27, 30
  Analysis 37
  Photo 29
Azure l. 4
  Rocks 9, 12, 19
  Trapping 5
Azure Lake belt 6-8, 12, 18

B

Balsam 25
Bamoos l. 26, 29, 33
Banksian ck. 9, 10
Banksian r. 2, 4, 9
  Boulder runs 18
  Clay 4
  Rocks 9
  Trees 5
Basalt.
  Heron Bay area 27, 29
  Ontario-Manitoba boundary. *See* Keewatin.

PAGE

Basic intrusives 11, 12
Batholith. *See* Port Coldwell batholith.
Beach deposits 5
Beaches 18, 31
Bear, black 25
Beaumont, J. 33
Beggs, T. J. 22, 33
Bell, Robert 21, 23, 32
Benson bay 4
Biotite granite.
  Heron Bay area 27
  Ontario-Manitoba boundary 13, 15
Birch 4, 25
Black granite 35, 36
Black r. 23, 24
  Indians; rocks; timber 25, 30
Boulder clay 5, 16
Boundary. *See* Interprovincial monuments.
Brögger, W. C. 36
Building stone. *See* Black granite; Granite; Syenite.
Burwash, E. M. 3

C

Calcite, Gorman l. 8
Canadian Pacific Ry.
  See also Heron Bay.
  Black granite quarried by 35, 39
Carbonate replacement 8, 9
Caribou 5
Cedar ck., Black r. 24
Chalcedony 28
Chalcopyrite 14, 19, 32, 33
Charron l. 2
Chatterway, C. 1
Chert 28
Chlorite schist 27-29
Clay 4, 5
  See also Boulder clay; Clay belt.
Clay belt.
  Agricultural possibilities 19, 20
Cobble stones for ball mills 35
Cobham l. 4
Cobham r. 2, 6
  Character; course 4
  Fish and game 5
  Varved clay 16
Cocos l. 13, 16
Cold Spring Granite Co. 35
Coleman, A. P. 23, 30, 31
Collins, W. H. 23, 28
Conglomerate 5, 10
Copper 26, 33
  See also Chalcopyrite.
Correlation of rocks.
  Ontario-Manitoba boundary 15, 16
Coveney, R. 22
Craig's gravel pit 35
Currie, F. 22, 23

PAGE

D

Davidson, J. 33
Dawson, John 22
Deer 5, 25
Derry, D. R.
Report by (and MacKenzie) on Ontario-Manitoba boundary 1-20
Diabase 26, 27, 31, 32
Diorite.
Heron Bay area 27
Ontario-Manitoba boundary 5, 11, 12
Ducks 5
Drainage.
Heron Bay area 4, 5
Ontario-Manitoba boundary 4

E

Elevation. *See* Altitudes.
Elliott l. 2, 13
England, H. 22, 33, 38
England granite claims 38, 39
Epidote rock 11

F

Favourable l. 3, 6, 8
Feldspar porphyry.
Heron Bay area 26, 27
Ontario-Manitoba boundary 5, 13, 14
Fire. *See* Forest fires.
Fish 5, 25
Fisher 25
Forest fires.
Heron Bay area 22, 25
Ontario-Manitoba boundary 4, 19
Fox 25

G

Gabbro.
Heron Bay area 27, 29
Ontario-Manitoba boundary 5, 11, 12
Galena 32
Game 5, 25
Geology, economic.
Heron Bay area 25, 26
Ontario-Manitoba boundary 18, 19
Geology, general.
Heron Bay area 26, 32-39
Ontario-Manitoba boundary 5-18
George isld. 2
Ghent, F. A. 37
Glaciation. *See* Pleistocene and Recent.
Gold.
Heron bay, prospects 21, 26
Johnston claims 32
Gold-eyes 5
Gorman ck. 4, 7, 8, 14
Gorman l.
Ducks 5
Rocks 6, 8, 14, 19
Striae 16
Granodiorite 5, 7, 13, 15
Granite 12
See also Black granite; Syenite.
Heron Bay area, for building 21, 26, 30
Ontario-Manitoba boundary 12
photo 14
Granite gneiss 26, 27
Granite porphyry 30
Gravel and sand. *See* Sand and gravel.

PAGE

Greenstone.
Heron Bay area 22, 27, 30, 31
Ontario-Manitoba boundary 7-11, 13
Greywacké 5, 8, 9, 10, 19
Grouse 5
Gunisao r. 3

H

Hayes River series 12
Hayward l. 1
Hemlo 21, 27
Heron bay.
Gold prospects 21
Report on area (with map), by J. E. Thomson 21-39
Rocks near 28
Heron Bay 21, 23, 24, 25
Blueberries 25
C. P. R. line at, photo 24
Heron Cove claim 23, 32
Herring 25
Hilton l.
Photo looking towards ..... *frontis.*
Rocks 13
Striae 16
Hornblende granite.
Heron Bay area 27
Ontario-Manitoba boundary 5, 13, 15
Hurst, M. E. 3, 6, 8

I

Ice-sheets. *See* Pleistocene and Recent.
Indians, Heron Bay area 25
Interprovincial monuments and mounds, photos 1, 3
Intrusive series.
Ontario-Manitoba boundary 5, 12-15
Iron. *See* Magnetite.
Iron formation.
Heron Bay area 28
Ontario-Manitoba boundary 5, 7
Iron ore, Heron Bay area 33
Iron pyrites. *See* Pyrite.
Island l. 1, 3, 4
See also Sagawitchewan bay.
Fish 5
Rocks 10, 12
Terminal moraine 18
Island Lake series 10, 18, 19

J

Jackfish 5
Jackpine 4, 19, 25
Johnston, H. J. 32
Joint l. 15

K

Keewatin.
Heron Bay area 26-29
Ontario-Manitoba boundary 5-12
Kerr, H. L. 22, 23, 26 29, 30, 37, 38
Keweenawan 26, 27, 31
Key map.
Heron Bay area 22
Ontario-Manitoba boundary 2
King station 27
Kyanite schist 7

PAGE

L

Lake of the Woods....15, 16
Lake Superior.
See also Heron bay.
Fish.... 25
Rocks....29, 31
See also Ogilvy pt.
Lamprophyre dikes.... 26
Laurvikite....26, 36
Lava....27, 28
See also Keewatin.
Lead. *See* Galena.
Lewis l.... 2
Ling.... 5
Little Black r.... 25
Lit par lit structure....7, 30
Louis l....26, 33

M

MacKenzie, G. S.
Report by, and Derry, on Ontario-Manitoba boundary.... 1-20
McLaughlin r.... 3
Magnetite.... 26
Mallard.... 5
Manitoba. *See* Ontario-Manitoba boundary.
Manitouwadge l.... 23
Maps, geological, coloured.
Heron Bay area (No. 40*d*)....*in pocket*
Ontario-Manitoba boundary....*in pocket*
Maps, geological, sketch.
Peninsula Granite Quarries, Ltd.... 34
Marten.... 25
Martin, A.... 1
Mica schist.... 10
Molybdenite.... 14
Monument, boundary, photo.... 1
Monumental stone.... 26
Moose....5, 25
Moraine, terminal.... 17
Morrison, Wm....22, 35
Mounds.
Ontario-Manitoba boundary, photo... 3
Mud bay.... 29
Muskeg.... 3, 4
Muskrat.... 25

N

Natural resources.
Heron Bay area.... 25
Ontario-Manitoba boundary.... 4, 5
Nelson r.... 3
Nepheline syenite....26, 30
Nickel....26, 33
Nipissing l., beaches.... 31
Norway.
Augite syenite.... 36
Black granite.... 26
Norway House.... 3

O

Oasis l., birds.... 5
Ogilvy pt.... 28
Olivine diabase....26, 27, 31
Ontario-Manitoba boundary.
Report on (with map), by Derry and MacKenzie.... 1-20
Opasquia l....16, 17

PAGE

P

Palsen r.... 2
Paragneiss....5, 7, 14, 19
Parsons, A. L....23, 24
Peat.... 5
Pebble stones for ball mills.... 5
Pegmatite.
Heron Bay area.... 30
Ontario-Manitoba boundary...5, 9, 14, 19
Peninsula, Ont.
Beaches; blueberries....25, 31
Glacial deposits.... 24
Paving stone.... 21
Quarrying.... 26
photo.... 38
Rocks....27-30
black granite.... 35
analysis.... 37
Peninsula Granite Quarries, Ltd.....35-38
Peninsula harbour....31, 35, 36
Pic r....21, 22
Character.... 23
Name, meaning of.... 24
Rocks....27, 28, 29, 30
Varved clay, photo.... 31
Pic tp....21, 32
Iron formation.... 28
Topography.... 24
Pickerel....5, 25
Pierce, J. W.... 1
Pike.... 25
Pintadoite.... 35
Playter harbour....27, 32
Pleistocene and Recent.
Heron Bay area....24, 27, 31
Ontario-Manitoba boundary....5, 16-18
Plutonic rocks....5, 12-15
Ponask ck.... 3
Poplar....2, 4, 18, 19, 25
Porcupine.... 25
Porphyry dikes....30, 32
Port Coldwell....26, 35
Port Coldwell batholith....26, 29
Port Munroe.... 29
Pot-holes.... 10
Prairie-chicken.... 5
Pre-Cambrian.
Heron Bay area....21, 26-31
Ontario-Manitoba boundary.... 5-16
Pringle siding....23, 24
Pukatawagan l....22, 23
Pulpwood.... 25
Pyrite.
Heron Bay area....28, 32, 33
Ontario-Manitoba boundary....14, 19
Pyroclastic rocks....10, 11

Q

Quartz-biotite schist. *See* Keewatin.
Quartz diabase....26, 27, 31
Quartz-diorite.
Heron Bay area.... 29
Ontario-Manitoba boundary.... 13
Quartz-mica schist.... 7
Quartz porphyry....5, 14
Quartzite....5, 10
Quaternary. *See* Pleistocene and Recent.

PAGE

R

Recent formation. *See* Pleistocene and Recent.
Red granite....37, 38
Red Sucker l., Man....19
Red syenite....27, 29
Rhyolite....29
Rickaby, H. C....3
Robinson, A. H. A....37
Roccian l....28
Rous l....23
Ruhnke, G. N....19

S

Sagawitchewan bay....1-3
Rocks....8-13, 19
Striae....16
Sagawitchewan r....4
Rocks....9-13
Striae....16
Sand and gravel.
Heron Bay area....27, 35
Ontario-Manitoba boundary....5, 16, 17
Sandy l....3
Severn r....2, 4, 9, 16, 17
Silts....5
Silver....32, 33
Soil, Ontario-Manitoba boundary....19, 20
Spruce....4, 25
S.S.M. 6,302, 6,533-34 mineral locs....32
Stevenson l....3
Stones for ball mills....35
Striae, glacial. *See* Pleistocene and Recent.
Suckers....5
Syenite....26

T

Table of formations.
Heron Bay area....27
Ontario-Manitoba boundary....5
Tamarac....4
Tansley, Wilfred....23
Tantalite....14

PAGE

T.B. 9,079 gold loc....33
T.B. 9,270, 9,885 granite locs....37, 39
Teal....5
Terraces....51
Thompson, E. P....23
Thomson, J. E.
Report by, on Heron Bay area....21-39
Till. *See* Boulder clay.
Timber.
Heron Bay area....25
Ontario-Manitoba boundary....4, 5
Topography.
Clay belt, photo....19
Heron Bay area....22, 23
Ontario-Manitoba boundary....3, 4
Tourmaline....14
Trapping....5, 25
Trout....25
Tuff.
Heron Bay area....27, 28
Ontario-Manitoba boundary....5-7

U

Upham, Warren....18

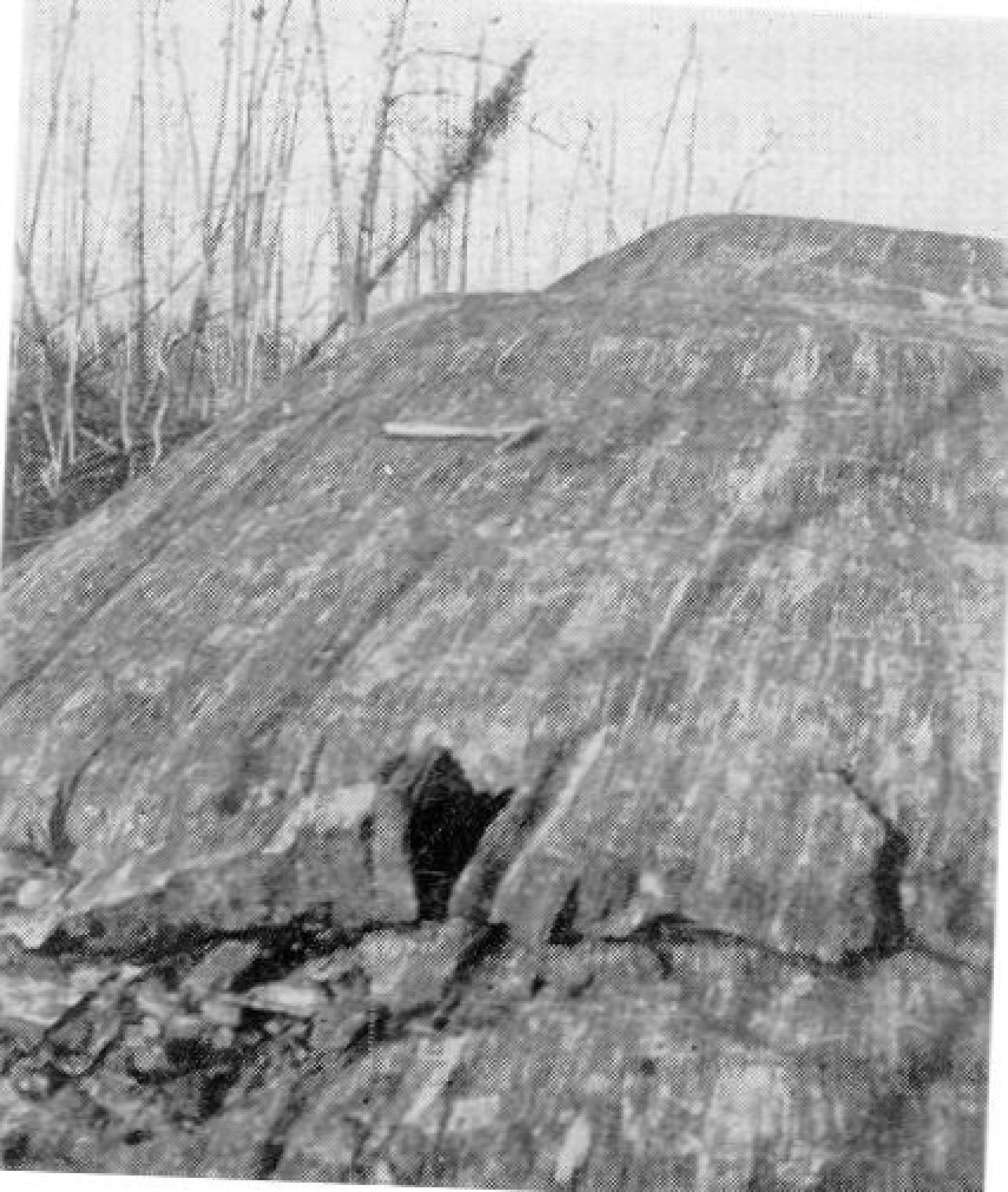
V

Vanadium....33, 35
Varveclay l....17
Varved clay, notes and photos....16, 17, 31
Volcanic rocks....11
Volcanic tuff. *See* Tuff.

W

Walker, T. L....35
Warrens Landing....3
Warrington l....16, 19
Warrington r....6
Whitefish....5, 25
Willow....4, 25
Winnipeg l....2, 18
Winnipeg r....3
Wolverine, S.S....2, 3
Wright, J. F....3, 10, 12, 18

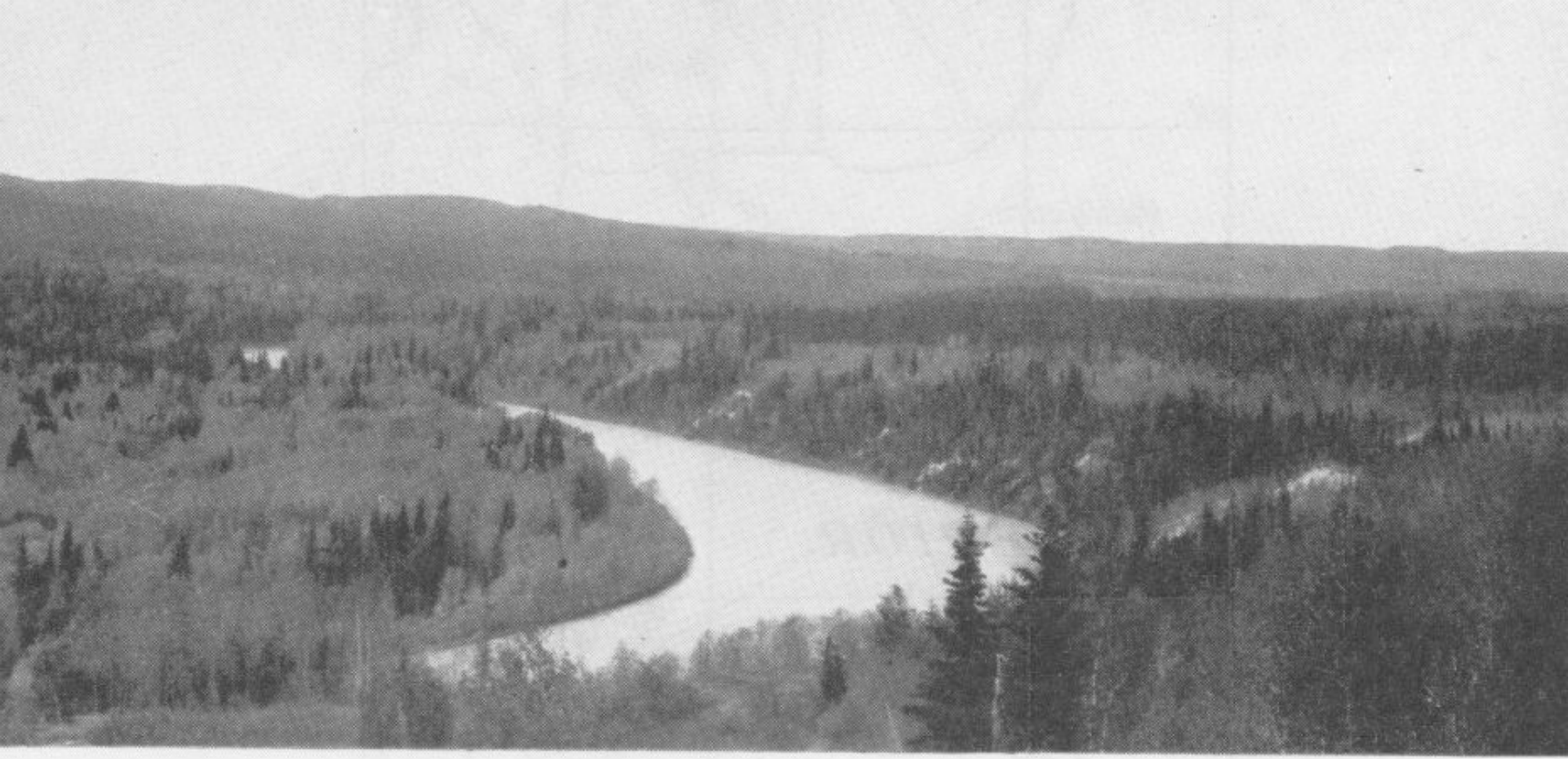




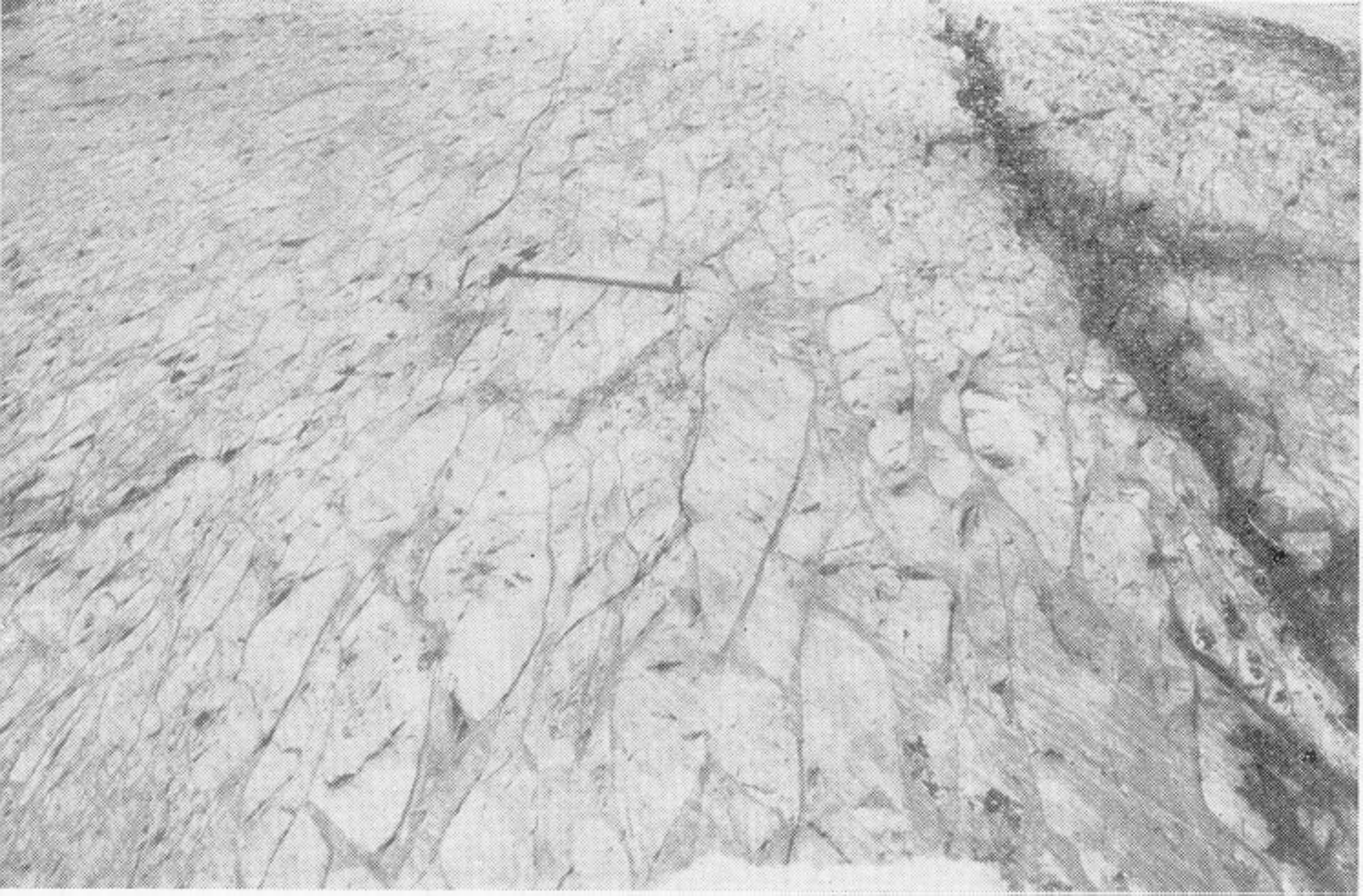

A
G
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A





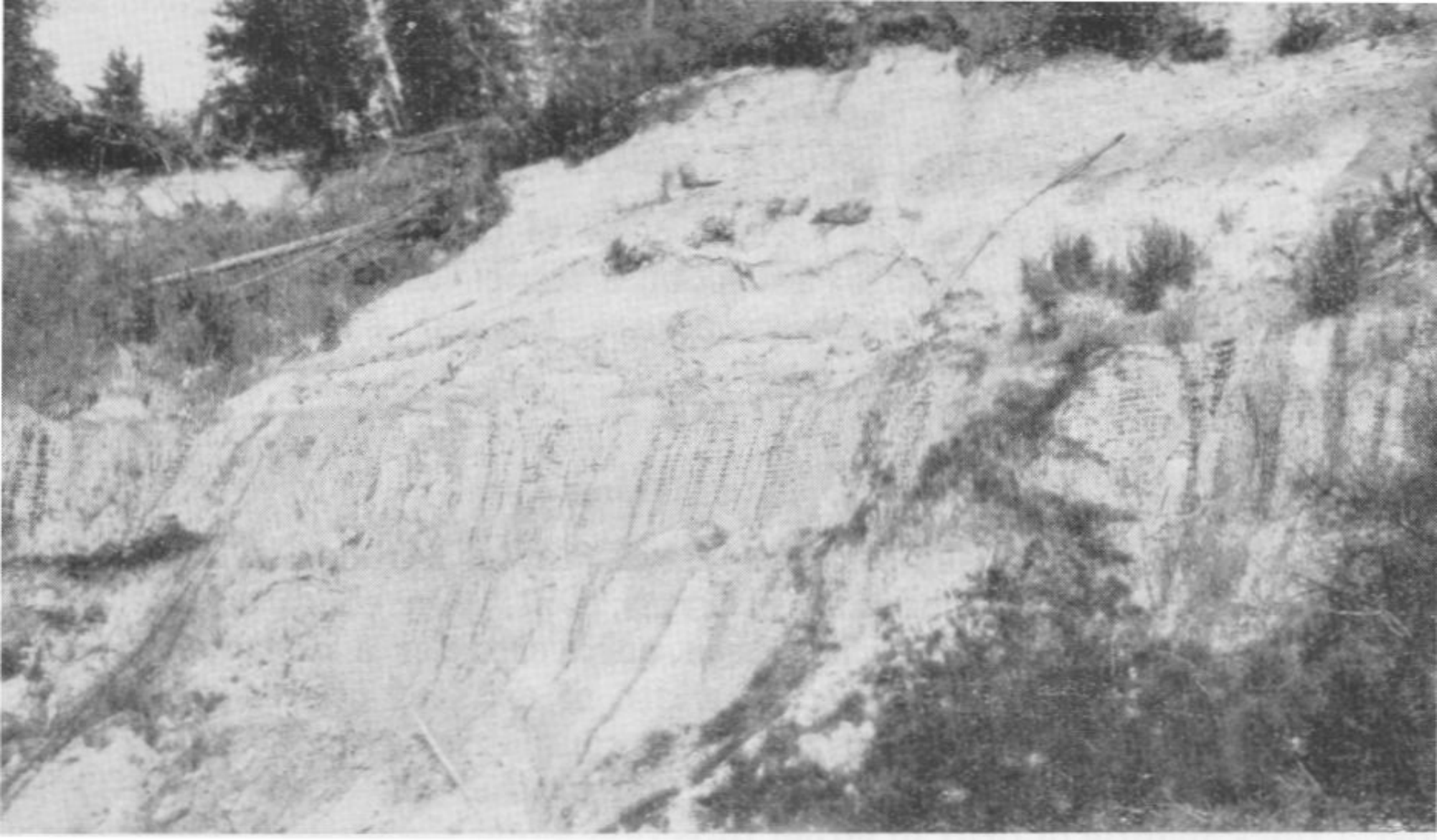




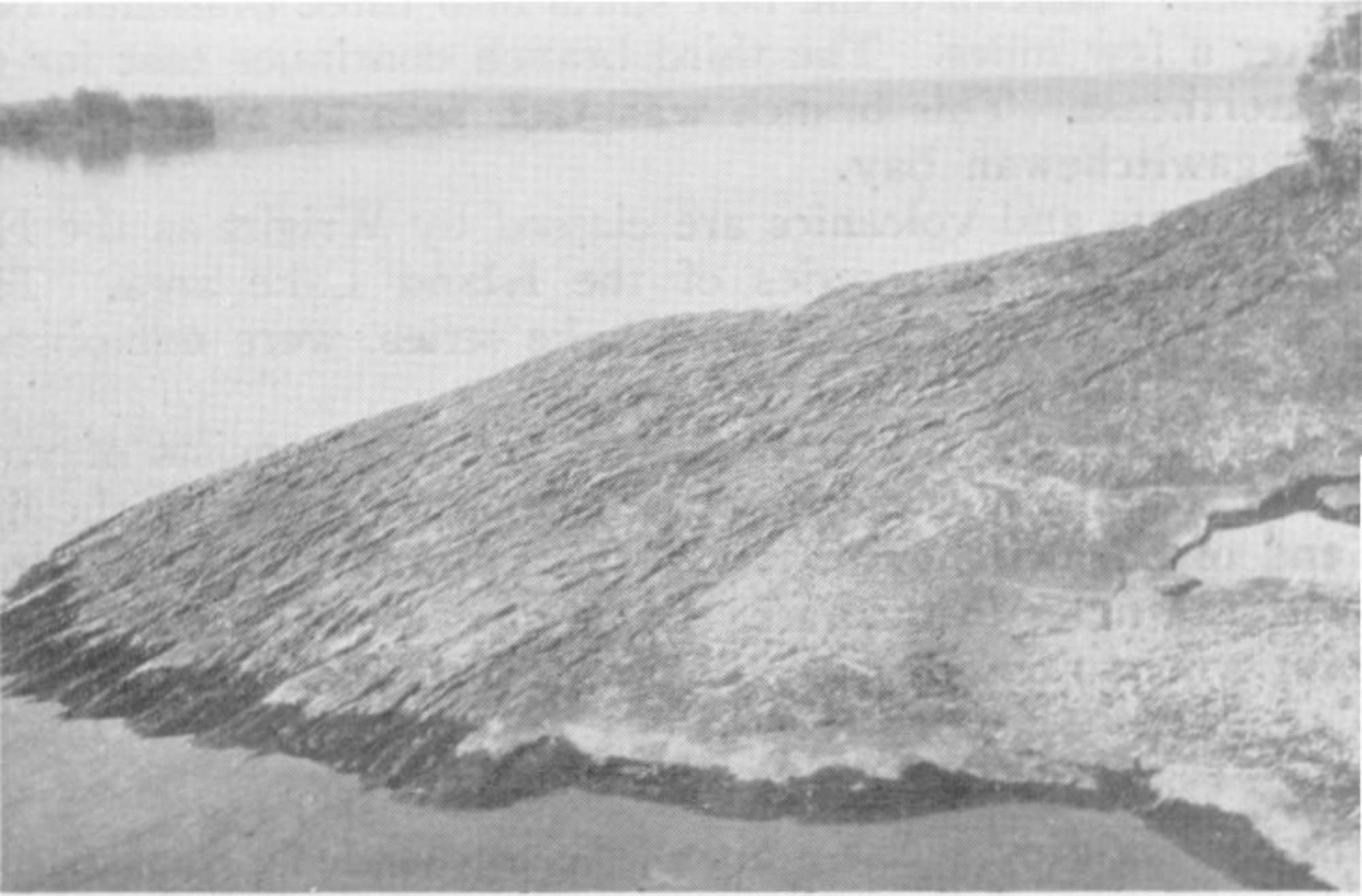














PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. CHAS. McCREA, *Minister of Mines* THOS. W. GIBSON, *Deputy Minister*

FORTIETH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

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German-Currie Area, District of Cochrane, by H. C. Laird 1-22

Groundhog-Kamiskotia Area, District of Cochrane, by A. R. Graham - - - - - - 23-36

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Contents, Vol. XL, Part III

GERMAN-CURRIE AREA

Introduction 1
Acknowledgments 1
Previous Work 2
Access and Communication 2
Topography and Drainage 3
Natural Resources 4
Agriculture 4
Timber 5
Fish and Game 6
Power 6
General Geology 6
Keewatin 7
Volcanics 7
Sediments 10
Carbonate Rocks 11
Timiskaming 12
Pre-Algoman Intrusive 12
Algoman 13
Post-Algoman Intrusives 14
Pleistocene 16
Recent 19
Economic Geology 19
Gold 20
Macklem Township 20
Gold Island 20
Other Prospects 21
Currie Township 21
Samuel Reid 21
J. Anderson 21
Nickeliferous Pyrrhotite 22
Clay 22

GROUNDHOG-KAMISKOTIA AREA

Introduction 23
General Character of the Area 23
General Character of the Area.—*Cont'd.*
Access 23
Canoe Routes 24
Surface Characteristics 25
Previous Work 26

General Geology 26
Stratigraphy 27
Keewatin 27
Haileyburian 28
Algoman 30
Matachewan 30
Pleistocene and Recent 31
Description of Townships 31
Nova Township 31
Belford Township 31
Strachan Township 31
Montcalm Township 31
Fortune Township 32
Enid Township 32
Whitesides Township 32
Massey Township 32
Côté Township 32
Byers Township 33
Aitken Township 33
Poulett Township 33

Economic Geology 33
Gold 33
Union Mine 34
Lusikauf Claims 35
Jack Claims 35
Jamieson Claims 35
Copper 35
Kamiskotia Minerals Syndicate 36
Sweet Claims 36

ILLUSTRATIONS

View looking south over Northeast bay of Night Hawk lake 4
Egan chutes on the Watabeag river, Currie township 6
Pillow lava, lot 5, concession II, Currie township 8
Photomicrograph showing devitrification in a glass matrix 9
Photomicrograph showing an aggregate of initial devitrification points in the glass 9
Volcanic fragmental, Night Hawk lake, Macklem township 10
Volcanic breccia, southern part of Macklem township 10
Diabase porphyry, island H. XXXI, Night Hawk lake 11
Coarse greywacké with a conglomerate band, lot 9, concession I, German township 12
Contact between amphibolite and feldspar porphyry cut by later diabase dikes 13
Narrow diabase dikes intruding Algoman rock in *lit par lit* fashion, Currie township 15
High clay banks, east shore of Night Hawk lake 17
Varves of buff-coloured silt material thinning upwards into clay varves, Night Hawk lake 18
Disturbance in varved clay, Night Hawk lake 18
Granite erratics on the sand plain, Macklem township 19
Auriferous quartz stringers cutting green carbonate rock, Gold island, Night Hawk lake 20
High falls on the Ivanhoe river, Montcalm township 24
Byers mountain in the central part of Byers township 25
Chlorite schist at the three falls on the Ivanhoe river in Belford township 28
Photomicrograph of altered gabbro showing epidote crystals in a uralitic hornblende crystal 29
Specimen of chlorite carbonate schist cut by a small carbonate vein, Union mine 33
Photomicrograph of gabbro showing sulphides replacing labradorite 36

SKETCH MAPS

Key map showing location of the German-Currie area 1
Key map showing location of the Groundhog-Kamiskotia area 23
Geological sketch map of the Union mine, Whitesides township 34

COLOURED GEOLOGICAL MAPS

(In pocket at back of report)

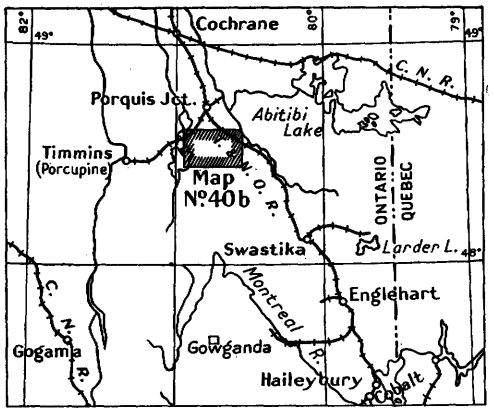
Map No. 40*b*—German-Currie Area, District of Cochrane. Scale, 1 mile to the inch.
Map No. 40*c*—Groundhog-Kamiskotia Area, District of Cochrane. Scale, 2 miles to the inch.

German-Currie Area, District of Cochrane

By H. C. Laird

INTRODUCTION

The area described in this report consists of the townships of German, Stock, Macklem, Bond, and Currie, in the district of Cochrane. It includes a portion of Night Hawk lake to the southwest and extends east to within 4 miles of the village of Matheson. Connaught Station lies at the extreme northwest corner, and the village of Monteith is near the northeast corner. The centre of the area lies approximately 25 miles east of the producing portion of the Porcupine gold area. It is north of the height-of-land and a part of the so-called clay belt, which forms an extensive tract of excellent agricultural



Key map showing location of the German-Currie area. Scale, 60 miles to the inch.

land in this part of Northern Ontario. Probably ninety per cent. of the area itself is deeply covered with sand and clay, the latter predominating. For this reason it is well adapted to agricultural pursuits, and for the same reason prospectors are at a great disadvantage in their search for favourable rock formations. Gold is known to occur at several places, but up to the present no discoveries of any economic importance have been made, with the possible exception of Gold island in Night Hawk lake.

Acknowledgments

The writer wishes to take this opportunity of thanking residents and officials for information, many favours, and courteous assistance. Special thanks are due to Dan O'Connor, veteran prospector, for his cordial hospitality and general interest in the welfare of the party.

During the summer we made use of several cabins that were conveniently located for the work in hand. The writer is particularly indebted to the various

owners of these cabins for the privilege of occupation, especially as the season was unusually wet.

Dr. Ernst Antevs, of the American Geographical Society, eminent glaciologist and authority on the glaciology of this particular area, willingly examined photographs of certain glacial features. His interest and suggestions are much appreciated. The writer is also much indebted to E. S. Moore, University of Toronto, whom he frequently consulted.

The personnel of the party included A. H. Stewart, B. I. F. Breakey, and L. E. M. Jarvis. These gentlemen performed their duties in a highly efficient and satisfactory manner.

Previous Work

The earlier geological work pertaining to this and contiguous areas are to be found in reports of the Ontario Bureau of Mines, dating back to 1896. Since that time, this part of Ontario from Porcupine east to the Quebec boundary has been mapped and reported on in some detail, with the exception of the five townships under discussion. The previous geological reports dealing with this area are enumerated in the following bibliography:—

E. M. Burwash, "Geology of the Algoma-Nipissing Line," Ont. Bur. Mines, Vol. VI, 1896, pp. 175-177. This work gives a general description of the topography and general geology of the country south and west of the area discussed in this report.

W. A. Parks, "The Nipissing-Algoma Boundary," Ont. Bur. Mines, Vol. VIII, pt. 2, 1899, pp. 175-179. This report gives a good description of Night Hawk lake and the old portage route from Frederick House lake to Moose lake. A sketch map of this area is included in the report.

A. P. Coleman and W. A. Parks, "Map of Parts of the Districts of Algoma and Nipissing, Showing the Upper Basins of the Moose, Ottawa, and Michipicoten Rivers"; scale, 8 miles to the inch; Ont. Bur. Mines, Vol. IX, 1900. This map includes the area discussed in this report.

G. F. Kay, "The Abitibi Region," Ont. Bur. Mines, Vol. XIII, pt. 1, 1904, pp. 108, 109, 113-115; Appendix, pp. 122-125, 132, 133. This report gives a general account of the physical features, topography and resources, and petrology of the rocks. In the appendix, T. D. Jarvis discusses the agricultural and timber resources from the biologist's point of view.

W. G. Miller, "Lake Abitibi Gold Deposits," Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, pp. 219, 220. This report contains notes from a report by A. A. Cole on the occurrence of gold on Gold island, Night Hawk lake.

A. P. Coleman, "Lake Ojibway: Last of the Great Glacial Lakes," Ont. Bur. Mines, Vol. XVIII, pt. 1, 1909, pp. 288, 289.

A. G. Burrows, "The Porcupine Gold Area," Ont. Bur. Mines, Vol. XXI, pt. 1, 1912, pp. 208-221; and Vol. XXXIII, pt. 2, 1924, pp. 6, 25, 38, 40, 41, 44. These reports refer to the geology of Night Hawk lake, and particularly Gold island. In the report of 1912 Night Hawk lake and parts of Macklem and German townships are included on the accompanying geological map.

C. W. Knight, A. G. Burrows, P. E. Hopkins, and A. L. Parsons, "Abitibi–Night Hawk Gold Area," Ont. Bur. Mines, Vol. XXVIII, pt. 2, 1919. This report gives a comprehensive account of the geology of the area, and contains a very useful geological map, 2 miles to the inch.

D. G. H. Wright, "Geology of the Watabeag Area," Ont. Dept. Mines, Vol. XXXI, pt. 7, 1922, pp. 5, 28. This report includes a map of an area lying immediately to the south of the townships of Bond, Currie, and Macklem.

B. Rose, "Murphy, Hoyle and Matheson Townships," Ont. Dept. Mines, Vol. XXXIII, pt. 3, 1924. This area is immediately to the west of German township.

P. E. Hopkins, "Night Hawk Lake Gold Area," Ont. Dept. Mines, Vol. XXXIII, pt. 3, 1924. This report is accompanied by a geological map of the northeast portion of Night Hawk lake.

Access and Communication

The townships in this area have been more or less settled for several years with the result that good roads, telephone service, and other conveniences are now commonplace. Any part of the area is readily accessible from Matheson,

Monteith, or Connaught Station on the Temiskaming and Northern Ontario railway. The Ferguson highway turns west from Matheson and follows the north boundary of Currie township to Shillington P.O.; it then turns north along the east boundary of Stock township towards Monteith and Porquis Junction. A road, known locally as the Porcupine road, connecting Shillington with Connaught Station is much used at the present time by motor traffic and is about 14 miles closer to Timmins than the highway via Porquis Junction. This road follows the boundary between Stock and Bond townships, then cuts diagonally across the sand plain of German township, where it joins the Timmins highway at Connaught Station. In Stock, Bond, and Currie townships, several good roads extend back from the main highways along concession lines. Many of these are suitable for motor cars except in the early spring and very wet weather, when the soft clay makes them almost impassable. As the necessity arises, much work is being done to improve and extend these roads. Gravel pits of fair grade in German and Currie townships are a great asset in this respect.

Extending from the graded roads is a veritable network of old tote roads and trails that have been used in taking out pulpwood. In this connection it is of interest to mention the old Porcupine tote road used in the early days of the camp before the advent of the railway. Tons of supplies were taken from Matheson over this corduroy, much of which is still preserved near the south boundary of German township. These roads and trails are very convenient in traversing an area so devoid of good water routes.

Canoes are of little use except on Driftwood river and the streams flowing into Moose lake in Bond township. Of these, South river and Driftwood river are suitable for power boats, and Crooked creek is navigable by canoe to a small lake in the northwest corner of the township. It is also possible to travel from Barber bay, an arm of former Frederick House lake, to Moose lake via McIntosh lake and North Driftwood creek; this is not, however, a good canoe route owing to the prevalence of log jams and other debris that frequently choke the stream. Watabeag river, Currie township, is of considerable size but hardly navigable owing to its steep gradient with resulting chutes and rapids every few chains.

Topography and Drainage

The area is in general a low-lying undulating clay plain, which is broken here and there by low ridges of rock that never rise more than a hundred feet above the general level. These, for the most part are residual diabase dikes, which have successfully withstood the processes of erosion. Between the ridges, which trend north-south, there are wide expanses of low, wet ground occupying the hollows in the clay, and testifying to the poor drainage of the area. The typical spruce muskeg is not as common as in most sections of Northern Ontario.

High hills occur to the south on the boundary between Currie and Egan townships and also between the townships of Bond and Sheraton. To the north the hills in the townships of Clergue and Dundonald are conspicuous features on the horizon, although not nearly as high as those to the south. Between these two sets of hills, which are some 14 miles apart, lies the basin of Moose lake, the lowest point in the area. Creeks and rivers run into this drainage basin from all directions. Of these, South river, Crooked creek, and North Driftwood creek are the largest and form the main drainage system of Bond, Stock, and parts of German township. The water flows out by way of the Driftwood river into the Black river, and finally into the Abitibi River system. Currie township is drained to the east by Watabeag river and to the west by

Grindstone creek, which joins the Driftwood river one mile east of Moose lake. Watabeag river has its origin in Watabeag lake, several miles to the south, and flows directly into the Black river. It carries a considerable volume of water and, on account of its steep gradient, is used to good advantage in the floating of logs in the spring.

The waters flowing into Moose lake are separated from those flowing into Night Hawk lake by an extensive sand plain that stretches north and south across the central part of German township and the eastern part of Macklem township. This plain is peculiar for the great number of kettle lakes, which range in size from mere pot-holes to lakes a mile in length. They are always much below the level of the plain, and often the banks are so steep that it is difficult to reach the water's edge. The water is a remarkably clear green colour. Spring water bubbles from the sand at many places on the border of the plain and probably has its source in the kettle lakes.

The east shore of Night Hawk lake is for the most part formed by uniformly low-lying to gently undulating clay banks, rising 50 to 60 feet above the level



View looking south over Northeast bay of Night Hawk lake.

of the lake. There are scarcely any outcrops of rock except at the water's edge and in Macklem township near the south boundary. Bottley creek and two other small streams flow into Night Hawk lake from the east, but on the whole this part of the area is poorly drained. This is surprising since the elevation is said to be several feet higher than the lake. It would appear that the water accumulating in the hollows is successfully retained by the thick, impervious substratum of clay.

Both Night Hawk lake and Moose lake are very shallow, averaging not over 20 feet in depth. The evidence points to the conclusion that they are mere remnants of former Lake Barlow-Ojibway, which was a very extensive body of water in this part of Ontario in glacial times. This subject is discussed more fully under the heading of glacial features.

Natural Resources

Agriculture

The area is essentially adapted to agricultural pursuits. It has been sparsely settled for several years, and quite recently there was an influx of

farmers from the Haliburton area of eastern Ontario. The early settlers have demonstrated that farming is and can be a successful and profitable venture to those who are willing to undergo the early years of hardship and uncertainty. The general surroundings and fine buildings on many farms in Stock and Currie townships testify to the prosperity of some. Others, less favourably located, have been forced to vacate their lot after having lived on it for two or three years. This is said to be due to lack of communication and difficulty in obtaining a livelihood, mainly because of the depletion of the pulpwood which is often the only means of getting ready cash.

The soil is classified as clay, clay loam, loam, sandy loam, vegetable, and sand. This wide variation in character should favour the growing of a considerable variety of crops. The soil around Night Hawk lake is good clay with very little humus material, while that in the townships of Bond, Stock, and Currie is largely of a loamy nature.

The crops depend much upon the weather conditions. The growing season is short but favourable for rapid growth due to the long hot days with frequent showers. September is usually a very wet month, and a period of considerable anxiety for the farmer. The crops consist of hay, oats, barley, and wheat, as well as roots and garden produce. Cattle and sheep are being raised in greater numbers each year. The proximity to such towns as Matheson, Monteith, Iroquois Falls, and Timmins provides a ready market for general farm produce.

Timber

Lumbering and pulpwood-cutting has been the chief occupation of the settlers. The work is largely carried on during the winter months, and to a lesser degree during the summer. The Hawk Lake Lumber Company, of Cochrane, appears to have dominated the industry in this area; large deserted camps in the townships of Macklem, Bond, and Currie attest to the magnitude and importance of their operations. What might be called the best of the timber has been either cut or devastated by forest fires, but isolated patches still remain, as in the southeastern part of Currie township and in lots 4 and 5, concession II, Stock township.

The reports of twenty-five and thirty years ago mention the thick virgin forest that covered this area at that time. In contrast, to-day we see large portions ravaged by forest fires that swept through here from time to time. This is particularly true of the sand plain in the townships of German and Macklem, and also of the southeastern part of Bond township and the southwestern part of Currie township, which are now largely covered with slash, making travel difficult and impeding the clearing of this fine agricultural land. Fires set out and supervised by fire rangers would do much to clear up this slash land and at the same time add considerably to its value by encouraging settlement.

The following is a list of the trees according to their abundance: black spruce, white spruce, aspen poplar, paper birch, balsam, Balm of Gilead, banksian or jackpine, white cedar, larch or tamarac, black ash, Norway or red pine, white pine, white elm, soft maple.

The smaller species of trees are: mountain maple, alder, mountain ash, shad-bush or juneberry, wild red cherry, mountain alder, willow.

Black and white spruce and balsam grow best in the high, better-drained clay areas; poplar and birch are more common on the loam, and jackpine on the sand plain. Balm of Gilead, cedar, and elm grow along the streams. The

muskegs and low areas are occupied by scrub timber, chiefly black spruce and scattered tamarac. In brulé areas second-growth saplings consist of poplar and birch on the clay, and jackpine on the sand plain.

Fish and Game

Suckers, pike, pickerel, and perch are plentiful in Moose lake and Driftwood river, and particularly so in South river. A clay bottom, shallow water, and frequent winds keep Night Hawk lake in a constantly muddy condition with the result that fish are not plentiful; indeed, it is said that it is almost impossible to hook one. Brook trout occur in Hooker creek and Watabeag river, Currie township, but they are not plentiful. Egan chutes near the boundary between Currie and Egan townships is a well-known locality for this species of fish.

Big game and fur-bearing animals are scarce, as would be expected so close to settlements. However, members of the party observed the following types of the more timid animals: moose, red deer, bear, bank beaver, otter, and weasel.



Egan chutes on the Watabeag river, Currie township.

Ducks are very abundant in the marshes of Frederick House lake and on the streams flowing into Moose lake. These places are natural breeding and feeding grounds for the duck, and attempts are being made further to encourage them by the sowing of wild rice, their favourite food.

Power

There are no waterfalls of importance in the area, except Egan chutes on the Watabeag river. It is, however, improbable that this waterfall will ever be utilized since an abundance of power is already available near by.

GENERAL GEOLOGY

The consolidated rocks of this area are all pre-Cambrian and range in age from Keewatin to Keweenawan. The outcrops are few in number and more or less scattered, often making it difficult to decide on age relationships. When this was the case and the intrusive character of the rock was not clear, the writer found it necessary to depend on a lithological comparison with similar rocks in nearby areas, the age and relations of which had been previously established by others.

The following is a table of formations showing the character, age, and relationship of the rocks, with the oldest at the bottom of the table:—

QUATERNARY	
RECENT:	Sand beaches, peat deposits.
PLEISTOCENE:	Boulder clay, varved clay, sand, gravel, and boulders.
	Great unconformity
PRE-CAMBRIAN	
KEWEENAWAN:	Olivine diabase, quartz diabase.
	Contact not observed
MATACHEWAN:	Diabase with huronite.
	Intrusive contact
ALGOMAN:	Dikes of aplite, felsite, feldspar porphyry, quartz-feldspar porphyry, hornblende syenite porphyry, and possibly some narrow basic dikes.
	Intrusive contact (with Keewatin and pre-Algoman only)
PRE-ALGOMAN:	Amphibolite.
	Contact not observed
TIMISKAMIAN:	Coarse greywacké with bands of fine conglomerate.
	Contact not observed
KEEWATIN:	Altered and schistose derivatives of basic to intermediate lavas, chiefly basalt and andesite, carbonate schists, pillow lava, amygdaloidal lava, volcanic fragmentals, volcanic breccia, gabbro and diabase phases, altered tuff, greywacké with conglomerate bands.

Keewatin

There is reason to believe that this heavily drift-covered area is for the most part underlain by rocks of Keewatin age, but the outcrops are largely confined to the wave-washed shore and islands of the northeastern part of Night Hawk lake and the townships lying to the south of the Ferguson highway or the old Porcupine road.

Volcanics

The volcanic rocks comprise a large part of the Keewatin. They consist of dark-green to grey lavas showing characteristic ellipsoidal pillow structures, amygdules, and ropy surfaces. It has long been thought that pillow structures are indicative of subaqueous conditions of origin, whereas ropy surfaces suggest that the lava was poured out over a surface in contact with the air. These structures suggest that they were basic in composition, probably basalts or andesites. Alteration processes, however, have gone so far as to preclude any specific determination of their original character, and as A. G. Burrows[1] has suggested for similar rocks in the Porcupine area, they are more correctly called meta-basalts or meta-andesites.

In the townships of Bond and Currie it would appear that only where the volcanics have been intruded by diabase dikes have they been preserved, owing to the resistance to erosion of the latter. They are often seen clinging, so to speak, to the edge of a diabase dike, or more often in the larger outcrops they

[1]Ont. Dept. Mines, Vol. XXXIII, pt. 2, 1924, p. 13.

lie between two or more parallel diabase dikes some few feet apart. For the most part the lavas are very closely sheared in an east and west direction, the dip of the schistosity varying from 80°S. to vertical. Along the schist planes they have been injected with much feldspathic or granitic material, epidote, and quartz, as well as with narrow dikes of aplite and porphyry. In places where the shearing was less intense, ellipsoidal pillows have been preserved and often show porphyritic as well as amygdaloidal structures in an ellipsoid. A striking instance of this type of pillow lava was seen in the outcrop just south of Samuel Reid's cabin, south half of lot 5, concession II, Currie township. The small apparent phenocrysts of white to reddish feldspar occur toward the centre of the ellipsoid, and the amygdules are aggregated close to the margin. An examination of a thin section shows that these structures are not true feldspar phenocrysts but merely amygdules filled with feldspathic material (orthoclase). In some cases the crystallization has been such that the secondary material has assumed the shape of a primary feldspar phenocryst. The feldspathic material



Pillow lava, south half of lot 5, concession II, Currie township.

was no doubt introduced from the aplite intrusives. The intensely sheared lavas are composed almost entirely of fibrous hornblende, with small quantities of quartz.

Near the north boundary of German township, north half of lot 2, concession VI, there is a small exposure of a dark-grey andesitic pillow lava with a very peculiar type of interstitial matter between the ellipsoids. It is dark-coloured and shows fragmentary material apparently cemented together with silica. A thin section shows that it is a shattered glass, the fractures of which have been filled with fine-grained silica. The glassy portions are quite black between crossed nicols except for certain aggregates of minute points of light which represent the beginning of a devitrification process.

Amygdaloidal lava is well developed in outcrops on the south half of lot 1, and on the north half of lot 8, concession VI, Currie township. At the former the amygdules are filled with quartz; at the latter the filling material is quartz, calcite, or hornblende.

On the mainland and on some of the islands of Night Hawk lake near the south boundary of Macklem township, there are several outcrops of a volcanic fragmental rock. The fragments are irregular in shape and of various sizes; in

some places they are thickly packed together; in others they are somewhat scattered. As a rule they are lighter in colour than the dark-green matrix and



Photomicrograph of interstitial matter between ellipsoids showing a devitrification along fractures in a glass matrix (G), north half of lot 2, concession VI, German township. (× 20.)

usually coarser. Although they are generally composed of the same material as the matrix, sometimes they are different.

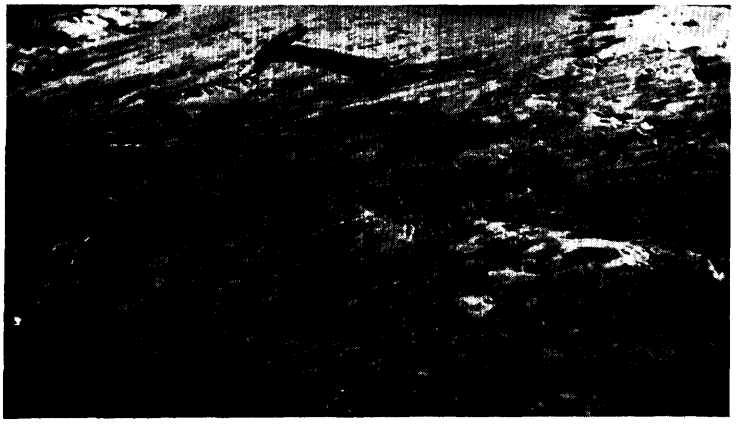
On the trail one mile east from the mouth of Bottley creek, Macklem township, there is an isolated outcrop of volcanic breccia with fragments up to



Photomicrograph of the same thin section as seen above showing an aggregate of initial devitrification points in the glass. (× 50.)

two feet in diameter. They are light in colour, and being somewhat harder than the matrix, they stand out prominently on the weathered surface.

On some of the islands along the east shore of Night Hawk lake, gabbro-diabase phases of the Keewatin were observed. On one small island, indicated by the survey bench-mark H.XXXI, there is a striking diabase porphyry with light-weathering phenocrysts of plagioclase feldspar, sometimes

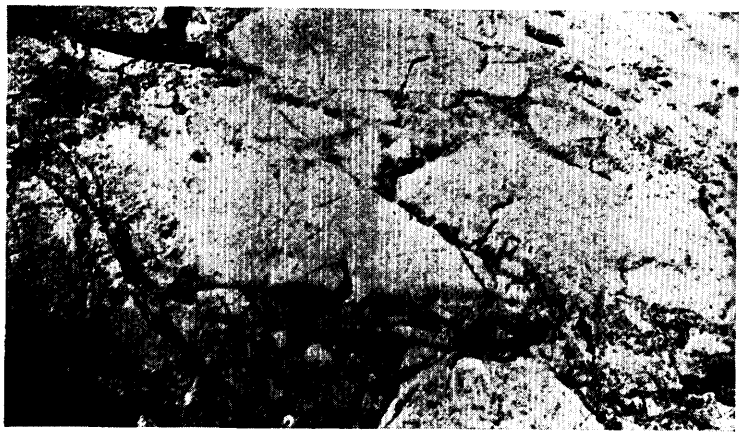


Volcanic fragmental, Night Hawk lake at the south boundary of Macklem township.

over an inch in length. These coarse phases are common toward the centre of thick lava flows and are no doubt caused by slow cooling in this portion.

Sediments

On the south half of lot 2, concession IV, Bond township, on the edge of the hill just behind the Mosure house, there is a small outcrop consisting of



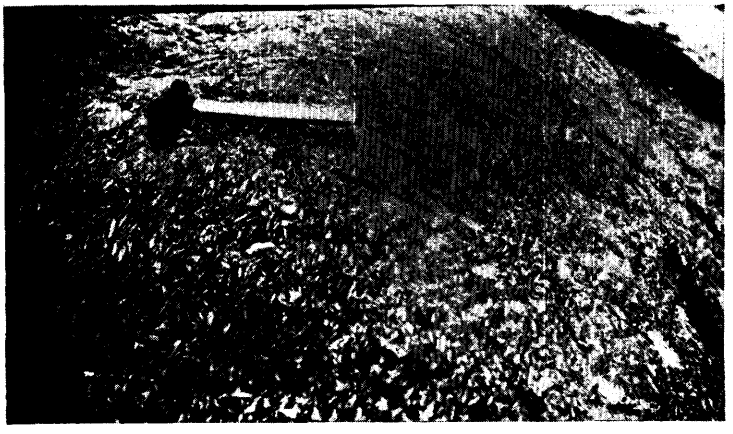
Volcanic breccia, southern part of Macklem township.

greywacké with local bands of conglomerate. The beds are vertical and strike east-west. The greywacké is fine-grained and much altered, and weathers to a light-grey colour. A diabase dike cuts it off sharply a few feet to the west, and it was not observed again.

There is some reason to believe that these sediments may be Timiskaming in age and a part of the Timiskaming sedimentary belt of the Porcupine area, but the evidence is so meagre that the writer, tentatively at least, prefers to place them in the Keewatin series.

Carbonate Rocks

Carbonate material accompanied by chlorite and serpentine is one of the commonest types of alteration products of the Keewatin rocks in this area. Among the more interesting occurrences are those on Gold island and along the north shore of East peninsula, Night Hawk lake, where the schistose rocks are almost entirely composed of these materials. P. E. Hopkins[1] has divided them into two groups, namely, the rusty-weathering grey to green dolomitic type, as on Gold island, and the serpentine-chlorite-carbonate type, as on East peninsula. A thin section of the former shows that the characteristic green colour is due to a very pale green chromiferous mica known as fuchsite, a variety of muscovite containing up to 3 per cent. of chromium oxide and commonly associated with



Diabase porphyry, island H. XXXI, Night Hawk lake.

auriferous quartz veins and carbonate rocks, as at Larder lake and several other places. In addition, the section shows a great development of carbonate and minor amounts of an acid feldspar, plagioclase, quartz, and cubes of pyrite.

Opinions as to the origin of certain ferruginous dolomites in Northern Ontario and Quebec have been so varied as to show that a more detailed study is desirable. They have been variously regarded as a thermal replacement of aplite,[2] as a chemical precipitate,[3] and as solutions emanating from acid dikes.[4] At Night Hawk lake it would appear difficult to dissociate the aplite dikes and the carbonate rocks in any theory that might propose to account for the origin of the carbonate. However, as Hopkins has suggested, some of it may have been derived from serpentine rocks. It is significant that on the islands and mainland to the south of East peninsula, where there are no aplite dikes, there is no development of ferruginous carbonate in the pillow lavas.

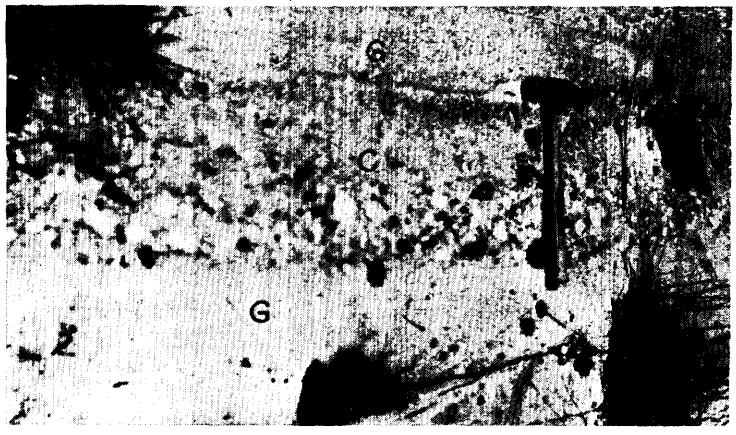
[1]Ont. Dept. Mines, Vol. XXXIII, pt. 3, 1924, pp. 28-30.
[2]M. E. Wilson, Geol. Surv. Can., Mem. 39, 1913, pp. 65-70.
[3]R. W. Brock, Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, p. 207.
[4]H. C. Cooke, Geol. Surv. Can., Mem. 131, 1922, p. 51.

Timiskaming

Outcrops of the Timiskaming sediments occur at the water's edge on the north shore of Northeast bay, Night Hawk lake, and also between the lake and the government road, concession I, German township. The best exposures occur along the shore to the west in Cody township. This represents the eastern limit of the Timiskaming series traced by Burrows from the Porcupine area. He describes them in the following terms:[1]—

> Greywacké, with strike east and west and dip 85° north, occurs on the northeast shore of Night Hawk lake. In the greywacké are thin bands of conglomerate containing pebbles of dark-green Keewatin rock, numerous quartz pebbles, and some felsite. Some of the pebbles are six inches in diameter. A sample of the greywacké is seen under the microscope to consist of angular fragments of quartz and feldspar, with finer particles of the same material and chlorite, sericite, and limonite.

The outcrops are small and separated by a heavy covering of drift material. On this account the relation of the Timiskaming series to the older Keewatin volcanics and to the younger Algoman intrusives was not observed here. An



Coarse greywacké (G) with a conglomerate band (C), south half of lot 9, concession I, German township.

olivine diabase dike on a point on the north shore of Northeast bay probably cuts the sediments, but the contact was hidden by drift.

The economic significance of the Timiskaming series of sediments is pointed out in the section on "Economic Geology."

Pre-Algoman Intrusive

In the south half of lots 5, 6, and 7, concession II, Currie township, the Keewatin rocks are intruded by several small, irregularly shaped masses of a rough green and white speckled rock. This is in turn intruded by later dikes of granite and of diabase. Under the microscope, thin sections show a preponderance of hornblende, chlorite, and highly altered feldspars, with varying quantities of epidote and quartz, which are thought to have been introduced by the granitic intrusions. The original character of the rock is almost completely masked by the strong metamorphism that it has undergone, but the granitic texture points to the fact that it was probably a diorite. In its present condition it may be known as an amphibolite.

[1]Ont. Bur. Mines, Vol. XXI, pt. 1, 1912, p. 221.

If the amphibolite intrudes the Timiskaming sediments it is Haileyburian in age, but this relation was not observed. However, its relation to the Keewatin series and to the post-Timiskaming rocks is such that with some degree of certainty its age may be regarded as Haileyburian.

Algoman

The Keewatin rocks in this area are intruded by many dikes of acidic material, ranging in width from a few inches to several feet, and rarely up to a few hundred feet, as in the case of the dike at Merriman mountain on the south boundary of Currie township. These are in turn intruded by diabase dikes of Keweenawan age. Although they vary widely as to type, they are thought to be closely related to the same granitic magma and Algoman in age. They consist of pink to grey aplites, felsites, and syenites, each with its porphyritic facies, and quartz-feldspar porphyry.



Contact between amphibolite (A) and feldspar porphyry (F) cut by later diabase dikes (D), north half of lot 12, concession I, Currie township. These rocks are of Haileyburian, Algoman, and Keweenawan age, respectively.

Dikes of Algoman age are common at Night Hawk lake. On Gold island a reddish aplite dike about 40 feet wide cuts across the island in an east-west direction. In thin section the microscope shows a fine-grained texture composed of quartz, orthoclase, plagioclase of the albite variety, and large quantities of secondary carbonate, quartz, and sericitic material. On Anniversary island, immediately to the south, a similar reddish dike shows a porphyritic phase with phenocrysts of albite. On East peninsula, on the mainland, both red and grey aplite or felsite dikes cut the carbonate rocks in an east-west direction.

Large cubes of iron pyrites are scattered throughout the aplite dikes, and the small quartz veinlets carry native gold. In addition to that, in the aplite a general network of narrow quartz stringers pervades the Keewatin carbonate rocks in great profusion. Burrows has suggested that this quartz represents the end phase of the same magma that gave rise to the aplitic material, and hence belongs to the Algoman period.

In lots 2, 3, and 4, concession I, Bond township, there are many pinkish aplite dikes up to 6 feet wide cutting the sheared Keewatin rocks in a rather irregular fashion. The lavas here are characterized by much pink granitic

material associated with epidote, and the granite is injected in such a way as to give the appearance of a *lit par lit* structure. In the south half of lot 2, concession IV, a pink feldspar porphyry dike cuts the Keewatin rock.

The Keewatin rocks of Currie township have been profusely intruded by narrow, irregular pink to grey aplitic dikes, the larger of which have been indicated on the accompanying map. Most of them have even a finer texture than those at Night Hawk lake, but often a distinct feldspar porphyry facies is well developed. It is noticeable that these dikes almost invariably strike in an east-west direction.

On the north half of lot 2, concession IV, Currie township, there is an old prospect pit near the contact of a quartz-feldspar porphyry dike and the Keewatin greenstone. The porphyry is mineralized with iron pyrites and is slightly sheared in an east-west direction. A thin section shows orthoclase, plagioclase (albite), hornblende, and quartz, the feldspars being much altered to sericite and carbonate.

On the road along the west boundary of Currie township, concession II, there is a small intrusion of a dark-coloured feldspar porphyry with inclusions up to 6 inches in diameter. The origin of these is somewhat doubtful on account of the extreme alteration that the whole rock has undergone, but they are believed to be Keewatin. A thin section shows hornblende, orthoclase, and plagioclase, with much zoisite, chlorite, sericite, and other saussuritic substances. The feldspars have been crushed and the fractures filled with secondary quartz.

On the west slope of Merriman mountain on the south boundary of Currie township, there is a quartz-hornblende syenite porphyry dike attaining a width of about 600 feet. It is a reddish rock and mineralized to some extent. A thin section shows phenocrysts of hornblende and orthoclase in a matrix of orthoclase and quartz with much limonitic material.

In Egan township, adjoining Currie township on the south, the Algoman rocks are more extensive.[1] Pinero mountain, one of the more conspicuous elevations in this township, rises 200 feet above the surrounding country. It is a part of a small batholith of pink hornblende granite which, in places, is coarsely porphyritic with feldspar laths 2 inches long. Two parallel diabase dikes 60 feet wide cut north and south across the highest part of the hill. The outcrop reaches within a few feet of the south boundary of Currie township and may extend into it beneath the heavy drift-covering.

In any case, the proximity of the granite batholith to the south has most profoundly affected the older rocks in Currie and Bond townships. The numerous acidic and porphyritic dikes intruding them are the truncated apophyses of this batholith, the metamorphic effects of which have served to introduce new material and severely alter the old. There is clear evidence of this in the great quantities of granitic material, epidote, and quartz, injected into the sheared zones of the Keewatin lavas and accompanied by the development of much secondary hornblende and secondary feldspar, the feldspar often giving the lavas an apparent porphyritic texture.

Post-Algoman Intrusives

The youngest rocks in the area are diabase dikes. They make up a very large part of the rock exposures, especially in the townships of Bond and Currie. Most of them are vertical and range in width from a few inches to 175 feet or more. They vary somewhat in direction from N. 10° W. to northeast, but in

[1]D. G. H. Wright, Ont. Dept. Mines, Vol. XXXI, pt. 7, 1922, p. 12 and accompanying map.

no case can they be followed for more than a few hundred feet owing to the extensive drift covering. The smaller outcrops are usually all diabase, but the larger ones may be comprised of two, and sometimes three, more or less parallel dikes a few feet apart, cutting older rocks. A rather peculiar instance occurs on the outcrop just south of Samuel Reid's cabin, on the south half of lot 5, concession II, Currie township, where the diabase dikes are so arranged as to form the letter N.

As usual the diabase appears to have had little or no exomorphic effects on the intruded rock, but at the contact the diabase itself is fine-grained on account of being chilled at the time of intrusion. The gradation from the fine-grained matter at the contact to the coarser rock in the centre of the dike is well shown. The diabase with a good ophitic texture quite often grades into a gabbro with an allotriomorphic texture. On the north half of lot 12, concession I, Currie township, dikelets of diabase intrude Algoman rock in *lit par lit* fashion. Under



Narrow diabase dikes intruding Algoman rock in *lit par lit* fashion, north half of lot 12, concession I, Currie township.

the microscope this rock is dense, black, and aphanitic, but shows an occasional feldspar lath.

At several places in the area, but notably in those outcrops between Anderson lake and Grassy lake, Currie township, there is a remarkable porphyritic variety of diabase characterized by pale yellowish-green, somewhat rounded phenocrysts of an altered plagioclase feldspar. These are usually 2 to 3 inches in diameter, but at one place specimens were found with a diameter of 6 inches. They weather to a soft white material. A striking feature is the way in which the phenocrysts are confined to definite zones, which are always parallel to the dike. Some of these zones were marginal in the dike as though a sort of differentiation had taken place, but similar zones were observed toward the centre of a dike. The edge of a phenocryst zone is sharp, but there is no apparent change in the general matrix of the diabase. Apart from the phenocryst zones the diabase is quite ordinary and like that assigned to the Keweenawan age in many parts of Ontario.

A microscopic study of the phenocrysts shows that they are composed of a fine-grained aggregate of secondary minerals, namely, calcite, sericite, chlorite, zoisite, epidote, and an occasional trace of the twinning of the original plagioclase

feldspar. This aggregate is so uniform as to constitute a mineral species known as huronite.[1]

In the Matachewan and Gowganda areas, Burrows has described a similar diabase, which is post-Algoman but pre-Cobalt in age and to which he applied the name Matachewan. The age of the huronite diabase dikes in this area is in doubt owing to the absence of the Cobalt series and also to a lack of intrusive relations with the other diabase dikes. Its lithological character, however, is so much like that in the type area that with some confidence it may be regarded as Matachewan in age.

Many dikes of quartz diabase and olivine diabase occur in the townships of Currie and Bond and also on Night Hawk lake. They so resemble one another that they can seldom be identified with certainty without the aid of the microscope. When they are placed side by side, however, the olivine diabase appears to have weathered to a little darker brown than the quartz diabase. Outcrops of the former are often characterized by spheroidal weathering and a general crumbling of the material.

The microscope shows that the quartz diabase consists of plagioclase, augite, and quartz, with magnetite and apatite as accessory minerals. The olivine diabase is much fresher, and consists of olivine, plagioclase, and augite. The olivine alters to magnetite and serpentine along the fractures.

Narrow dikelets of pink aplitic material are often seen in the quartz diabase and probably represent a differentiation phase. The material consists largely of quartz and orthoclase.

The age of these dikes, as in the case of the porphyritic diabase, is known to be post-Algoman, and lithological similarities indicate that they belong to the Keweenawan epoch.

Quaternary

Pleistocene

A great hiatus representing millions of years exists between the consolidated pre-Cambrian rocks and the unconsolidated deposits of the Pleistocene or glacial epoch, which cover about 90 per cent. of the area to depths ranging from a few feet to 150 feet or more. They were deposited chiefly by lacustrine and fluviatile agencies directly upon the smooth glaciated surface of the pre-Cambrian rocks. On the islands and along the east shore of Night Hawk lake, where the waves have washed away the overburden, excellent striae, grooves, fluting, chatter marks, and *roches moutonnées* are preserved in the rock and exemplify the general scouring action of the moving ice.

The material of these deposits consists of thick beds of stratified or varved clay and boulder clay or till, and sand and gravel. Excellent exposures on Northeast bay and on the east shore of Night Hawk lake show varved clay beds at the top and the bottom with boulder clay between them. The latter is particularly free of boulders. The banks rise 50 to 60 feet above the water, and this depth of clay is maintained over a large part of Macklem township. Although there is a difference in elevation of 79 feet between Night Hawk lake and Matheson station, observations from well-borings at these and many intermediate points show that the mantle of clay is approximately the same thickness throughout the area. It would appear that only in parts of Bond, Currie, and to a minor extent in German township, do rock outcrops rise above this clay plain. These are "islands" and no doubt were of such configuration in the glacial lake that occupied this area at that time.

[1]T. L. Walker, University Toronto Studies, Geol. Series No. 16, 1923; No. 24, 1927.

The glacial history of this region has been the subject of much study by such eminent glaciologists as Coleman[1] and Antevs. The former established the theory that this part of Ontario, lying north of the height-of-land and roughly speaking between Lake Abitibi and the Mattagami river, was occupied by an extensive post-glacial lake, remnants of which can be seen to-day in Abitibi, Frederick House, and Night Hawk lakes, to which the writer can add Moose lake. This lake he called Lake Ojibway. It stood in front of the ice-sheet and drained to the south rather than to the north. More recently Antevs has shown that this post-glacial lake was even more extensive than Coleman supposed, since it really merged with Lake Barlow (glacial Lake Timiskaming). He calls it Lake Barlow–Ojibway.[2]

Normal sedimentation took place in this lake, giving rise to well-varved clay and silts, which are now well exposed on the east shore of Night Hawk lake, on the highway near Anderson lake, and at many other points in the area. The varves are of two kinds: a thinly bedded dark variety, and a thicker bedded



High clay banks, east shore of Night Hawk lake.

silty variety. The former shows alternate layers of light-grey and dark-grey material of very fine texture, up to half an inch in thickness. These represent seasonal changes, the light-coloured being the summer layer and the dark-coloured being the winter layer. The varves of silt are composed of buff-coloured coarser material up to 8 inches in thickness, alternating with extremely thin layers of clay material. The thick varves may express the amount of melting and probably represent very long warm summers with little change of deposition. At one point on the east shore of Night Hawk lake, thick varves of silt were observed to thin out upwards, merging into fine clay varves near the surface. This feature, according to Antevs,[3] suggests that the lower silty varves were near or at the substratum, and the thinning out upwards was due to the increasing distance from the ice border. At the surface, in the same section, an apparent unconformity was observed between two sets of

[1]A. P. Coleman, "Lake Ojibway: Last of the Great Glacial Lakes," Ont. Bur. Mines, Vol. XVIII, pt. 1, 1909, pp. 284-293.

[2]Ernst Antevs, "Retreat of the Last Ice-sheet in Eastern Canada," Geol. Surv. Can., Mem. 146, 1925, p. 74; "The Last Glaciation," Amer. Geog. Soc., Research Series No. 17, 1928, pp. 103, 143-150, 169.

[3]Personal communication.

varves. Antevs[1] points out that such disturbances are common and are due largely to sliding or slumping movements and hence are not a true unconformity. On the other hand, icebergs digging into the soft clay may be the cause of much disruption in beds.



Varves of buff-coloured silt material thinning upwards into clay varves near the surface, east shore of Night Hawk lake.

A study of the relation of the varves to the boulder clay suggests that there has been a repetition of the advance and retreat of the ice. The presence of two distinct sets of glacial striae, one striking south to S. 10° E., the other



Disturbance in varved clay, east shore of Night Hawk lake.

S. 40° E. to S. 35° E., point to the same conclusion. The latter set represents the last advance of the ice, since it definitely cuts the former set.

The central part of German township, the eastern part of Macklem, and a portion of Bond are occupied by an extensive outwash plain as indicated on the accompanying map. It consists of sand, gravel, and boulders showing little

[1]Ernst Antevs, "The Recession of the Last Ice Sheet in New England," Amer. Geog. Soc., Research Series No. 11, 1922, p. 72.

or no assortment and indicating rapid deposition in waters flowing from the melting ice-front, which had been more or less stagnant for a considerable time prior to the retreat of the ice. The outwash material overlies the stratified clay. The east side of the plain is characterized by very steep banks that drop off suddenly into the low spruce muskeg 100 feet below. Bubbling springs are common at the bottom of these steep banks and are often the source of streams. The west side of the plain falls off more gradually as a rule. For half a mile or so on either side of the apparent margin of the plain, the clay is overlain by a thin veneer of fine sand. The plain itself is comparatively flat, but not absolutely so, since there are many depressions, some of which are occupied by beautiful kettle lakes. Similar deposits of outwash material occur in the northern part of Currie township and along the Watabeag river.

Recent

Peat deposits are commonly developed in the undrained areas, but on the whole these are of little importance. A 4-foot bed is exposed near the water's



Granite erratics on the sand plain, southern part of Macklem township.

edge on the east shore of Night Hawk lake. Many of the streams carry large quantities of clay in suspension. During the spring floods this material is dropped along the margins and has gradually built up banks that are higher than the banks a little farther inland. The streams have not cut deeply into the unconsolidated material with the exception of Watabeag river. For a mile or more below Egan chutes, this stream has cut a narrow gorge 75 feet or more in depth.

ECONOMIC GEOLOGY

Attention was first directed to this and adjacent areas in 1907 when a discovery of native gold was made on Gold island in Night Hawk lake. A year later, gold claims were staked on the northeast shore of Porcupine lake. Since that time prospectors have paid little attention to this area, as it is heavily covered with drift material and the outcrops of rock are small and scattered.

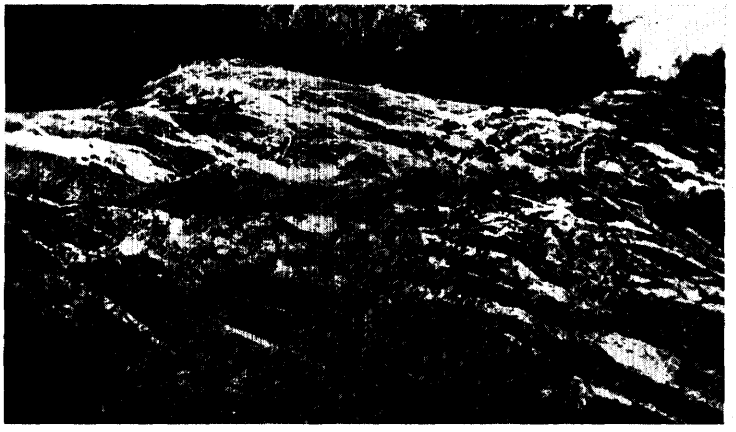
It is, however, important to point out that this area lies directly in the theoretical northern gold belt, which, as suggested by Cyril W. Knight[1] and

[1]Ont. Dept. Mines, Vol. XXXIII, pt. 3, 1924, p. 44.

P. E. Hopkins, extends from the Porcupine area to the Lightning River area. This idea is based on the occurrence of similar and deeply infolded sediments of Timiskaming age at such widely separated points as the Dome mine, Northeast bay at Night Hawk lake, the Croesus Mine area, and the Lightning River area. The intervening regions are drift-covered. If this sedimentary series continues through the area future prospecting may be rewarded by the discovery of important gold deposits.

Gold

This is the most important economic mineral to be found in this area. It is genetically connected with some phase of the Algoman intrusive, which here is largely confined to dikes of aplite, syenite porphyry, quartz and feldspar porphyries, and small discontinuous quartz stringers.



Auriferous quartz stringers cutting green carbonate rock, Gold island, Night Hawk lake

During the past summer some surface work was done on three different prospects but the values obtained were not encouraging.

MACKLEM TOWNSHIP

Gold Island

The most important prospect is that of Gold island. It was here, in 1907, that Victor Manson and Harry Benella, two Finnish prospectors, discovered native gold in a small quartz stringer in a reddish aplite dike. In 1908, a small mill was erected but it was burned a short time after. In 1921, the Night Hawk Peninsular Mining Company optioned the property for a considerable sum and did extensive diamond-drilling, but the option was dropped. Since that time independent parties have sampled the property, but nothing has been done. In July, 1930, Jas. G. Cameron optioned the property, and under the direction of Jno. W. Callinan, approximately two tons of the aplite dike material from Gold island was shipped to the testing laboratories of the Mines Branch, Ottawa. This was done to ascertain the character of the ore and the best method of treatment. Through the courtesy of officials the following information is made available:—

1. The assay of two representative lots from different dikes give values of $3.40 and $2.80, respectively, in gold per ton, over a width of 40 feet.

2. The greater part of the gold in the ore is present as native gold.

3. An amalgamation process recovers 80 per cent. of the gold, but in practice probably not more than 58 per cent.

4. Amalgamation combined with flotation recovers 96.7 per cent. of the gold.

5. Cyanidation recovers 97 per cent. of the gold with a cyanide consumption of 0.60 pounds KCN per ton of ore milled.

6. Fine grinding is necessary in any of the above processes.

It is felt that, at the present time at least, this low-grade ore would not allow a profit over and above initial expenditure and subsequent operating costs.

On Gold island, the gold is associated with narrow quartz stringers cutting red aplite dikes and a rusty carbonate rock. The aplite contains many cubes of iron pyrites, and nests of tourmaline occur in the quartz in some places. The presence of the latter suggests a high-temperature origin for this deposit.

Other Prospects

Anniversary island, a few yards to the south of Gold island, is in itself an aplite dike carrying auriferous quartz stringers. In 1917, a 50-foot shaft was sunk on Bald island and a crosscut driven 50 feet to the north to intersect a narrow quartz vein carrying some gold.

On East peninsula there is a similar association of carbonate rocks cut by aplite or felsite dikes. Narrow quartz stringers in one of these dikes gave a value of 80 cents in gold per ton.

On the Red Dog, claim P. 12,581, Dan O'Connor reports gold values in quartz veinlets cutting a chert band.

Several claims were staked some years ago near the south boundary of Macklem township, about 2 miles east of Night Hawk lake. The showing is reached by a trail starting at the mouth of Bottley creek. Low values in gold were obtained from quartz stringers in a rusty carbonate or dolomitic schist.

CURRIE TOWNSHIP

Samuel Reid

Samuel Reid, prospector and settler, has done considerable surface work on a showing on the south half of lots 5 and 6, concession II, Currie township. Prospect pits on the west side of the large outcrop, claim P. 13,302, disclosed small lenses and discontinuous stringers of quartz in closely sheared and highly altered Keewatin pillow lavas. Silicified parts of this zone have given values up to $4.17 in gold per ton from handpicked specimens. For the most part the quartz appears to be barren of any mineralization; but in places where it is clouded with chloritic and aplitic material, fine iron sulphides are observed. Small quantities of zinc blende, malachite, and chalcopyrite are associated with fine iron sulphides in the sheared zones of the Keewatin lavas. These are also much impregnated with pink granitic material and epidote. The mineralization is thought to have been introduced by several narrow granitic dikes that cut the lavas. Strong magnetic attraction at certain places in the diabase dikes here and in the covered areas adjacent are probably due to a concentration of magnetite in the diabase.

J. Anderson

A little over a year ago J. Anderson, farmer, made a spectacular discovery of native gold on his farm, north half of lot 6, concession VI, Currie township. The outcrop lies to the south of Anderson lake and only a few hundred yards

from the Ferguson highway. The interest and hope of prospectors and nearby farmers was so aroused that there was a mild rush to stake claims, some of which were located on the open sand plain to the south. The gold evidently occurred in a few small pockets in a quartz vein 2 feet wide. The vein followed a faulted zone in the Keewatin greenstone. The native gold, which was indeed of the spectacular variety, was soon completely removed. No more gold has been found, despite the fact that surface work has been pushed diligently. A picked specimen of the vein matter assayed by the Provincial Assay Office gave no values in gold per ton.

The quartz vein as well as the silicified wall rock contains considerable fine iron sulphides and lesser quantities of zinc blende, galena, chalcopyrite, bornite, and garnet. This mineralization appears to be genetically connected with a feldspar porphyry dike 15 feet in width cutting the Keewatin lavas.

Nickeliferous Pyrrhotite

At the Alexo mine in Dundonald township, nickeliferous pyrrhotite occurs along the contact between serpentine rock and andesite. To the southwest of this there are similar occurrences. On the south half of lot 5, concession I, Dundonald township, and a short distance east of McIntosh lake, Z. Lafontaine has done considerable surface exploration on a pyrrhotite zone, which is reported to contain values in nickel. The zone is associated with diabase or norite.

The writer wishes to point out that, when the need arises, the drift-covered parts of German and Stock townships adjacent to Dundonald may be expected to disclose similar zones of nickeliferous pyrrhotite. Since this mineral is magnetic, it is especially susceptible to dip-needle or electrical survey methods.

Clay

This material, in addition to its importance in agriculture, is under certain conditions suitable for the manufacture of building brick and drainage tile.

Keele has pointed out that all the clays in the area have defective drying and high shrinkage characteristics. This type of clay is known as "tender" by brickmakers. "The addition of 25 per cent. of sand improves the drying qualities and reduces the drying shrinkage by 2 per cent. With this amount of sand a very fair buff building brick and field drain-tile can be produced."[1]

[1]Geol. Surv. Can., Mem. 142, 1924, p. 117.

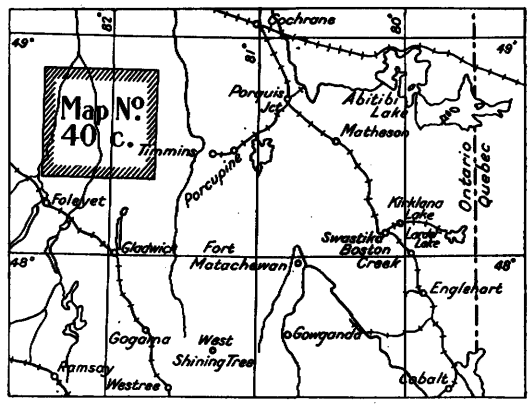
Groundhog-Kamiskotia Area, District of Cochrane

By A. R. Graham

INTRODUCTION

During the summer of 1930, a geological survey of a number of townships in the Groundhog-Kamiskotia area was made by the writer and his party. The area is situated between the Sudbury-Longlac branch and the Northern Transcontinental line of the Canadian National Railways and comprises the townships of Belford, Nova, Poulett, Montcalm, Strachan, Aitken, Fortune, Enid, Byers, Côté, Massey, and Whitesides, all of which lie in the district of Cochrane.

As the townships investigated are situated just west of the Kamiskotia gold and copper field, this area has attracted the attention of prospectors since the year 1910. A number of quartz veins with gold values and sulphide bodies with copper and nickel values have been located in the intervening years.



Key map showing location of the Groundhog-Kamiskotia area. Scale, 60 miles to the inch.

Although the work to date performed on these occurrences has not indicated a deposit of economic value, certain prospects are worthy of further exploration.

With a view to aiding exploration, the writer was instructed by the Deputy Minister of Mines to prepare a geological map and report of the area. The early part of the summer was spent in a reconnaissance of the western townships about which little geological information has been available. In the latter part of the summer detailed work was performed in the eastern townships, in which a large number of claims have been staked for gold and copper. In conducting this work, able assistance was rendered in the field by Neil Runnalls, W. L. Brown, and J. L. Hough.

General Character of the Area

Access

Although certain townships are difficult of access, most of them are reached by canoe routes that are easily travelled. Canoe routes down the Ivanhoe and

Groundhog rivers into the western townships of the area are crossed by the Sudbury-Longlac branch of the Canadian National Railways at Shawmere and Groundhog River Bridge. The eastern townships are accessible by canoe route from Gladwick on the same railway line or by canoe route or trail from Timmins.

Canoe Routes

The Ivanhoe river and its tributary, the Goose river, form one of the best waterways into the area. The Canadian National railway crosses the Goose river one mile east of Shawmere. Three miles below the railway, the Goose river joins the Ivanhoe river, which continues north, passing through Nova and Belford townships and uniting with the Groundhog river in the central part of Montcalm township. Along the greater part of this route, the Ivanhoe is a sluggish river. All drops are abrupt; consequently the portages are short.

The Groundhog river, which flows north through the townships of Strachan and Montcalm in the central part of the map area, is crossed by the Canadian



High falls on the Ivanhoe river, Montcalm township.

National railway about 13 miles east of Foleyet. It is a turbulent river, filled with many long rapids, Sixmile rapids in Strachan township being particularly treacherous for canoeing and difficult to ascend. The river is not travelled very often by canoeists coming up-stream to the rail, as the Ivanhoe river is a much better route.

The Nat river may be used to reach the townships of Enid and Fortune. Starting from the island portage on the Groundhog river in Reeves township, a mile and a half portage leads east over high rolling ground to the Nat river. North from this portage the Nat river makes an excellent canoe route with few portages. It flows into the Groundhog river about 30 miles to the north in Poulett township.

Two miles west of Gladwick on the Canadian National railway, a mile portage leads north to Kaneki lake. A short portage connects Kaneki lake with Kenogaming lake, the headwaters of the Kamiskotia river. Twenty miles north from Kenogaming lake, the Kamiskotia flows into Whitesides township and through Massey and Côté. There are many long rapids in the river in Whitesides and Massey, and canoeing is an arduous task. A trail from Kamiskotia lake crosses the river a little west of the centre of the east boundary of Côté township and leads 8 miles west to the Sweet claims in Enid township.

Prospectors going to Côté and Byers townships generally take the canoe route from Timmins down the Mattagami river to the Kamiskotia river, where a two and a half mile portage leads to Kamiskotia lake, from which another portage of about the same length is taken to the Kamiskotia river. A trail starting from the Kamiskotia river in the northwestern corner of Robb township leads 8 miles across country to the Jamieson claims in Byers township.

The townships of Whitesides and Massey may also be reached by canoe route or trail from Timmins. A wagon road leads from Mattagami Heights by way of Sandy falls to the De Santis claims in the southwestern corner of Turnbull



Byers mountain in the central part of Byers township.

township, from which a trail follows the north line of Whitesides township to the Robb claims in the northwestern corner of the township. A canoe route may be taken from Mattagami Landing up the Mattagami river to Wawaitin falls, thence by way of the Redsucker river and Cripple creek to Dana lake in Whitesides township.

Surface Characteristics

Since the area lies on the edge of the clay belt, much of the region is covered with post-glacial lake deposits of clay. Extensive clay flats extend up the valleys of the chief rivers. These areas are low and poorly drained, and rock outcrops are not plentiful.

A few prominent ridges relieve the otherwise low relief of the area. The most rugged country observed by the writer is in Enid, Massey, and Whitesides townships, where granite and gabbro hills rise at intervals above extensive deposits of glacial drift. High granite ridges are also seen on the western border of Belford township. The east flank of this granite region is covered with glacial deposits in the form of low hills and ridges of gravel and sand. Prominent granite hills rise to a height of two hundred feet above the surrounding country in the western part of Fortune township. Another high granite ridge in the central part of Byers township is locally referred to as Byers mountain. Most of these rock ridges have a north and south trend, which is, no doubt, due largely to erosion by glaciers moving in a southerly direction during Pleistocene time. Morainal ridges have a similar trend. A chain of high moraines extend from north to south along the eastern boundaries of Massey and Whitesides townships.

The western and central townships of the area are drained by the Groundhog river and its two large tributaries, the Ivanhoe and the Nat. Only a few small lakes are found in this part of the area, but many small streams meander through clay flats carrying much detritus, which is deposited in deltas where they empty into the larger rivers. It is noticeable, when coming down-stream, that the farther the river progresses into the clay belt the muddier the appearance of the water.

The eastern townships are drained by the Kamiskotia river and Enid creek (North branch). Numerous small lakes are found in shallow depressions in the glacial drift, many of which are filled with clear cold water. Trout are generally to be found in both the lakes and streams.

A great proportion of the pine forests on the higher areas has been burned during the last thirty years. The extensive spruce swamps on the clay flats have escaped the fires and, in many cases, have acted as a barrier. The forest fires have exposed the rock ridges through Enid, Fortune, and Byers townships. A large brulé is found in the southern part of Belford township. The timber in the area is not readily accessible, and no lumbering is being carried on at the present time.

Previous Work

The Groundhog and Ivanhoe rivers were explored by W. A. Parks[1] in 1899. E. W. Todd,[2] while reporting on the area to the south in 1923, also investigated Strachan and Enid townships.

GENERAL GEOLOGY

All the solid rocks of the area are of pre-Cambrian age and of igneous origin. The ancient Keewatin volcanics have been intruded first by gabbro, then by granite. The basic intrusives are much more prominent than is usually the case in Northern Ontario. Both the gabbro and volcanics underwent structural deformation during the period of granitic intrusion. Diabase dikes, which represent the final stage of igneous intrusion, have penetrated all other rocks. Erosion removed all subsequent formations, and glacial drift was deposited upon the eroded surface. Finally, widespread post-glacial lake deposits of clay and sand covered glacial drift and rock outcrops.

In the eastern townships of Byers, Côté, and Whitesides, numerous small exposures of Keewatin greenstone were noticed by the writer. They are inclusions or roof pendants suspended in the younger intrusives. A large boss

[1]Ont. Bur. Mines, Vol. IX, 1900, p. 132.
[2]Ont. Dept. Mines, Vol. XXXIII, pt. 6, 1924.

of gabbro outcrops in Whitesides, Massey, and Côté townships. A great granite batholith underlies the central townships of Enid, Fortune, Strachan, and Montcalm; and granite tongues extend eastward from this mass into the greenstone and gabbro in Byers, Côté, Massey, and Whitesides townships. Numerous porphyry dikes are associated with these granite tongues. The western townships in the area are heavily overburdened with post-glacial lake deposits of stratified clay and sand. Rock outcrops occur only along the larger rivers where erosion has cut deep into the overburden. There are indications of a Keewatin schist belt underlying the lake beds in Belford township, but the outcrops are so few that it is impossible to outline the contacts with the surrounding granite.

Stratigraphy

In the following table the rocks have been classified according to their relative ages, the oldest being at the bottom:—

QUATERNARY	
PLEISTOCENE and RECENT:	Boulders, gravel, stratified clays, and sand.
	Unconformity
PRE-CAMBRIAN	
MATACHEWAN:	Diabase dikes.
	Intrusive contact
ALGOMAN:	Granite, granophyre, aplite, quartz porphyry, lamprophyre.
	Intrusive contact
HAILEYBURIAN:	Gabbro.
	Intrusive contact
KEEWATIN:	Rhyolite, agglomerate, tuff, basalt, andesite, chlorite schist, banded iron formation.

KEEWATIN

Remnants of Keewatin volcanics enclosed in younger basic and acid intrusives are infrequently exposed throughout the area. The fissile nature of the altered Keewatin volcanics makes them subject to deeper erosion than the massive intrusives; consequently, the volcanics forming the low ground have been heavily overburdened with glacial drift and lake beds. The Keewatin consists principally of basic flows and fragmentals. The massive basalts are fine-grained and dark-green in colour and have been highly altered. The microscope shows that they now consist of chlorite, hornblende, epidote, calcite, and other secondary minerals. The basalts have also been metamorphosed into chloritic schists, which, in thin section, are seen to consist largely of minute scaly aggregates of chlorite. Adjacent to granite, the basic flows have been altered to coarse-textured recrystallized hornblendites, which, in some cases, are garnetiferous. Along contacts with the gabbro, the basic flows have been impregnated with epidote.

Agglomerate and tuff are interbedded with the basic flow at the Union mine in Whitesides township. Rhyolite flows are not common, but several outcrops were encountered in Fortune township. A narrow band of iron formation is found in basalt on the Jamieson claims in Byers township; the iron is in the form of magnetite interbanded with white silica.

HAILEYBURIAN

Before the advent of the great granite batholiths, a group of basic rocks were intruded into the Keewatin volcanics. No doubt they were boss-like masses of deep-seated origin, although their form is not now evident. The surface outline is irregular and lacks conformity with the structural directions of the Keewatin volcanics. The texture is granitoid, and they may generally be



Chlorite schist at the three falls on the Ivanhoe river in Belford township.

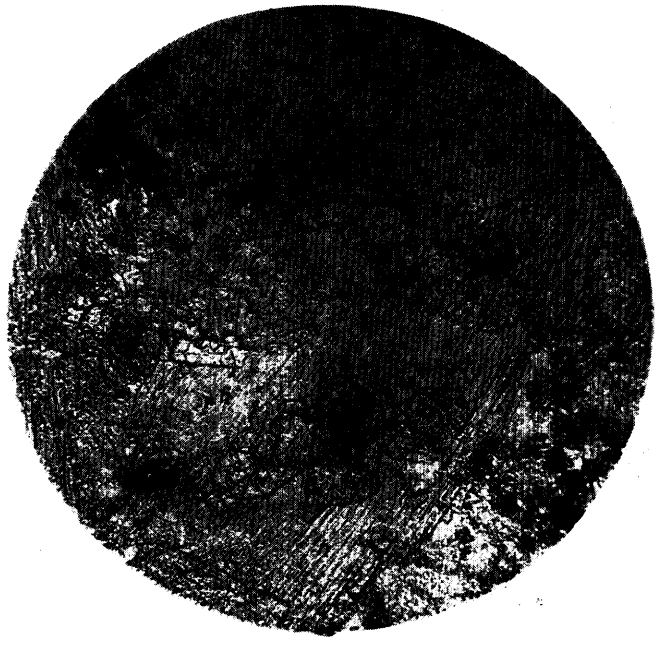
classified as gabbro. Certain fine-grained types have the texture of diabase and are dark-green in colour. Thin sections show that they consist of labradorite, augite, hornblende, magnetite, and aplite. They have partially decomposed into an aggregate of epidote, zoisite, calcite, uralitic hornblende, and chlorite.

In contact with Algoman intrusives, the gabbro has been metamorphosed into a chlorite carbonate schist, which resembles very closely that formed from Keewatin basalt by similar action. In thin section, the chlorite carbonate

schist is seen to consist largely of chlorite and carbonates with small amounts of zoisite, albite, and quartz.

A banded structure is also found adjacent to the Algoman granite. Apparently there has been recrystallization and separation into layers, which in one case consists of an excess of feldspathic, and in the other of pyroxenic constituents. It is also possible that this structure may be due to differentiation during the cooling of the magma.

Magnetite is always an abundant constituent and can be readily seen with the naked eye in hand specimens of the rock. In the more basic types, especially those of coarse crystallization, the magnetite is sometimes segregated into small lenses or stringers.



Photomicrograph of altered gabbro showing epidote crystals (e) in a large uralitic hornblende crystal (h).
(One nicol × 50.)

The gabbros range in texture from fine-grained to coarse-grained. All grades of texture may be observed in the one body, the differences being due to variations in the fluidity and rate of cooling of the magma. The coarse-grained varieties are composed essentially of hornblende and feldspar, crystals of which are sometimes 3 inches in length.

A basic phase of the gabbro outcropping on the Ross claims in Whitesides township contains considerable olivine. This olivine gabbro, when examined microscopically in thin section, is seen to be composed essentially of saussuritized bytownite, serpentinized olivine, and augite. The olivine is always separated from the bytownite by a narrow reaction rim of fibrous enstatite and actinolite. Magnetite is abundant both as a primary mineral and as a secondary mineral after the alteration of the olivine to serpentine. A sample of this olivine gabbro, which was analysed at the Provincial Assay Office, gave the following results:—

Analysis of a Sample of Olivine Gabbro

	Per cent.
SiO_2	41.37
Al_2O_3	22.95
Fe_2O_3	2.03
FeO	4.14
CaO	13.96
MgO	10.44
Na_2O	.71
K_2O	.34
CO_2	.41
H_2O (−100)	.02
H_2O (+100)	3.53
T_1O_2	.08
MnO	.04
FeS_2	.25
P_2O_5	None
Total	100.27

Calculations from this analysis show that the rock was primarily composed of approximately 63 per cent. bytownite, 7 per cent. augite, and 30 per cent. olivine.

ALGOMAN

Following the gabbro, there was a great invasion of acid rocks of various types. The large granite batholiths brought about the folding and faulting in pre-existing formations and caused contact metamorphism of the invaded rocks. The Algoman intrusives are the most widely distributed rocks in the area. Petrographically, they are characterized by a greater variation in texture than in composition.

The greater part of the granite found in the area is gneissic, and the predominating dark mineral is biotite. In thin section, the biotite granite gneiss is seen to consist of biotite, quartz, kaolinized orthoclase, apatite, zoisite, titanite, and magnetite. A massive hornblende granite was also found in Nova township. In the hand specimen, this granite is seen to contain pink feldspar, quartz, and dark-green hornblende.

Aplitic variations of the granite are common. They are pink in colour and are marked by the fine granulitic texture of the essential constituents, quartz and orthoclase. A basic type of aplite dike occurs in the gabbro in Enid township. These dikes, which are dark-grey in colour, may be acid differentiates of the gabbro magma. In thin section, they are seen to consist of quartz, orthoclase, albite, biotite, and chlorite.

A number of quartz porphyry dikes are found in the townships of Côté and Byers. The porphyries are light-grey in colour and show rare quartz phenocrysts in a microcrystalline groundmass of quartz and feldspar. The dikes are generally highly altered to sericite carbonate schists. Where such alteration has occurred, the schist is commonly filled with quartz stringers, and both are well mineralized with pyrite.

A granophyre dike was found intruding Keewatin basalts in Belford township. The pink crystalline groundmass, when examined in thin section, is seen to consist of a graphic intergrowth of quartz and orthoclase, with a few quartz phenocrysts.

MATACHEWAN

The quartz diabase dikes of Matachewan age intrude all other rocks and are the youngest igneous rocks in the area; they range in width from a few

inches to 300 feet. A striking feature is the constant northerly trend. The margins of the dikes are sharply chilled against the older rocks. Otherwise, they have the characteristic ophitic texture of diabase and consist essentially of labradorite and augite, with accessory magnetite and interstitial quartz. Phenocrysts of feldspar, which reach a diameter of 2 inches, are found along the margins of some of the larger dikes.

PLEISTOCENE AND RECENT

The greater part of the area is covered with overburden. Glacial ground moraines of sand, gravel, and boulders are found on the high ground throughout the area. Morainal ridges trending northward occur along the eastern boundary of the area. Post-glacial lake beds of stratified sand and clay have been deposited in the wide valleys of the chief rivers.

Description of Townships

Nova Township

The western part of the township is covered with ground moraines of sand and gravel. Pine, poplar, and birch grow on this rolling country. The eastern part is covered with post-glacial lake beds of sand and clay on which is a spruce muskeg. Granite gneiss ridges outcrop in the northwestern part of the township. High clay and gravel banks rise above the Ivanhoe river along its course north through the township. A few outcrops of granite and diabase occur at various points along the river bed. Apparently the township is underlain by granite gneiss.

Belford Township

The granite ridges outcropping in the northwestern corner of Nova township continue northward into Belford. On their eastern flank, glacial ground moraines of sand and gravel have spread out over a Keewatin greenstone area. The Ivanhoe river has cut deeply into the glacial deposits to expose bedrock at the three falls. Here, chlorite schists and tuff have been intruded by a coarse gabbro. At the rapids, half a mile below the falls, basalt is cut by a narrow granophyre dike. Paypeeshek creek, which empties into the Ivanhoe a short distance below the rapids, can be followed by canoe for six miles to the west boundary of the township. It has many long rapids, where it falls over boulder moraines. A few outcrops of basalt are found along the creek a short distance above the Ivanhoe. In the northeastern corner of the township the glacial drift has been covered by post-glacial lake beds of clay, on which is a spruce swamp. The pine that once covered the ground moraines in the southern part of the township has recently been burned.

Strachan Township

Clay soil covers most of the township, and rock outcrops are not plentiful. Biotite granite gneiss outcrops along the Groundhog river, and half-way down Sixmile rapids, a band of Keewatin basalt schists is found. Small creeks can be followed by canoe west from the river for several miles through flat clay land covered with spruce and poplar.

Montcalm Township

Very little rock is seen in this township, and the soil over the greater part is clay. There are a few outcrops of gabbro along the Groundhog river for a

mile below the south boundary of the township. No rock outcrops are exposed along the remaining part of the river. Keewatin basalts are cut by a large diabase dike at High falls on the Ivanhoe river, and half a mile below High falls the river has formed a rapid over andesite porphyry intruded by a narrow granophyre dike. High clay banks are found on either side of the river for the remaining six miles to the junction with the Groundhog.

Fortune Township

A large part of the township is underlain by granite gneiss, a high ridge of which is exposed in the western part of the township. Glacial sands cover the central part of the township. This region was burned over a number of years ago and most of the pine destroyed; small second-growth pine is now coming up. Along the Nat river there are a few outcrops of granite gneiss and diabase. A narrow belt of Keewatin greenstone is exposed in the southeastern corner of the township. Claims have been staked over this area.

Enid Township

A narrow belt of Keewatin volcanic rocks striking northeast outcrops on the Nat river in the Indian Reserve and can be followed to the corner of the township and beyond. Since an extensive swamp covers the country between the Nat and Groundhog rivers, this belt cannot be followed farther than a mile west of the Nat. In the northeast corner of the township, Keewatin basalts have been intruded by gabbro. Pyrrhotite lenses have been found in this gabbro on the Sweet claims. Granite ridges outcrop in the vicinity of Enid and Harriet lakes. The granite has been intruded by a remarkably large number of diabase dikes. The central and southwestern parts of the township are very low, swampy land, underlain by granite gneiss.

Whitesides Township

A narrow band of Keewatin volcanics strike east and west across the central part of the township. Although outcrops of the greenstone are not numerous, a number of quartz veins have been located in the volcanics that are exposed. To the north the greenstone belt is intruded by a large gabbro boss, which extends over the northern part of the township. A large granite batholith extends into the southern and western parts of the township.

Massey Township

The southeastern part of the township is underlain by gabbro, which is well exposed along the Kamiskotia river. East of the river, it is covered by swamps and morainal ridges. The granite batholith outcropping along the western boundary sends a tongue eastward into the gabbro in the northern part of the township. There are few rock exposures, as in this area a spruce swamp extends across the valley of the Kamiskotia river.

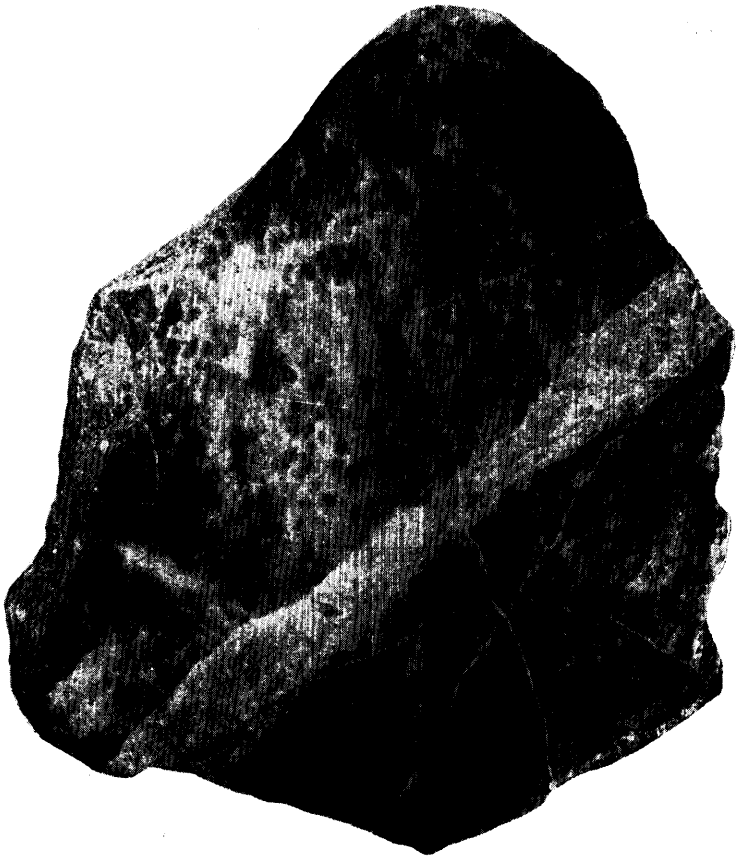
Côté Township

Although there are very few rock outcrops, a large number of claims have been staked in the central part of the township, most of which is covered by an extensive spruce swamp. The claims have been staked on a narrow band of Keewatin rocks bordered by granite to the north and south. Numerous gabbro bosses are found in the Keewatin volcanics, and quartz prophyry dikes intrude

both basalt and gabbro on the Jack and Lusikauf claims. The porphyry is schisted and contains quartz lenses and stringers.

Byers Township

A high granite ridge outcrops in the central part of the township. A considerable area of basic volcanic rocks is exposed northwest of this ridge. On the Jamieson claims, in the northern part, a wide porphyry dike, which intrudes the greenstones, is mineralized and contains numerous quartz lenses. A narrow band of iron formations has also been found on these claims.



Specimen of chlorite carbonate schist cut by a small carbonate vein, Union mine, Whitesides township.

The western part of the township is very low and swampy along the valley of Enid creek. The northeastern corner is also low and lacking in rock outcrops. The timber has been burnt off the high ground throughout the township.

Aitken Township

Spruce muskeg covers the greater part of the township. A few rock outcrops are exposed along the Nat river, where they generally form rapids in the river. Two outcrops of chlorite schist are found on the river bank a short distance east of the boundary of Poulett township. Traverses were made eastward in an attempt to locate a more extensive area of greenstone, but thick beds of

post-glacial clay are covered in this region with spruce muskeg. Outcrops of granite along the Nat river indicate that the southern part of the township is probably underlain by granite.

Poulett Township

The wide low valley of the Groundhog river continues northward from Montcalm township. For eight miles down the river to the junction with the Nat, only one outcrop of diabase is exposed along clay banks. Below this point the river has cut deeply through glacial gravel beds which rest on granite gneiss. The country along the Nat river is also low and drift-covered. At two points the river drops sharply over low ridges of granite, which are not exposed beyond the banks of the river.

ECONOMIC GEOLOGY

Gold

The main period of gold deposition came at the close of the Algoman. Gold-bearing quartz veins have been found in the Algoman porphyry dikes or in greenstone or gabbro adjacent to them. In some cases the veins are well-defined lenticular bodies; in others, reticulating quartz veinlets form deposits of the stockwork type. Carbonates accompanied the intrusion of the quartz veins, altering the wall rock into carbonate schists. The carbonates also form streaks or lenses within the veins or cut the wall rocks in narrow veinlets. Mineralization occurs in the quartz veins and altered wall rocks. The gold occurs with pyrite, pyrrhotite, and chalcopyrite. In one case, zinc blende accompanies a quartz vein that has fractured a band of iron formation. The gangue minerals are quartz, calcite, ankerite, and chlorite.

Union Mine

In 1921, the Union Mine and Trust Company, of Chicago, sank a 230-foot shaft on a property consisting of four claims (P. 2,772, 2,773, 2,785, and 2,784) in the central part of Whitesides township. The shaft was put down on a chlorite carbonate schist zone, which is 60 feet wide and outcrops over a length of 300 feet. This zone, resulting from the alteration of a Keewatin basalt flow top, is filled with stringers and irregular masses of quartz. Associated with the quartz are pyrite, pyrrhotite, chalcopyrite, calcite, and ankerite. The schist enclosing the quartz is also well mineralized with sulphides. A small aplite dike, a foot wide, penetrates irregularly through Keewatin basalts about 400 feet south of the schist zone. A 60-foot diabase dike cuts north through the centre of this zone.

Alteration and mineralization of the Keewatin basalt resulted from the intrusion of a large granite dike, which was encountered at depth in the shaft. The property has been idle since 1921. A boiler and steam engine remain on the property; other machinery has been removed.

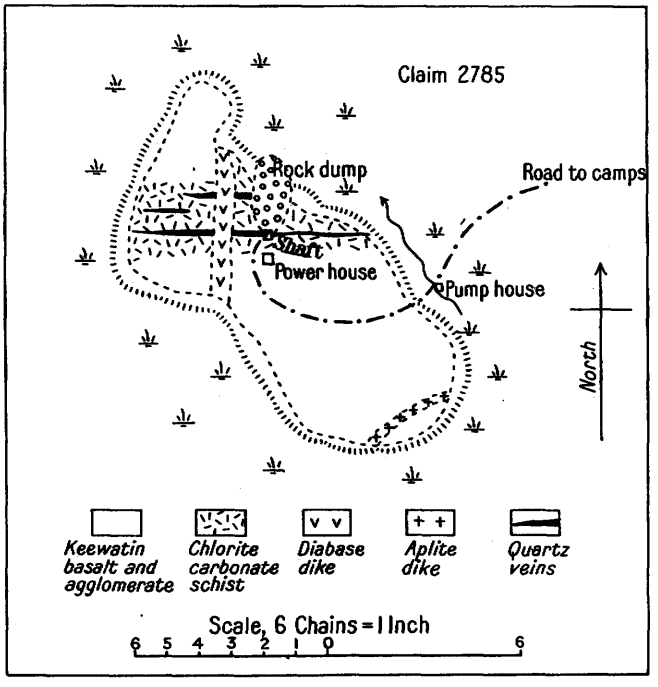
Lusikauf Claims

The Lusikauf claims (P. 16,861 and 16,862) in Côté township were optioned by the Hollinger in 1927. A quartz vein 2 feet wide is contained in carbonate sericite schist, the alteration product of a porphyry dike intruding gabbro. The overburden is heavy on the claims, and the vein outcrops for only 30 feet. Pyrite and chalcopyrite are found in the quartz and enclosing wall rock. The writer selected a grab sample of the mineralized quartz in which the Provincial

Assayer found $3.40 per ton in gold. Certain samples of this quartz vein have been reported to assay as high as $24 per ton in gold. During the winter of 1928, the Hollinger sent a diamond-drill to the property and two shallow holes were put down. The total drilling amounted to 235 feet, and the results indicated that further development would not be warranted.

Jack Claims

Within the last few years considerable trenching was done by the owner on the Jack claims (P. 13,108, 13,109, 16,852, 16,851) in Côté township. A wide porphyry dike cutting through gabbro and Keewatin basalts outcrops at points across three claims. Where exposed, the porphyry is schisted and contains



Geological sketch map of the Union mine, Whitesides township.

stringers and lenses of quartz. The quartz and schist are mineralized with pyrite and chalcopyrite. At one point, quartz is exposed across 40 feet. The owner reports that a channel sample across 4 feet of this quartz lens ran $4 in gold. Native gold has been found in a quartz stringer in this porphyry dike.

Jamieson Claims

The Jamieson Exploration Company have trenched and blasted a wide mineralized zone in schisted quartz porphyry on claim P. 17,330 in Byers township. Quartz lenses and stringers occur in places in this zone, which has been traced for 300 feet. Pyrite is common in the schisted porphyry, and the quartz lenses contain pyrite, pyrrhotite, and chalcopyrite. A narrow band of iron formation outcrops across claim P. 17,021 on the company's property in Byers township. At one point, the iron formation is fractured by a 2-foot

quartz vein, which can be followed for 20 feet along the strike of the iron formation. The quartz contains pyrite, chalcopyrite, and zinc blende. Gold assays have been reported up to $5 per ton on this vein.

Copper

Following the development of the Jamieson copper property in Byers township during 1927, there was a wide search for further copper prospects in adjacent areas. A large boss of gabbro outcrops in Whitesides, Massey, Côté, and Enid townships. At certain points in this gabbro mass, pyrrhotite lenses have been located which contain nickel and also have considerable chalcopyrite associated with them. Basic aplite dikes, which are usually found close to the pyrrhotite bodies, are either acid differentiates of the gabbro magma or offshoots



Photomicrograph of gabbro showing sulphides (dark) replacing labradorite (white). A narrow rim of altered feldspar surrounds the sulphides (pyrrhotite and chalcopyrite). (×20.)

from the Algoman granite. The sulphides are associated with these dikes, having formed along fractures in the gabbro and replaced the wall rock on either side. Lenses of massive sulphide are bordered with disseminated sulphides contained in the partially replaced gabbro. In some cases the wall rock has been silicified into a hard cherty rock. Silicification must have taken place before the advent of sulphides, for very little silica accompanies them. The gabbro, into which these sulphides intrude, contains much magnetite and is usually a coarse-textured type.

Kamiskotia Minerals Syndicate

In 1927, the Kamiskotia Minerals Syndicate was formed to develop the Ross property in Whitesides township. Two sulphide zones occur in coarse gabbro on claim P. 15,511. The mineralization can be traced for approximately

400 feet in the eastern zone and for 300 feet in the western zone. Widths of disseminated sulphides run to 40 feet in the eastern zone and to 30 feet in the western zone. Lenses of massive pyrrhotite occur in the disseminated sulphides, but they are small and irregular in both zones. A sample of this massive pyrrhotite was analysed by the Provincial Assayer and found to contain 0.6 per cent. nickel and 0.1 per cent. copper. During the winter of 1928, the syndicate completed 1,700 feet of diamond-drilling in exploration of both zones. No large bodies of massive sulphides were encountered in drilling, and further exploration stopped.

Sweet Claims

In 1930, the Hollinger optioned the George Sweet property of nine claims in Enid township and performed approximately 500 feet of diamond-drilling in exploration of two sulphide zones. One diamond-drill hole was put down on a disseminated sulphide zone, 6 feet wide and 700 feet long, in banded gabbro outcropping on claim S. 19,519. The sulphides are pyrrhotite and chalcopyrite. On claim S. 19,507, three shallow diamond-drill holes were put down on a 6-foot sulphide zone of chalcopyrite and pyrrhotite in gabbro, which is intruded by narrow, basic aplite dikes. Massive pyrrhotite lenses with widths up to one foot occur in this zone over a length of 100 feet on the surface. A sample of pyrrhotite taken by the writer from one of these lenses contained 0.47 per cent. nickel. Diamond-drilling revealed greater widths of massive pyrrhotite at depth. The Hollinger has not continued development.

INDEX, PART III

PAGE

A

Abitibi l. 17
Abitibi r. 3
Acess to areas reported on.
  German-Currie area 2
  Groundhog-Kamiskotia area 23
Acknowledgments 1, 23
Agglomerate 27
Agriculture 1, 4, 5
Aitken tp. 23, 33
Alder, mountain 5
Alexo mine 22
Algoman rocks.
  German-Currie area 7, 13, 14
  Groundhog-Kamiskotia area 27, 30, 36
Amphibolite 7, 12, 13
Amygdules 7, 8
Analysis, olivine gabbro 30
Anderson, J. 21
Anderson l. 15, 17, 21
Andesite.
  German-Currie area 7
  Groundhog-Kamiskotia area 27
Andesite porphyry 32
Ankerite 34
Anniversary isld. 13, 21
Antevs, Ernst 2, 17, 18
Aplite.
  German-Currie area 7, 8, 11, 13, 20, 21
  Groundhog-Kamiskotia area 27, 30, 36
Ash 5
Aspen poplar 5

B

Bald isld. 5
Balm of Gilead 5
Balsam 5
Banksian pine 5
Barber bay 3
Barley 5
Barlow-Ojibway l. (glacial) 4, 17
Batholith 14
Basalt.
  German-Currie area 7
  Groundhog-Kamiskotia area 27, 31-34
Beaches, sand 7
Bear 6
Beaver 6
Belford tp. 23, 26-28, 31
Benella, Harry 20
Bibliography, German-Currie area 2
Biotite granite gneiss 31
Birch 5, 31
Black r. 3, 4
Bond tp. 3, 5, 7, 10, 14, 16
Bornite 22
Bottley ck. 4, 9, 21
Boulder clay 7
Breakey, B. I. F. 2
Breccia 7, 10
Brick, building 22
Brock, R. W. 11
Brown, W. L. 23
Brulé, Belford tp. 26

PAGE

Burrows, A. G. 2, 7, 13, 16
Burwash, E. M. 2
Byers mt. 25, 26
Byers tp. 23, 26, 30, 33
  See also Jamieson copper claims.

C

Callinan, Jno. W. 20
Cameron, James G. 20
Carbonate rocks 7, 11, 21, 34
  Cutting chlorite schist, photo. 33
  Quartz stringers cutting, photo 20
Cedar 5
Chalcopyrite 21, 22, 34-36
Chatter marks 16
Cherry, wild red 5
Chert 21
Chlorite schist 27, 28, 31, 33-35
Clay.
  German-Currie area 1, 4, 5, 7, 19
    banks, photo 17
    economic 22
    varves, photo 18
  Groundhog-Kamiskotia area. 25, 31, 32, 34
Clergue tp. 3
Climate, German-Currie area 5
Cobalt series 16
Cody tp. 12
Cole, A. A. 2
Coleman, A. P. 2, 17
Conglomerate 7, 12
Connaught Station 1, 3
Cooke, H. C. 11
Copper 23, 25
  See also Chalcopyrite.
Corduroy roads 3
Côté tp. 26, 27, 30, 32, 36
  See also Jack claims; Lusikauf claims.
Cripple ck. 25
Croesus mine 20
Crooked ck. 3
Currie tp.
  Drainage 3, 4
  Gravel pits 3
  Lumbering; forest fires 5
  Mineral claims 21, 22
  Outwash deposits 19
  Rocks 8, 12-15

D

De Santis claims 5
Diabase.
  See also Olivine diabase; Quartz diabase.
  German-Currie area 3, 7, 8, 13, 16
  Groundhog-Kamiskotia area. 22, 26, 27, 34
Diabase porphyry, notes and photo 11
Diorite 12
Dolomite, ferruginous 11
Dome g.m. 20
Drainage, German-Currie area 3, 4
Drainage tile 22
Driftwood r. 3

PAGE
Ducks ... 6
Dundonald tp ... 3, 22

E

East peninsula, Night Hawk l ... 11, 13, 21
Egan chutes ... 6, 19
Egan tp ... 3, 6, 14
Elm ... 5
Enid ck ... 26, 33
Enid tp ... 23, 24, 26, 27, 30, 32
See also Sweet claims.
Erratics, glacial, photo ... 19

F

Farming. *See* Agriculture.
Feldspar porphyry ... 7, 13, 20, 22
Felsite ... 7, 13
Fish.
German-Currie area ... 6
Groundhog-Kamiskotia area ... 26-37
Forest fires ... 5, 26, 31-33
Fortune tp ... 23, 24, 26, 27, 32
Frederick House l ... 6, 17
Fur-bearing animals ... 6

G

Gabbro.
German-Currie area ... 7, 15
Groundhog-Kamiskotia area ... 26-37
photomicrographs ... 29, 36
Galena ... 22
Game ... 6
Garden produce ... 5
Garnet ... 2
Geology, economic.
German-Currie area ... 19-22
Groundhog-Kamiskotia area ... 33-37
Geology, general.
German-Currie area ... 6-18
Groundhog-Kamiskotia area ... 26-33
George Sweet claims ... 24, 37
German tp.
Forest fires ... 5
Gravel pits ... 3
Nickeliferous pyrrhotite ... 22
Outwash deposits ... 18
Rocks ... 8, 9, 12
Sand plain ... 4
German-Currie area.
Report on (with map), by H. C. Laird . 1-22
Glacial striae ... 18
Glaciation. *See* Quaternary.
Gladwick ... 24
Gold.
German-Currie area ... 1, 13, 19-22
Groundhog-Kamiskotia area ... 34-36
Gold isld ... 1, 11, 13, 19-21
Goose r ... 24
Gowganda area ... 16
Graham, A. R.
Report by, on Groundhog-Kamiskotia area ... 23-26
Granite.
German-Currie area ... 14
Groundhog-Kamiskotia area ... 26, 30, 32, 34
Granite gneiss ... 31, 32, 34
Granophyre ... 27, 30
Grassy l ... 15

PAGE
Gravel.
German-Currie area ... 3, 7, 18
Groundhog-Kamiskotia area ... 26, 27, 31, 34
Greywacké ... 7, 12
Grindstone ck ... 4
Groundhog r ... 24, 26, 31, 34
Groundhog-Kamiskotia area.
Report on (with map), by A. R. Graham ... 23-37

H

H. XXXI isld., rocks, photo ... 11
Haileyburian formation.
German-Currie area ... 13
Groundhog-Kamiskotia area ... 27, 28
Harriet l ... 32
Hawk Lake Lumber Co ... 5
High falls, Ivanhoe r ... 24, 32
Hints to prospectors ... 22
Hollinger Cons. Gold Mines, Ltd ... 34, 35, 37
Hooker ck ... 6
Hopkins, P. E ... 2, 11, 20
Hornblende granite ... 30
Hough, J. L ... 23
Huronite ... 7, 16

I

Index maps. *See* Key maps.
Indian Reserve ... 32
Iron formation ... 27, 33, 34
Iron pyrites. *See* Pyrite.
Iroquois Falls ... 5
Ivanhoe r ... 23, 24, 26, 28, 31, 32

J

Jack claims ... 33, 35
Jackpine ... 5, 6
Jamieson claims ... 25, 27, 33, 35, 36
Jamieson Exploration Co ... 35
Jarvis, L. E. M ... 2
Jarvis, T. D ... 2
Juneberry ... 5

K

Kamiskotia r ... 32
Kamiskotia Minerals Syndicate ... 36
Kaneki l ... 24
Kay, G. F ... 2
Keele, Joseph ... 22
Keewatin.
German-Currie area ... 7, 12, 21, 22
Groundhog-Kamiskotia area ... 26, 27, 32
Kenogaming l ... 24
Kettle lakes ... 4, 19
Keweenawan, German-Currie area ... 7, 15
Key maps.
German-Currie area ... 1
Groundhog-Kamiskotia area ... 23
Knight, C. W ... 2, 19

L

Lafontaine, Z ... 22
Laird, H. C.
Report by, on German-Currie area ... 1-22
Lamprophyre ... 27
Larch ... 5
Larder l ... 11

PAGE
Lava....10, 13, 14
Lava, pillow, notes and photo....7, 8, 11, 21
Lightning R. area....20
Lit par lit structure....14
Photo....15
Loam....5
Lusikauf claims....33, 34

M

McIntosh l....3,22
Macklem tp....4, 5, 8, 10, 19
Clay....16
Mineral claims....20, 21
Outwash plain....18
Magnetic attraction....21, 22
Magnetite....21, 27, 29
Malachite....21
Manson, Victor....20
Maple....5
Maps, geological, coloured.
German-Currie area (No. 40*b*)....*in pocket*
Groundhog-Kamiskotia area (No. 40*c*)....*in pocket*
Maps, geological, sketch.
Union m....35
Maps, index.
German-Currie area....1
Groundhog-Kamiskotia area....23
Massey tp....24, 26, 27, 32, 36
Matachewan area....16
Matachewan formation....7, 16, 27, 30, 31
Matheson....1, 2, 5, 16
Mattagami r....17, 25
Mattagami Heights....25
Merriman mt....13, 14
Miller, W. G....2
Mines Branch, Ottawa....20
Montcalm tp....23, 24, 31, 32
Monteith....3, 5
Moore, E. S....2
Moose....6
Moose l....3, 4, 6
Moraines....26, 31
Mosure house....10
Muskeg....3, 6

N

Nat r....24, 32-34
Natural resources, German-Currie area. 4-6
Nickeliferous pyrrhotite....22, 36
Nigh Hawk l.
Fish scarce....6
Glaciation....17
Gold. *See* Gold isld.
Peat....19
Photo....4
Rocks....7, 8, 12, 16
photos....10, 11, 17
Soil....5
silt and clay, photo....18
Night Hawk Peninsular Mg. Co....20
North Driftwood ck....3
Northeast bay, Night Hawk l....4, 12, 16, 20
Norway pine....5
Nova tp....23, 24, 30, 31

O

Oats....5
O'Connor, Dan....1, 21
Ojibway l....17
Olivine diabase....7, 12, 16
Olivine gabbro, analysis....30
Otter....6

P

P. 2,772-73, 2,784-85 gold locs. *See* Union g.m.
P. 12,581 gold loc. *See* Red Dog claims.
P. 13,108-9 gold locs. *See* Jack claims.
P. 13,302 gold loc. *See* Reid, Samuel.
P. 15,511 gold loc. *See* Ross claim.
P. 16,861-62 gold locs. *See* Lusikauf claims.
Parks, W. A....2, 26
Paypeeshek ck....31
Peat....7, 19
Perch....6
Photomicrographs.
Gabbro....36
Interstitial matter....9
Physiography. *See* Topography.
Pickerel....6
Pike....6
Pillow lava, notes and photo....7, 8, 11, 21
Pine....5, 31
Pinero mt....14
Pleistocene. *See* Quaternary.
Poplar....5, 6, 31
Porcupine area, rocks....7, 11, 20
Porcupine l....19
Porphyry....8, 27, 30, 35
See also Feldspar porphyry; Andesite porphyry; Quartz porphyry.
Auriferous....33
Porquis Junction....3
Post-Algoman intrusives, German-Currie area....14-16
Poulett tp....23, 24, 33, 34
Pre-Algoman, German-Currie area 7, 12, 16-19
Pre-Cambrian.
German-Currie area....7-16
Groundhog-Kamiskotia area....27-31
Prospectors, hints to....22
Pulpwood....5
Pyrite.
German-Currie area....13, 14, 21
Groundhog-Kamiskotia area....30, 34-36
Pyrrhotite....32, 34-37
Nickeliferous....22, 36

Q

Quartz, auriferous. *See* Gold.
Quartz diabase.
German-Currie area....7, 16
Goundhog-Kamiskotia area....30
Quartz porphyry.
German-Currie area....7, 13, 14, 20
Groundhog-Kamiskotia area..27, 30, 32-35
Quaternary.
German-Currie area....7, 16-19
Groundhog-Kamiskotia area....27, 31

R

Recent. *See* Quaternary.
Red Dog claims....21
Redsucker r....25
Reeves tp....24

PAGE
Reid, Samuel....8, 15
Gold claim.... 21
Rhyolite.... 27
Rice, wild.... 6
Roads.... 3
Robb claims.... 25
Roches moutonnées.... 16
Rose, B.... 2
Ross claim....29, 36
Runnalls, Neil.... 23

S

S. 19,507, 19,519 gold locs. *See* Sweet claims.
Sandy falls.... 25
Serpentine.... 22
Shad-bush.... 25
Shawmere.... 24
Sheep. *See* Agriculture.
Sheraton tp.... 3
Shillington.... 3
Sixmile rapids....24, 31
Soil. *See* Agriculture.
South r.... 3
Sphalerite. *See* Zinc blende.
Spruce....5, 31
Stewart, A. H.... 2
Stock tp....1, 3, 5
Strachan tp....23, 24, 31
Striae, glacial.... 18
Sulphides.
German-Currie area....21, 22
Groundhog-Kamiskotia area....34, 36, 37
Sweet claims....24, 37
Syenite.... 13
Syenite porphyry....7, 20

T

Tamarac.... 5, 6
"Tender" clay.... 22
Tile, drainage.... 22
Timber.
German-Currie area.... 5, 6
Groundhog-Kamiskotia area.... 26
PAGE
Timiskaming lake (glacial).... 17
Timiskaming series.
German-Currie area....7, 11, 12, 20
Timmins, Ont....5, 25
Todd, E. W.... 26
Tote roads.... 3
Topography.
German-Currie area.... 3, 4
Groundhog-Kamiskotia area....25, 26
Tourmaline.... 21
Trees. *See* Timber.
Trout.... 6
Tuff.
German-Currie area.... 7
Groundhog-Kamiskotia area.... 27
Turnbull tp.... 25

U

Union g.m....27, 34
Geological sketch map.... 35
Union Mine and Trust Co.... 34

V

Varves, clay and silt....17, 18
Volcanics.
German-Currie area....7-10
Groundhog-Kamiskotia area....26, 27, 32

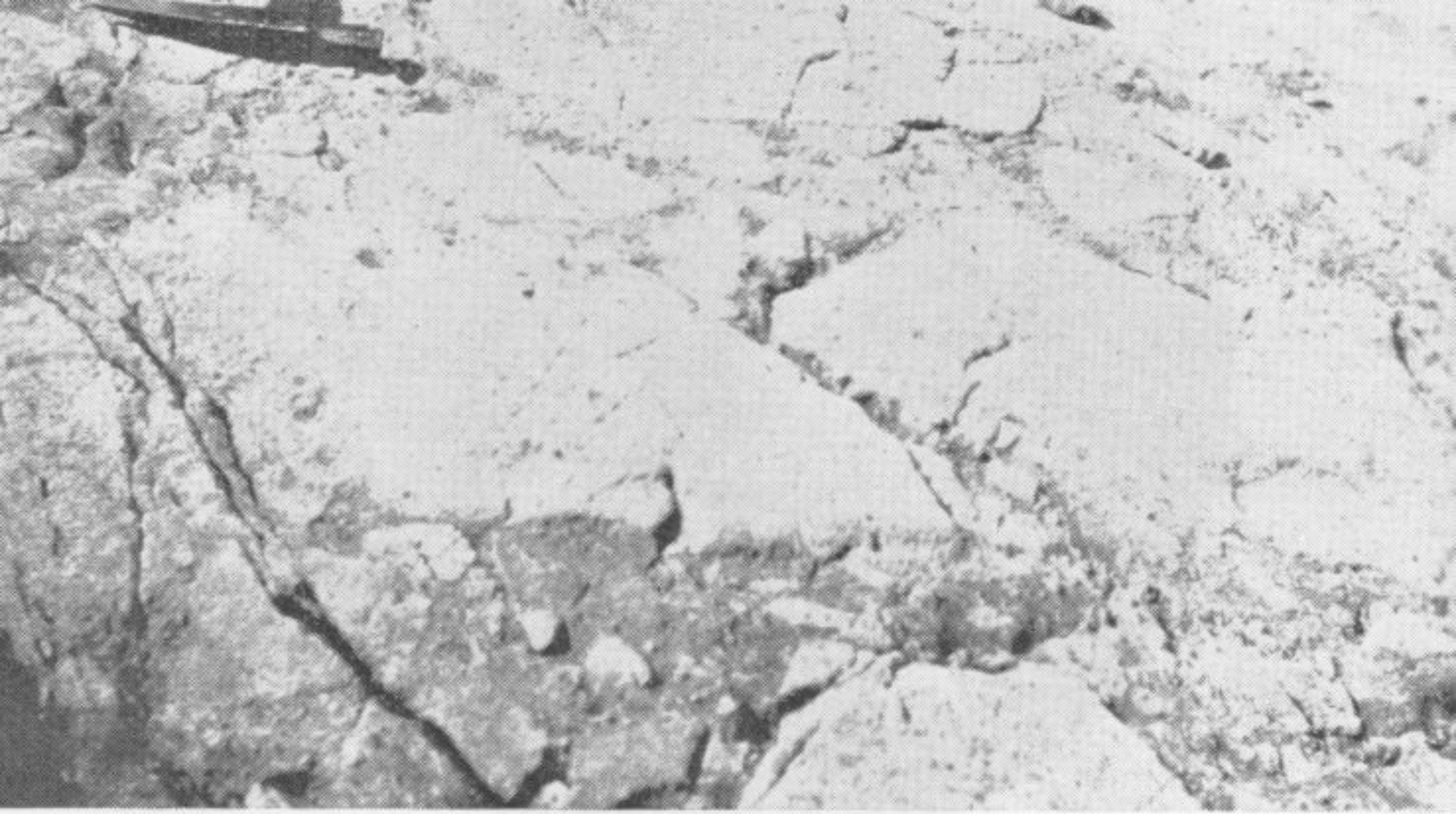
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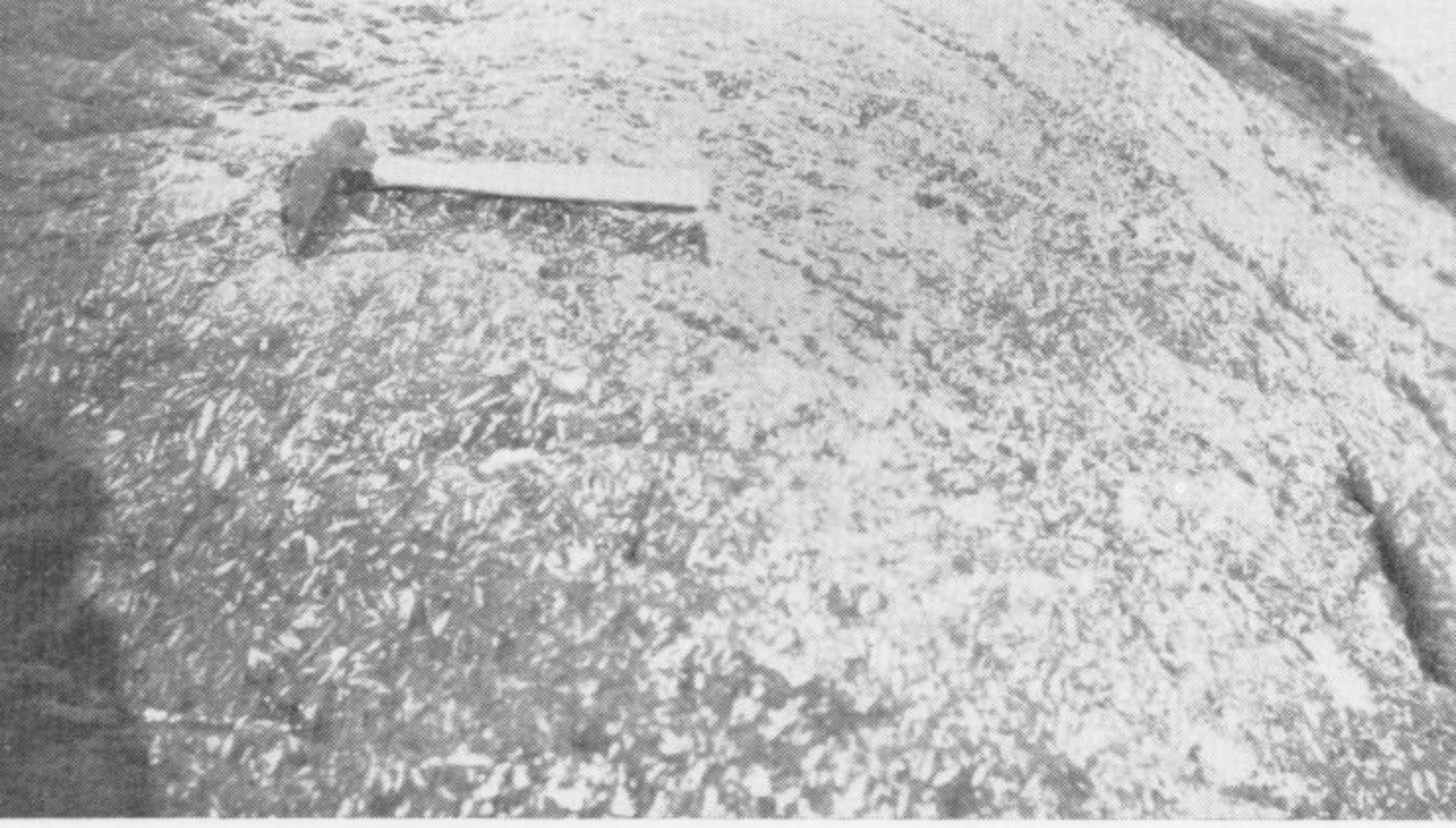
Walker, T. L.... 16
Watabeag l.... 4
Watabeag r....3, 4, 6, 19
Water, spring....4, 19
Water power.... 6
Wawaitin falls.... 25
Weasel.... 6
Wheat.... 5
Whitesides tp....23-26, 32
See also Ross claim; Union g.m.
Willow.... 5
Wilson, M. E.... 11
Wright, D. G. H....2, 14

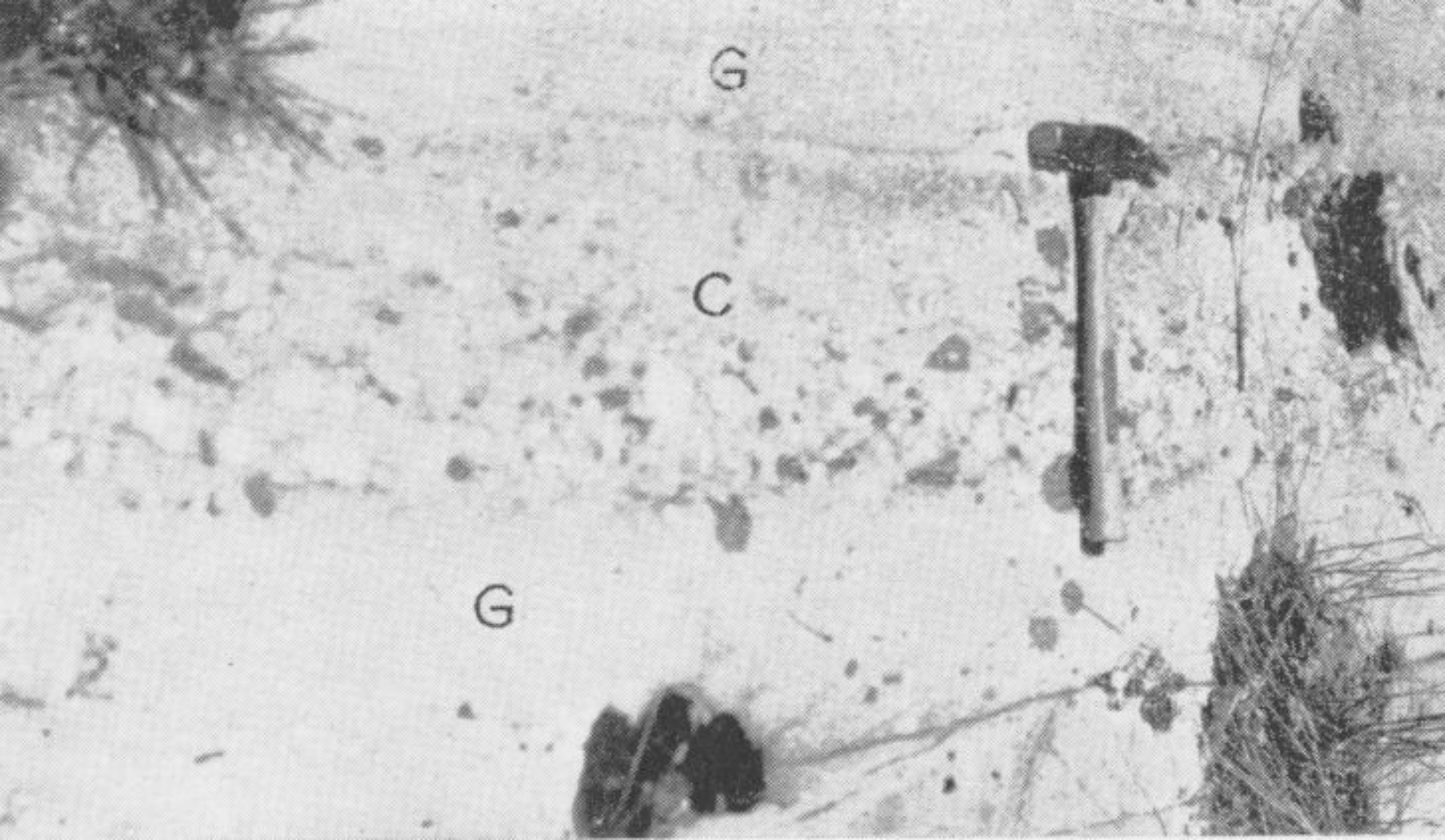
Z

Zinc blende....21, 22





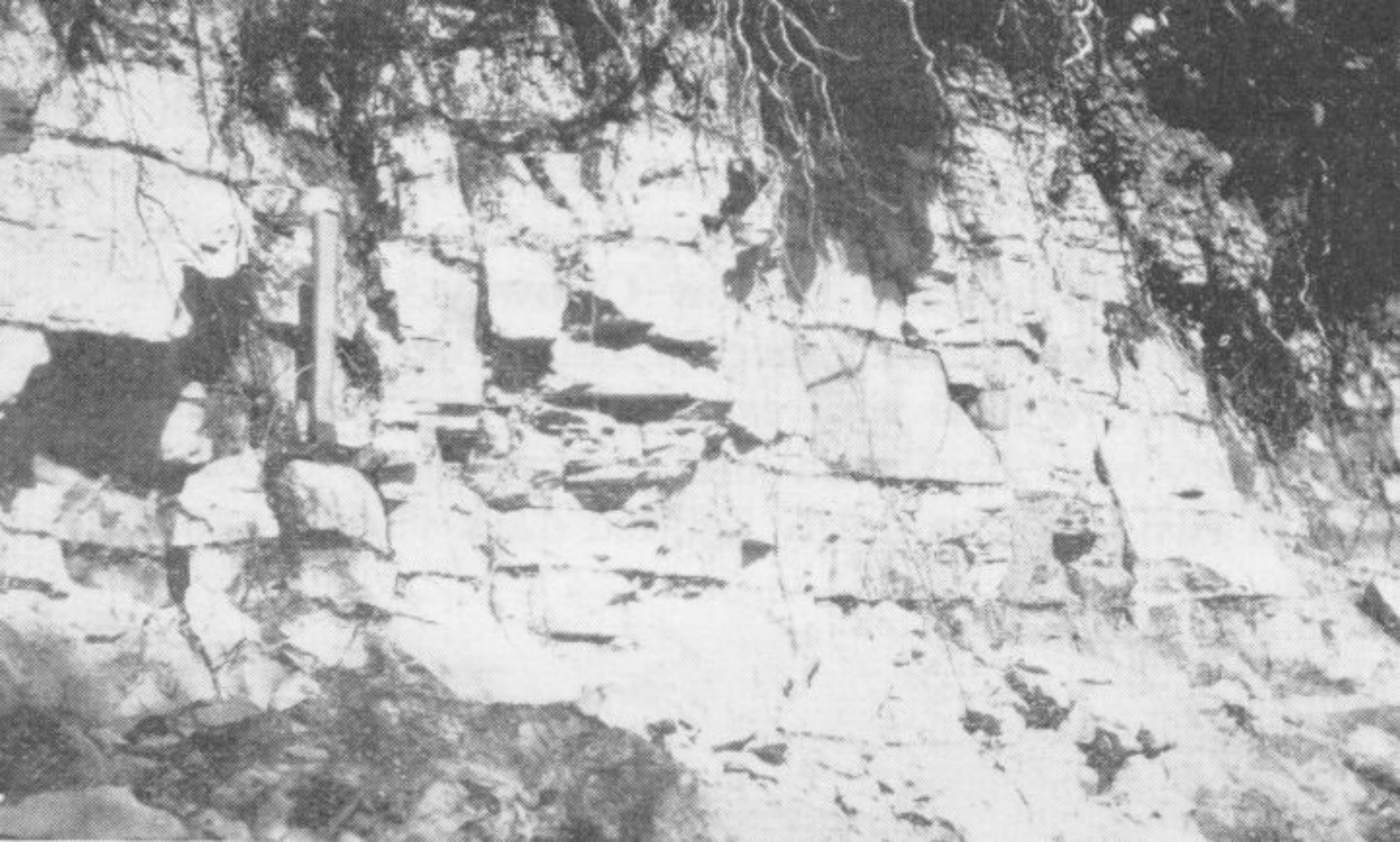



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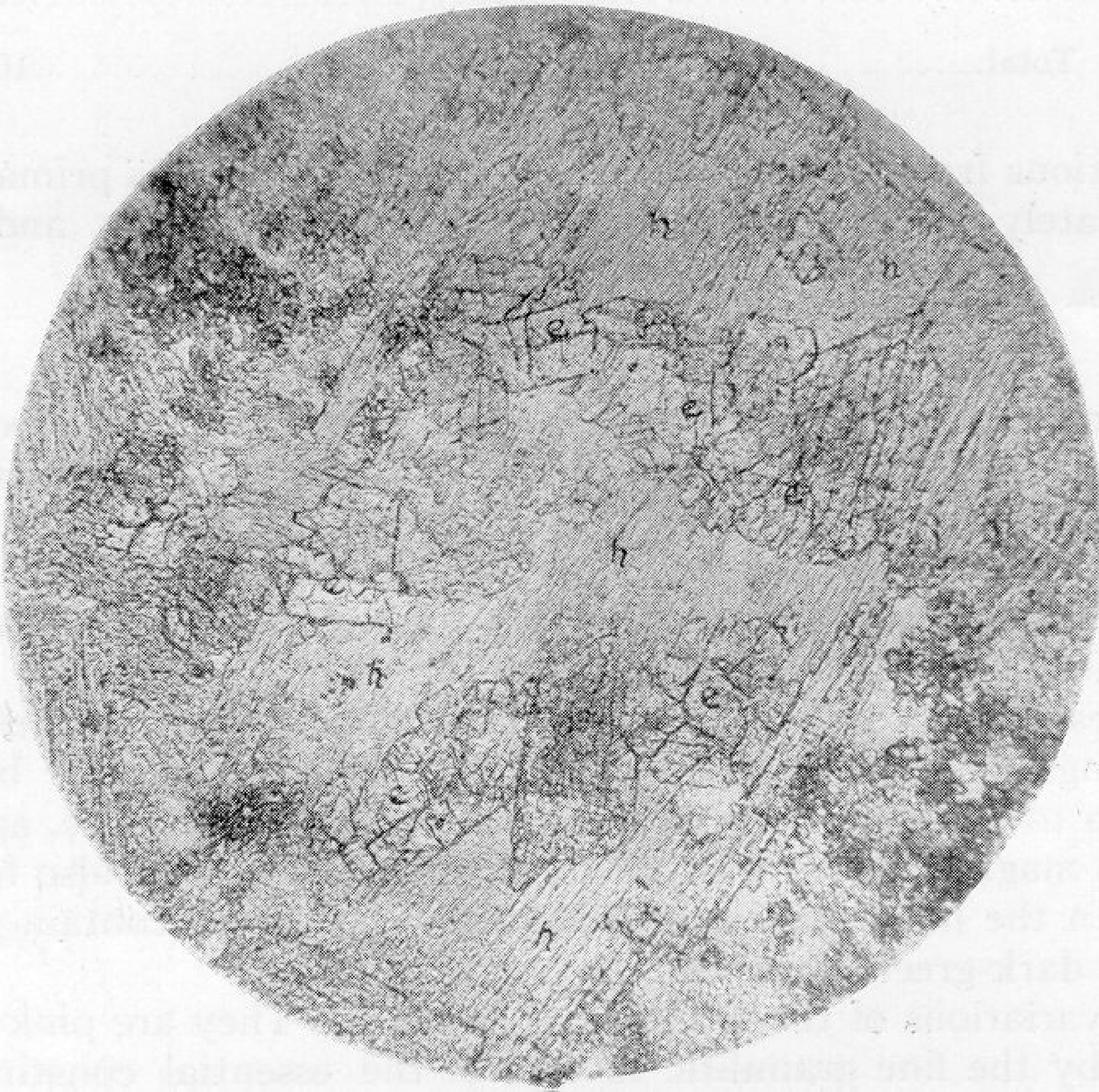


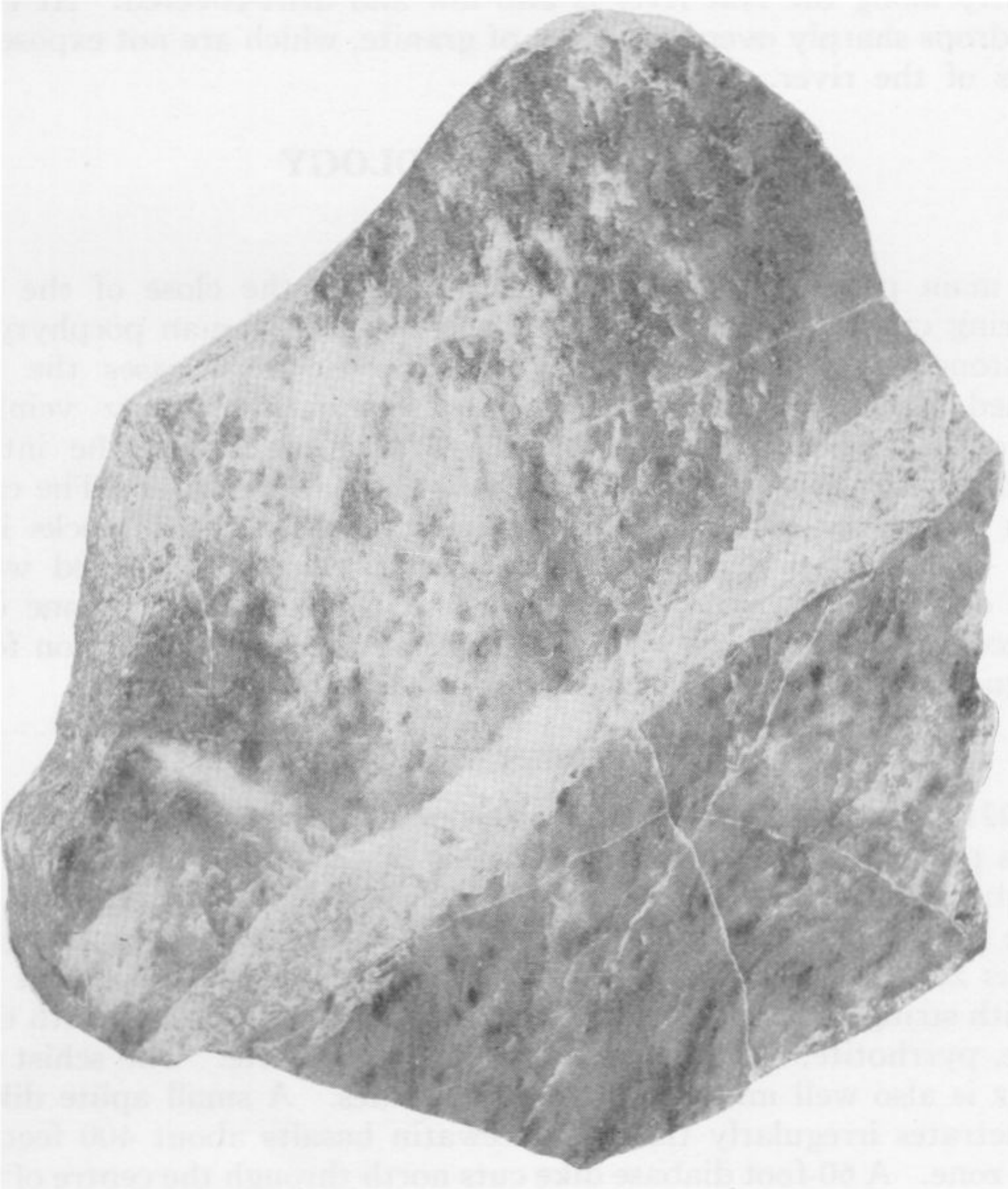


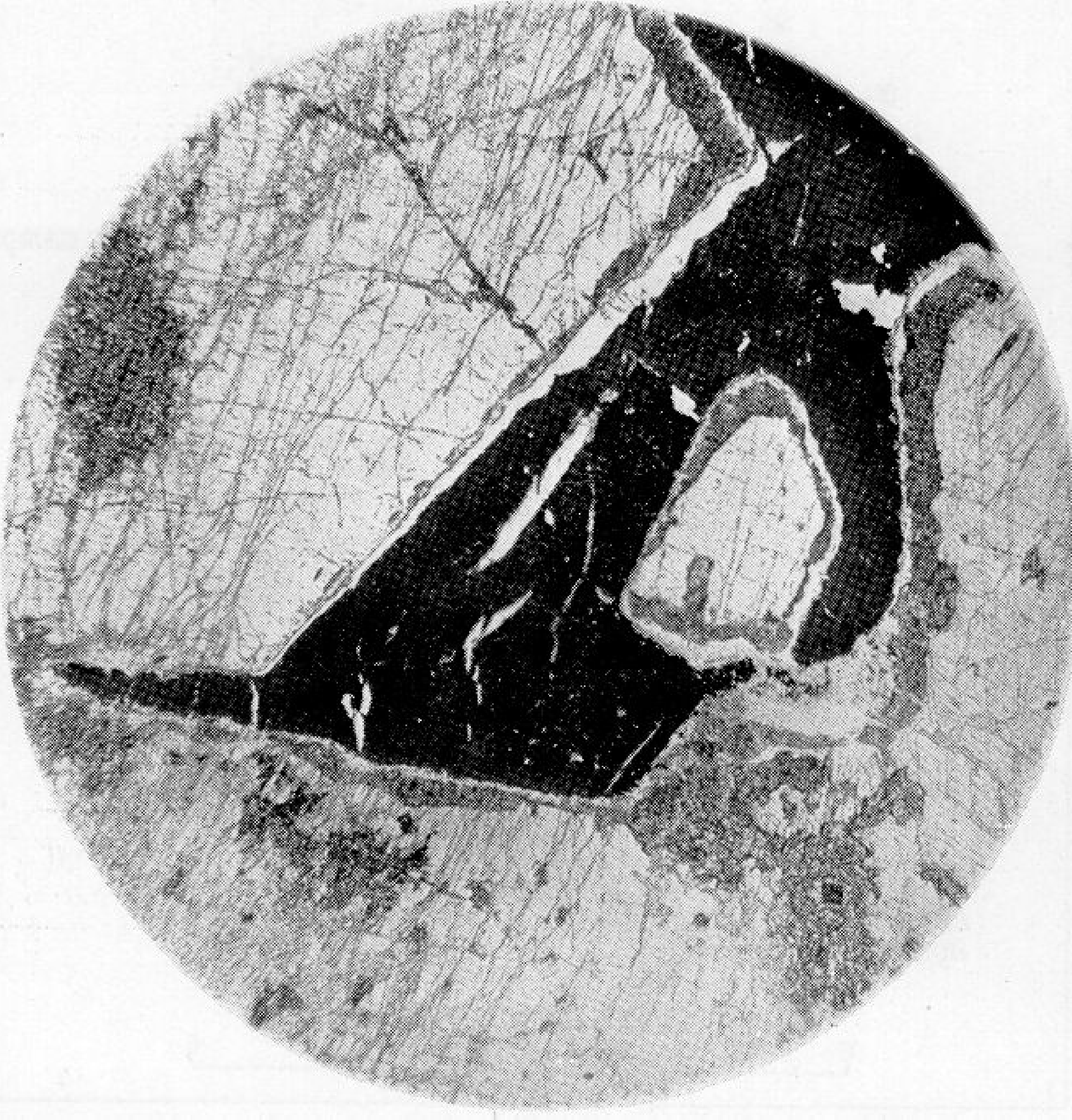


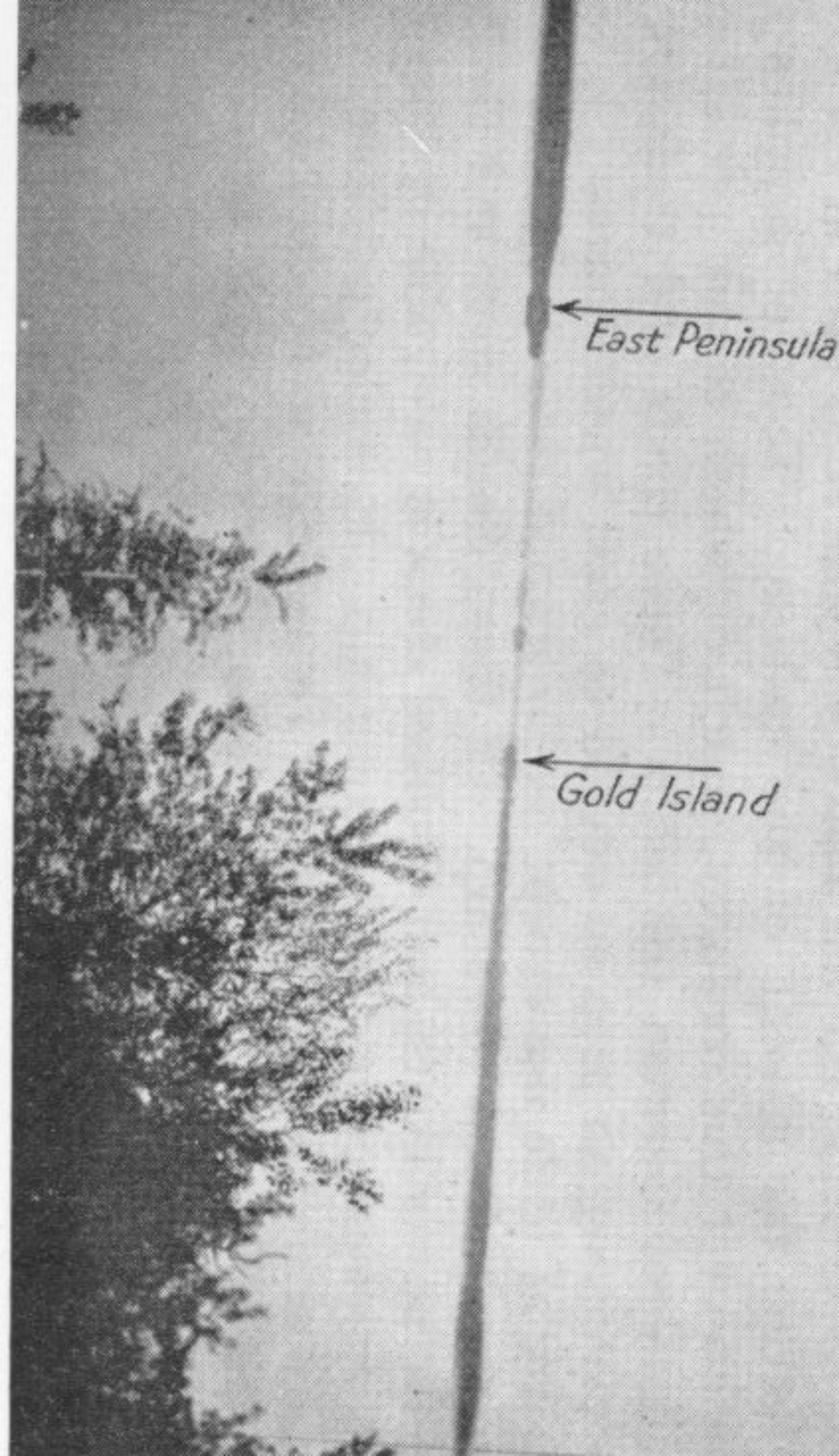




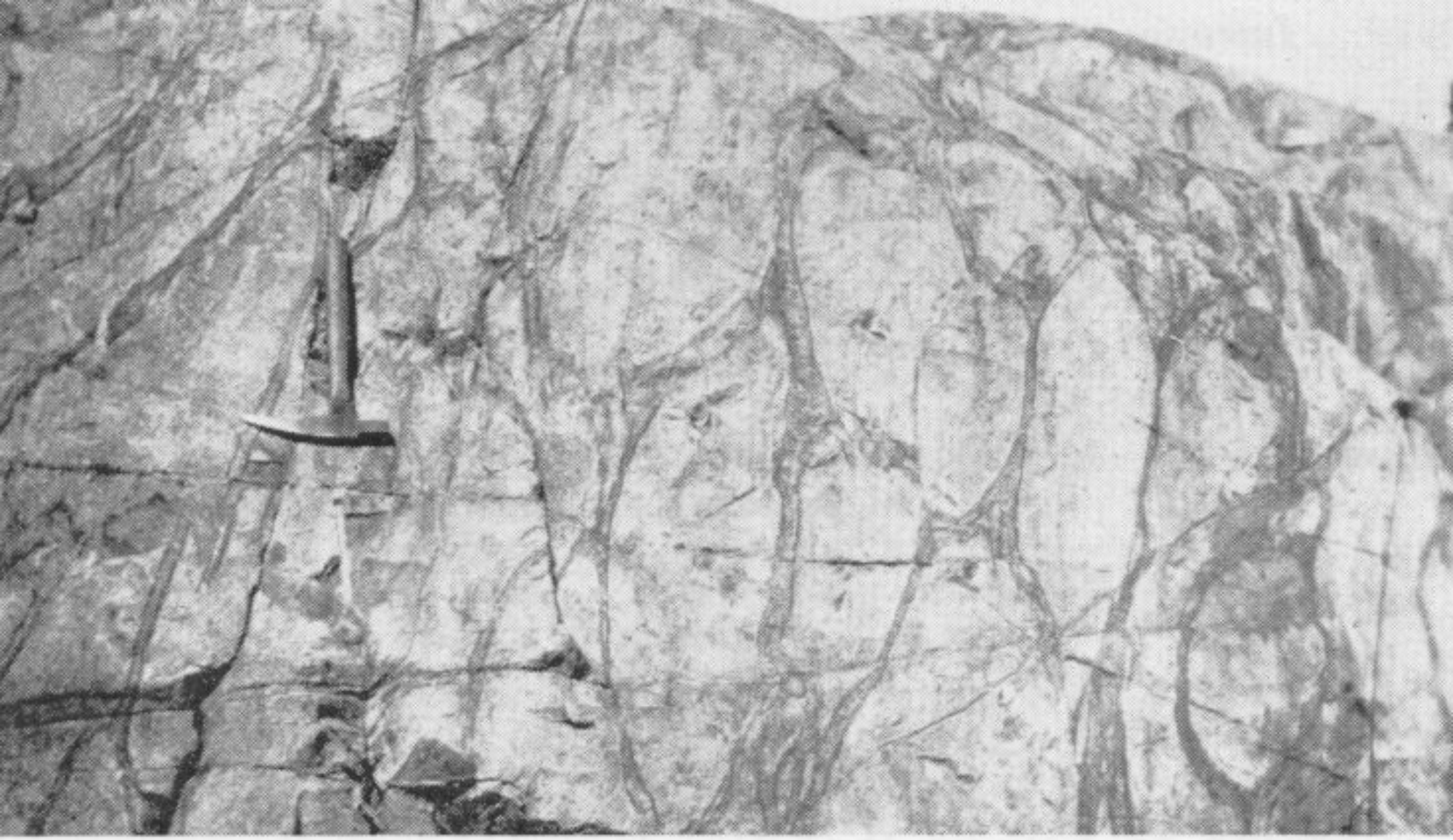







East Peninsula
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FORTIETH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XL, PART IV, 1931

Goudreau and Michipicoten Gold Areas, District of Algoma, by E. S. Moore - - - - - - - 1-54

Kowkash-Ogoki Gold Area, District of Thunder Bay, by L. F. Kindle - - - - - - - 55-104

A Deposit of Titaniferous Magnetite in Angus Township, District of Nipissing, by M. E. Hurst - - - 105-110

Chromite Deposits of the Obonga Lake Area, District of Thunder Bay, by M. E. Hurst - - - - 111-119

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TABLE OF CONTENTS

Vol. XL, Part IV

GOUDREAU AND MICHIPICOTEN GOLD AREAS

	PAGE
Introduction	1
Acknowledgments	2
Previous Work	2
Topography	3
Stratigraphic Geology	4
Keewatin	4
Acid Volcanics	5
Basic Volcanics and Intrusives	6
Iron Formation	7
Laurentian (?)	7
Doré Series (Timiskaming ?)	8
Algoman	8
Granite	8
Syenites	9
Granodiorite, Diorite, and Porphyrite	10
Quartz and Feldspar Porphyries	11
Lamprophyres	12
Keweenawan	12
Pleistocene	13
Structural Geology	15
Faulting	16
Igneous Intrusions	17
Economic Geology	17
Gold	18
Types of Gold Deposits	18
Description of Properties in the Goudreau Area	20
Goudreau Gold Mines, Limited	20
Barnes	25
Kozak	25
Kremzar	26
Michael Syndicate	30
McCarthy-Webb	32
Claim No. 2,138	35
Cline Canadian	35
Jackfish Lake	35
Towagmac	36
Description of Properties in the Michipicoten Area	36
Minto Gold Mines, Limited	36
Minto Mine	37
Jubilee Mine	38
Cooper Mine	39
Parkhill	39
Claim A. C. 2,301	41
Lead	41
Iron Ore and Pyrites	42
Nature and Origin of the Iron Ranges	42
Description of the Iron Deposits	47
Ruth	48
Pyrite Properties	50
Suggestions to Prospectors	51
Hydro-Electric Power Sites	52

KOWKASH-OGOKI GOLD AREA

	PAGE
Introduction	55
Acknowledgments	55
Previous Work	55
Bibliography	56
Access	56
Physiography	57
Forests and Fires	58
Agriculture	59
Fish and Game	59
Water-Power Sites	61
General Geology	61
Geological History	62
Structure	63
Folding	63
Fracturing and Shearing	64
Faulting	65
Metamorphic Derivatives	66
Ferruginous Carbonates	67
Stratigraphy	68
Marshall Lake Series	68
Keewatin	71
Basic Greenstone	71
Serpentine	71
Diabase, Gabbro, Granodiorite, Quartz Diorite	72
Rhyolite	74
Rhyolite Tuff, Agglomerate, Slate, Conglomerate	75
Iron Formation	76
Laurentian	77
Granite Gneiss and Granite	77
Timiskamian	77
Algoman	78
Granite	78
Syenite	79
Lamprophyre	79
Feldspar Porphyry	80
Quartz Porphyry	80
Pegmatite Dikes	81
Matachewan Diabase	82
Keweenawan Diabases	83
Pleistocene	84
Recent	86
Economic Geology	86
Types of Mineral Deposits	87
Gold	87
Silver	88
Copper	88
Pyrrhotite	89
Iron	89
Pyrite	89
Ground for Prospecting	90

Economic Geology—*Continued* PAGE
Principal Mining Prospects ... 90
Gold ... 90
Tashota Gold Mines, Limited ... 90
Cameron and Picotté ... 93
Geo. H. Adair ... 94
Kipper-Tashota ... 94
King-Dodds ... 96
Tash-Orn Mines, Limited ... 96
Cline ... 97
Richardson-Loudon-Ogilvie ... 97
Devanney ... 97
Kipper-Cameron ... 97
Canada Mines Syndicate ... 98
Kenty ... 98
Currie ... 98
Johnson ... 99
Brett-Trethewey ... 99
Russell Cryderman ... 99
Robert Wells ... 100
Copper ... 100
Holland-Chellew ... 100
J. Perry ... 102
Northern Airways Mining and Exploration Company ... 102
Principal Mining Prospects—*Continued* PAGE
Pyrrhotite ... 103
Colpitts Lake ... 103
South Shore of Meta Lake ... 104
South Shore of Marshall Lake ... 104

TITANIFEROUS MAGNETITE IN ANGUS TOWNSHIP

Introduction ... 105
Location and Means of Access ... 105
General Geology ... 105
Granite Gneiss ... 106
Diabase ... 106
Age Relationships ... 107
Description of the Deposit ... 107

CHROMITE DEPOSITS OF THE OBONGA LAKE AREA

Introduction ... 111
General Geology ... 113
Economic Geology ... 113
Description of the Deposits ... 117
Consolidated Chromium Corporation 117
MacDonald Property ... 119

ILLUSTRATIONS

Aerial view of Muriel Lake terrain, looking northwest ... *frontispiece*
Specimen of brecciated silica of the banded iron formation, Helen mine ... 7
Algoman porphyry dike south of Miller lake ... 11
Folding and faulting in banded siliceous iron formation, Ruth lake ... 15
Typical lode structure on the McCarthy-Webb property, showing mineralized zones in a monzonitic formation ... 19
Mill and shaft-house, Goudreau Gold Mines ... 20
Vein of high-grade gold ore on the Kremzar property ... 27
Auriferous quartz veins in green schist, Kremzar property ... 30
Transverse quartz-tourmaline vein, McCarthy-Webb property ... 33
Shafts Nos. 2 and 3, Cline Canadian property ... 35
New mill and shaft-house at the Minto mine ... 37
The Jubilee mine on Jubilee lake ... 38
Specimen of brecciated silica of the banded iron formation, Nichols Chemical Company ... 43
Bethlehem Steel Corporation's diamond-drill camp on Leg lake ... 48
Nichols Chemical Company, "C" pit, near Nicho lake ... 51
Old and new power-houses of the Algoma District Power Company, High Falls ... 54
Sand cliff on the northeast shore of Marshall lake ... 58
View of the cone hill between Albert falls and O'Sullivan lake ... 59
Falls on the Kapikotongwa river, three miles above Percy lake ... 60
Potato garden at Frank Gagnon's trading post, Briarcliffe lake ... 60
Falls on the Little Current river four miles above Percy lake ... 61
Slickenside groove in quartz porphyry dike on the Cameron-Picotté claims ... 64
Garnetiferous schist and pyrrhotite gossan at Iron lake ... 65
Garnet schist between the south and north pyrrhotite deposits, Iron lake ... 66
Green-banded carbonate rock north of the shear zone on the Cameron claim ... 67
Marshall Lake series outcropping on an island in Marshall lake ... 68
Cross-bedding in the Marshall Lake series on the Nass lake portage ... 69
Keewatin(?) old diabase on the island in Kupfer lake ... 70
Jointing in a feldspathic igneous sheet on the east shore of Iron lake ... 72
Thin section of a feldspathic igneous sheet on the east shore of Colpitts lake ... 73
Thin section of rhyolite or sedimentary schist from claim K. K. 1,895 ... 74
Matachewan porphyritic diabase dike, north of the Onaman river ... 82
Thin section of Matachewan diabase, north of the Onaman river ... 83
Contact of two diabase dikes of Keweenawan age on an island in Ogoki lake ... 84
Gravel pit at Cavell showing cross-bedding and a horizontal bed of glacial conglomerate ... 85
Stamp mill on the claims of P. B. Cameron and J. A. Picotté ... 87
Shaft at the Tashota mine ... 90
Polished surface of ore from the Cameron-Picotté claims ... 93

E. J. Holland and Charles Chellew at No. 1 pit of claim K.K. 1,895 101
Polished surface of a specimen of pyrrhotite from the west shore of Colpitts lake 103
Photomicrograph of thin section of diabase, O'Connor property 106
Glaciated exposure of titaniferous magnetite, O'Connor property 109
Photomicrograph of a thin section of ore, O'Connor property 110
Camp of the Consolidated Chromium Corporation at Chrome lake 111
Photomicrograph of serpentine rock containing disseminated chromite 114
Photomicrograph of massive chromite rock 114
Photomicrograph of serpentine rock containing chromite, used in analysis No. 1 116
Photomicrograph of chromite rock used in analysis No. 3 116
Surface plant at No. 1 shaft, Consolidated Chromium Corporation 118

SKETCH MAPS, DIAGRAMS, AND SECTIONS

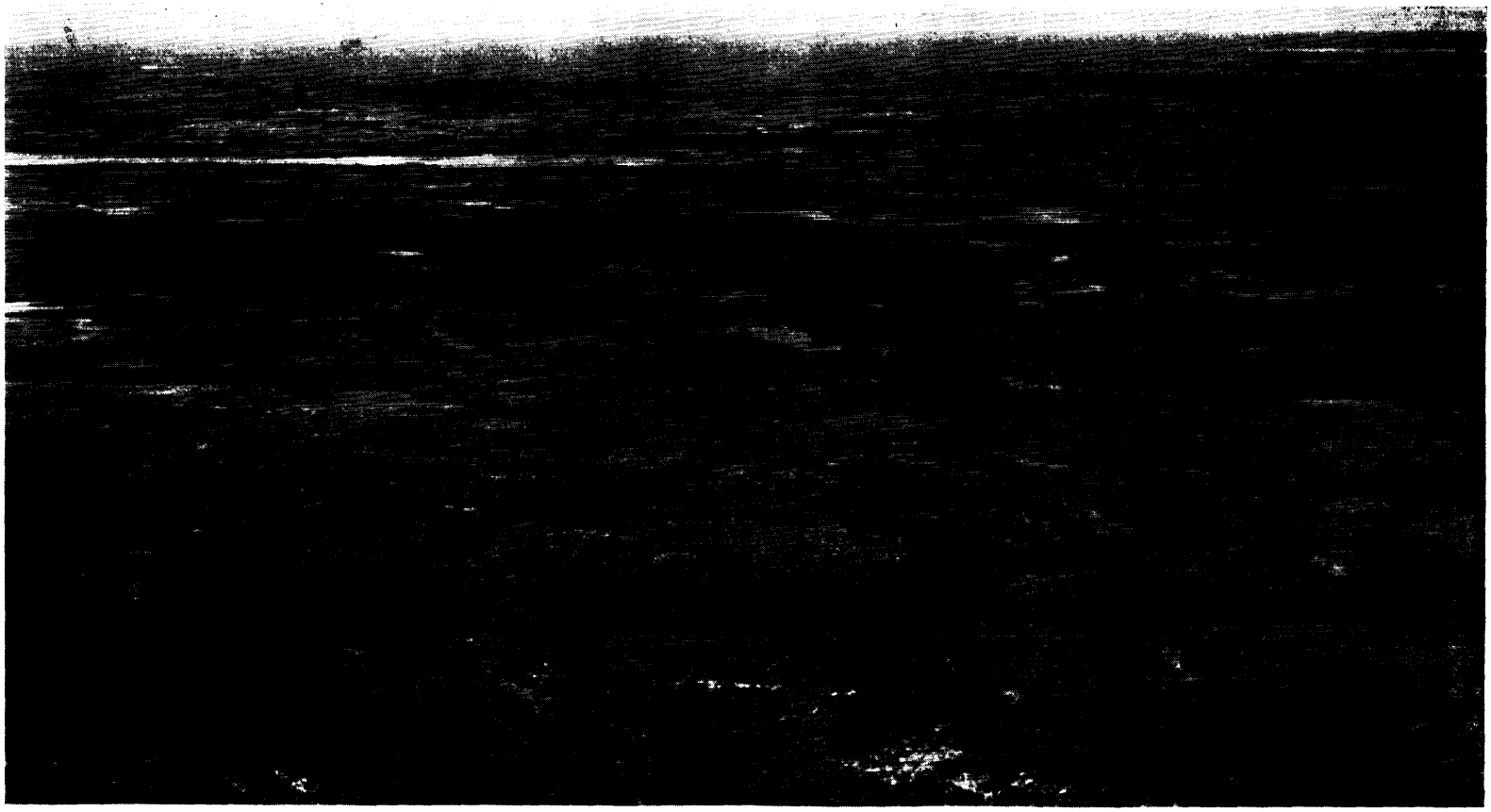
Key map showing location of the Goudreau gold area 1
Geological sketch map showing the main vein, Goudreau Gold Mines 22
Geological sketch map showing part of the Kremzar group 28
Geological sketch map of mining claims in township 48 ..... *insert facing* 30
Geological sketch map showing part of the McCarthy-Webb property 34
Geological sketch map of Parkhill Gold Mines ..... *insert facing* 40
Cross-section through "C" pit, Nichols Chemical Company 44
Sections illustrating the form of the pyrite deposits on Morrison No. 3 property 46
Sketch map of the Ruth property showing a portion of the surface outcrop of the ore body 49
Dam site at High Falls, Michipicoten river 53
Key map showing location of the Kowkash-Ogoki gold area 57
Sketch map showing geology at Tashota Gold Mines property ..... *insert facing* 90
Sketch map showing the geology of veins on the Cameron-Picotté property 92
Vertical section at trench 22; diagrammatic sketch showing south vein system; and vertical section of west face, 200-foot level, Tashota Gold Mines ..... *insert facing* 92
Sketch map showing geology three-quarters of a mile north of Tashota lake ..... *insert facing* 94
Sketch map showing geology in the vicinity of the shaft on the Kipper-Tashota property 95
Sketch map showing geology on the King-Dodds property ..... *insert facing* 96
Sketch map showing geology on some of the Holland-Chellew claims 100
Detail of Muriel Lake area ..... *insert facing* 100
Diagrammatic sketch of magnetic dip-needle readings on claim K. K. 1,895, Holland-Chellew group 102
General geology in the vicinity of the O'Connor magnetite property ..... *insert facing* 106
Plan showing the exposures of magnetite on claim W. D. 403 108
Map showing the canoe route from Collins station to Chrome lake 112
Sketch map showing the geology in the vicinity of the chromite deposits at Chrome lake ..... *insert facing* 116
Plan showing position of chromite bodies, Consolidated Chromium Corporation ..... *insert facing* 118
Vertical section, No. 1 shaft, Consolidated Chromium Corporation ..... *insert facing* 118

COLOURED GEOLOGICAL MAPS

(In pocket at back of report)

Map No. 40*e*—Goudreau Gold Area, District of Algoma, Ontario. Scale, one-half mile to the inch.
Map No. 40*f*—Kowkash-Ogoki Area, District of Thunder Bay, Ontario. Scale, 2 miles to the inch.

To accompany report by L. F. Kindle, page 55.



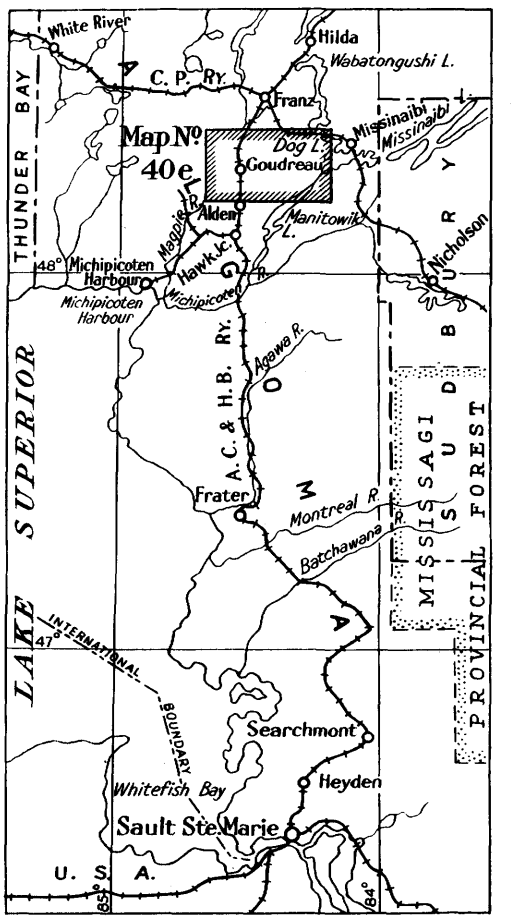
Aerial view of Muriel Lake terrain, looking northwest. A—Island in Muriel lake where granodiorite transition to diorite occurs. B—Location of the gossan zones and pits on the Holland and Chellew claims. C—North arm of O'Sullivan lake.

Goudreau and Michipicoten Gold Areas, District of Algoma

By E. S. Moore

INTRODUCTION

The Goudreau gold area, in the district of Algoma, is about 4 miles wide and stretches 15 miles northeast and 7 miles southwest from the village of Goudreau, a station on the Algoma Central and Hudson Bay railway 187 miles north of



Key map showing location of the Goudreau gold area. Scale, 35 miles to the inch.

Sault Ste. Marie, Ont. From Goudreau a motor road runs about 4½ miles west to the Goudreau mine and east to the Cline Canadian property, from which point some years ago a road was opened to Lochalsh, on the Canadian Pacific railroad not far from Dog lake at the east end of the mineral belt, but it was not completely graded and is now closed.

This area was mapped by T. L. Gledhill as the Goudreau-Lochalsh gold area; but since practically all mining operations at the present time centre in Goudreau, that name has been adopted in this report. It includes part of the Michipicoten and Missinaibi areas as mapped by the Geological Survey of Canada.

The geological survey of the Goudreau area, completed during the summer of 1930, was undertaken for the purpose of preparing a more detailed map than had previously been made. The larger scale (half a mile to the inch) of the accompanying map, No. 40*e*, has made possible the separation of the Keewatin system into more divisions and a clearer distinction between the acid rocks of the Algoman and Keewatin than has been possible on previous maps.

The Michipicoten gold area as described in this report lies south and southeast of Wawa lake in the district of Algoma. The time available for field work did not permit of the preparation of an areal map of this area, which has been partly mapped by other geologists, but new developments were investigated and detailed work was done on individual properties.

Acknowledgments

The writer is indebted to many persons in Sault Ste. Marie and in the areas investigated for valuable assistance and for hospitality while engaged in the field work for this report. Special acknowledgment is made of a service rendered by C. R. Kenny, Ontario Land Surveyor, of Sault Ste. Marie, in granting the use of his valuable map of the mining claims in the Michipicoten-Goudreau-Lochalsh mineral belt. In compiling this map, Mr. Kenny has rendered a great service to those working in this region. G. W. McLeod, mining engineer of the Algoma Central and Hudson Bay railway, as on former occasions, furnished much valuable information on mining developments. Patice Kremzar and Gordon L. Michael, who for many years have carried on prospecting operations in the region, and George Cowie, mining department, Algoma Steel Corporation, very kindly placed their cabins at the disposal of the writer and his party while they were working east of Goudreau.

To his assistants, J. D. Wright, W. E. White, and C. E. Green, acknowledgment is made of efficient services rendered in the field. The courteous assistance of officials of the various mining companies and prospectors engaged in development work in the areas visited is recognized in the description of their properties.

Previous Work

A great deal of geological work has been done in these areas by geologists of the Ontario Department of Mines and the Geological Survey of Canada, and the geologists and mining engineers of various mining companies. The following is a selected bibliography from the large number of reports that deal with the areas under discussion. A more complete bibliography may be found in Memoir 147, Geological Survey of Canada.

A. P. Coleman and A. B. Willmott, "The Michipicoten Iron Region," Ont. Bur. Mines, Vol. XI, 1902, p. 152.

A. P. Coleman, "Iron Ranges of Eastern Michipicoten," Ont. Bur. Mines, Vol. XV, pt. 1, 1906, p. 173.

E. L. Fraleck, "Iron Pyrites in Ontario," Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, p. 149.

A. W. G. Wilson, "Pyrites in Canada," Can. Dept. Mines, Mines Branch, Pub. No. 167, 1912.

A. L. Parsons, "The Productive Area of the Michipicoten Iron Ranges," Ont. Bur. Mines, Vol. XXIV, pt. 1, 1915, p. 185.

W. H. Collins, "The Ore Deposits of Goudreau and Magpie-Hawk Areas in Michipicoten District," Geol. Surv. Can., Sum. Rept., pt. E, 1918, p. 4.

A. G. Burrows, "Goudreau Gold Area, Ontario," Can. Min. Jour., Aug. 5, 1921, p. 621.

Ellis Thomson, "Goudreau Gold Area, Michipicoten District, Ontario," Geol. Surv. Can., Sum. Rept., pt. D, 1921, p. 17.

A. P. COLEMAN, "Glacial and Post-Glacial Lakes in Ontario," University of Toronto Studies, Geol. Series, No. 21, 1922.

W. H. COLLINS, T. T. QUIRKE and ELLIS THOMSON, "Michipicoten Iron Ranges," Geol. Surv. Can., Mem. 147, 1926, pp. 1-141.

G. W. MCLEOD and G. S. COWIE, "The Goudreau Gold Area," Bull. Can. Inst. Min. and Met., March, 1926, p. 393.

T. L. GLEDHILL, "Michipicoten Gold Area, District of Algoma," and "Goudreau-Lochalsh Gold Area, District of Algoma," Ont. Dept. Mines, Vol. XXXVI, pt. 2, 1927.

L. J. WEEKS, "Michipicoten River Map-Area, Algoma District, Ontario," Geol. Surv. Can., Sum. Rept., pt. C, 1928, pp. 1-11.

In the preparation of this report the geological maps of the Michipicoten and Missinaibi areas accompanying Memoir 147 of the Geological Survey of Canada have been of great assistance and were used as a base for the accompanying map. Tribute is paid to the excellent field work of Collins and his associates in the preparation of these maps and the report on the iron formations. The petrographic work of Gledhill in his reports on the Michipicoten and Goudreau-Lochalsh areas is also deserving of special mention for unravelling some of the intricate relations of the igneous rocks of these areas.

Topography

The altitude of Goudreau station on the Algoma Central and Hudson Bay railroad is 1,208 feet. The railroad shows a marked grade ascending from Lake Superior at Michipicoten Harbour to Hawk Junction. From Hawk Junction to Goudreau, 13 miles along McVeigh creek, the difference in altitude is 172 feet; whereas the difference in elevation between Goudreau and Franz, which is 17 miles farther north, is only 5 feet. As these figures indicate, there is a rapid rise in elevation from Lake Superior, the surface of which is 602 feet above the sea, to Goudreau, and that village is practically on the plateau-like area that extends to the north, east, and west. South of Goudreau the hills become higher and the country is much more rugged than to the north.

The Michipicoten and Goudreau areas present the characters of a peneplain, or plain formed by erosion. This has been deeply dissected by the streams flowing into Lake Superior. The rugged topography north and east of Lake Superior, where the sand plains are practically restricted to the valleys, grades upward into a plateau-like area where there are broader plains of sand and gravel and where the hills do not rise nearly so high above the general level. There are many high waterfalls in the zone about 10 to 20 miles wide bounding the northeast shore of Lake Superior. Beyond this, the falls are few and small, due largely to the fact that the streams entering Lake Superior in this region are youthful and in many cases follow new channels made since glaciation. A good illustration is seen in the Michipicoten river at High Falls where the present stream tumbles over rock for 128 feet only a few yards west of an old glacial valley, which is filled with glacial drift and post-glacial lake deposits consisting of gravel and silt. The bottom of this valley is lower than the foot of the falls. From the falls to Lake Superior the river follows the ancient valley, although it has not scoured out the drift to its bottom.

In the Goudreau area the hills rise in places to nearly 350 feet above the railroad and gradually increase in height to the south. In the Michipicoten area the topography is still more rugged, and Helen hill has an elevation of about 1,740 feet above sea-level and nearly 1,140 feet above Lake Superior, 11 miles distant. The altitude of Boyer lake at the old Helen mine is 1,250 feet, or 648 feet above Lake Superior. Helen hill is believed to be the highest point in the areas under discussion, although there are still higher hills a short distance to the west. On the whole, the Michipicoten area is exceedingly rough and rocky.

STRATIGRAPHIC GEOLOGY

The major geological features of the Michipicoten and Goudreau areas are similar. Practically the same series of rocks occurs in both areas, but there are a few marked differences in the character of some of the igneous rocks and the Doré conglomerate, which occurs abundantly in Michipicoten is relatively rare in the Goudreau area.

There has been much difference in opinion among geologists who have worked in the region regarding the age of some of the formations. The classification of the rocks by Coleman and Willmott[1] differs greatly from that of more recent writers owing to the now general application of the terms Timiskaming and Algoman in pre-Cambrian classification as well as to differences in opinion regarding the proper place of certain formations in the classification.

Collins, Quirke, and Thomson[2] considered the Doré conglomerate as Keewatin lying between volcanic series of this age. This necessitated placing the granite composing the boulders and pebbles of this conglomerate in the Keewatin also and assigning to it a greater age than that of any granite previously recognized in Canada. Gledhill[3] mapped the Doré series as probably Timiskaming. With this classification the writer[4] is inclined to agree because of the position of this conglomerate with respect to similar conglomerates in other areas. If it is Timiskaming there are probably considerable thicknesses of lavas in this series overlying the conglomerate, and the granite boulders and pebbles in this formation would be derived from the Laurentian granite as in many other areas. The problem of age is, however, not finally settled. The following classification of the formations has been adopted for this report:—

Table of Formations

QUATERNARY	
RECENT:	Alluvium.
PLEISTOCENE:	Glacial drift and lake deposits consisting of stratified gravel, sand silt, and clay.
PRE-CAMBRIAN	
KEWEENAWAN:	Olivine diabase and peridotite. Diabase and quartz diabase.
ALGOMAN:	Lamprophyre and aplite dikes. Gold-bearing veins. Granite, granodiorite, porphyrite, monzonite, alaskite, syenite (including nepheline and cancrinite varieties), quartz porphyry, and feldspar porphyry.
TIMISKAMING(?):	Doré series: conglomerate, arkose, greywacké, tuff, and basic lavas.
LAURENTIAN(?):	Granite and gneiss.
KEEWATIN:	Basic and acid volcanics (basalt, andesite, rhyolite, quartz porphyry, feldspar porphyry), tuff and schistose equivalents of these rocks. Banded iron formation, siderite, dolomite, and limestone.

Keewatin

The Keewatin formations are widely distributed over both the Goudreau and Michipicoten areas. They are apparently of great thickness, and the period was one of profound volcanic activity. The chief rocks are basic to intermediate and acid lavas.

[1]A. P. Coleman and A. B. Willmott, "The Michipicoten Iron Region," Ont. Bur. Mines, Vol. XI, 1902, p. 155.

[2]W. H. Collins, T. T. Quirke and Ellis Thomson, "Michipicoten Iron Ranges," Geol. Surv. Can., Mem. 147, 1926, pp. 11-13, 41.

[3]T. L. Gledhill, "Michipicoten Gold Area, District of Algoma," Ont. Dept. Mines, Vol. XXXVI, pt. 2, 1927, p. 10.

[4]E. S. Moore, "Keewatin-Timiskaming Boundary," Bull. Geol. Soc. Amer., Vol. 40, 1929, p. 547.

These rocks are interbedded to a considerable extent in some parts of these areas, but the wide distribution of one type of rock in other sections indicates that only one type of lava was extruded there. For example, south of Goudreau on the east side of McVeigh creek there is nothing but acid lavas for several miles, while to the north of the village the basic lavas cover practically the whole surface where Keewatin rocks are exposed. It seems practically certain that the acid rocks were here extruded first, the opposite condition to that found in the majority of Keewatin areas in the Canadian shield. In the Michipicoten area the basic volcanics are usually the older of the two types. Collins and Quirke[1] have worked out the stratigraphic relations of the lavas from observations of their position with respect to the iron formations, which is as follows, in order from bottom to top: acid lava or tuff, carbonate, pyrite, banded iron formation, basic lava. The writer also found this relation to hold for most of the sections where iron formation occurs.

Acid Volcanics

The acid volcanics are much alike throughout the Keewatin. There are three common types of lava: rhyolite, feldspar porphyry, and quartz porphyry. The fresher parts of the porphyries are distinguished with difficulty from some of the schisted and carbonated intrusions of the same varieties of rock of Algoman age. It is impossible to distinguish them in all cases in the field, but where one is found cutting the other a microscopic examination of thin sections shows that the Keewatin porphyry is more altered chemically, the feldspars being more sericitized or carbonated and the ferromagnesian minerals more completely changed to chlorite. When dynamically metamorphosed, the acid types have been changed to sericite schists, which are usually carbonated more or less. In some cases the carbonates comprise a high percentage of their total volume. Grains of pyrite, and in some cases magnetite, are found in practically all thin sections of these rocks, having been introduced by circulating waters.

A chlorite-like mineral resembling ottrelite is quite abundant in some of these acid rocks, although a comparatively rare species elsewhere. It was recognized and described by Collins and Quirke[2] when they studied this area. It is very common in the area to the east and southeast of Goudreau where it may be recognized as crystals resembling those of black hornblende. Specimens may be found on the south side of the Rand pyrite pits. It was found in quartz and feldspar porphyry, in schists derived from these rocks, and in an acid tuff near the north end of Emily lake. The mineral when examined under the microscope is polysynthetically twinned parallel to the elongation of the crystal and normal to the C axis. The cleavage is good normal to the C axis, with a prominent fracture to good cleavage normal to the basal cleavage. A common feature of many of the crystals is a distinct straight edge on the basal side of the crystal and a badly frayed edge on the prismatic side. Many of the crystals are sieve-like in appearance. The crystals are single or in groups, and when grouped frequently assume a fan-like arrangement. The colour of the mineral is bluish-green, and it is distinctly pleochroic. The pleochroism is: A = green, B = bluish-green to light-blue, C = yellowish-green to greenish-yellow. In an examination of this mineral made for Collins and Quirke, Poitevin found that its refractive index for B is only 1.708+0.005, compared with 1.741 for ottrelite. Most of its properties correspond with those of ottrelite, however, and it is apparently a variety of this mineral.

[1]Geol. Surv. Can., Mem. 147, pp. 51-56.
[2]Geol. Surv. Can., Mem. 147, p. 29.

In speaking of its occurrence in some of the porphyries, Collins and Quirke point out that the mineral has not been regarded as a primary constituent of igneous rocks elsewhere but state, "On the whole there seems excellent ground for believing it to be a primary constituent of the porphyry." The slides examined by the writer all point to the metamorphic origin of the mineral. Where the porphyries in which it occurs are schisted, as most of them are more or less, the crystals of ottrelite in many cases disregard the schistosity. They may lie in all directions in distinct schist, like phenocrysts of biotite formed under mass-static conditions. In some schists the ottrelite appears to have developed along the lines of schistosity contemporaneously with carbonate and other secondary minerals. Its occurrence in a tuff and in the carbonate of the iron formation, the latter occurrence mentioned by Collins and Quirke, seems to point to its development as a metamorphic rather than as a primary mineral. It has not been found in porphyries considered as Algoman, and this fact combined with the common occurrence of tourmaline in the Algoman porphyries, particularly near veins, may in some cases be used as a means of distinguishing schistose phases of the Keewatin porphyries in certain areas from those of Algoman age.

In the Michipicoten area there is much acid tuff in the Keewatin, but comparatively little of this rock was recognized in the Goudreau area. Some was found with the acid lavas on the east side of Emily lake near the north end, and there is a narrow band southwest of Goudreau on claim A.C. 516. Around Wawa lake there is a great thickness of this rock, and Coleman and Willmott[1] named the formation the Wawa tuff. This formation consists for the most part of pyroclastic material similar to the acid volcanics in composition, the fragments being chiefly of feldspar and quartz, which range in size from the finest particles of ash to those several inches in diameter. There is, on the whole, little evidence of stratification, but in some places lamination and banding may be seen.

Basic Volcanics and Intrusives

The basic volcanics in these areas are very similar to Keewatin greenstones elsewhere. They are all greatly altered to secondary minerals, including chlorite, uralite, serpentine, epidote, zoisite, biotite, carbonate, and leucoxene. Magnetite and pyrite have been introduced in many cases. The pyroxenes are almost entirely replaced by secondary amphibole, and the feldspars are in most cases saussuritized. Ilmenite may be partially or completely altered to leucoxene. The original rocks appear to have been basalt, andesite, diorite, and diabase. In the field some of the coarser phases of these rocks resemble the more recent Keweenawan diabases, but as a rule in thin sections they show much greater alteration than the Keweenawan rocks. In the hand specimen they are usually greener in colour and the crystals are less distinct owing to greater alteration. In some areas the basic volcanics are squeezed into chlorite schists, in others they are quite massive. Dark tuffs squeezed into mica schists are mingled with the lavas in parts of the Michipicoten area.

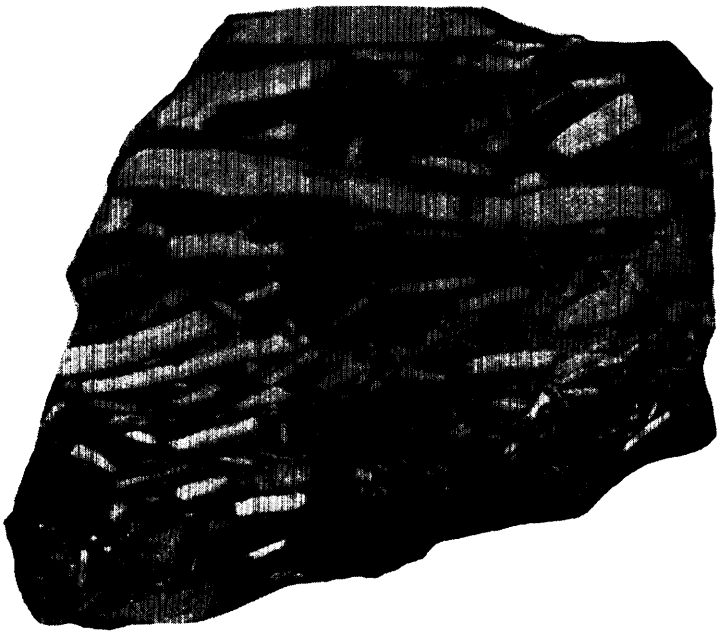
Pillow or ellipsoidal greenstones are abundant, especially in the vicinity of Goudreau, and large sections of the Goudreau area are covered with these rocks. Between Spring and Maskinonge lakes the pillows very commonly contain a nucleus of lava a little lighter in colour than the enclosing rock and ranging from 2 to 10 inches in diameter. These fragments vary greatly in shape and appear to be fragments of chilled lava rolled up in more fluid lava when the pillows were formed. This condition may be explained by assuming

[1]A. P. Coleman and A. B. Willmott, "The Michipicoten Iron Region," Ont. Bur. Mines, Vol. XI, 1902, p. 156.

that a hardened crust on the surface of a lava flow was broken up like ice on the surface of a stream. The fragments then became surrounded by the underlying, still liquid lava of the flow as it moved forward, becoming more viscous with cooling and rolling up into ellipsoids.

Iron Formation

There are numerous iron ranges in these areas. Most of these differ from the typical banded jasper ranges in so many Keewatin areas in that they contain great quantities of siderite and pyrite in addition to the characteristic banded silica. They occur as a rule at the contact between basic lavas above and acid lavas or tuffs below. There are, however, a number of exceptions to this rule, as some bands of iron formation occur entirely in the basic lavas. Collins and



Specimen of brecciated silica of the banded iron formation showing silica replaced by siderite and pyrite, taken from a place near the Helen mine, Michipicoten area.

Quirke considered all the iron formation found in place as younger than the Doré series, although there are a few pebbles of this formation in the Doré conglomerate. The age relations of the iron formation depend upon the position of this conglomerate. If the Doré series be regarded as infolded into the volcanics, and in this case the volcanics would be mostly Keewatin, then the iron formation also would be Keewatin. A more detailed description of the iron ranges will be found in the section of this report dealing with Economic Geology.

Laurentian(?)

In the Michipicoten area, Collins and Quirke found in place granite, granite porphyry, and gneiss, which they have regarded as the probable source of many of the pebbles and boulders in the Doré conglomerate. They consider this granite older than any granite previously recognized in the Canadian shield and, therefore, of Keewatin age. The writer raises the question as to whether this granite may not be equivalent in age to the Laurentian of other areas.

Doré Series (Timiskaming?)

The Doré series was named and first described in detail by Sir William Logan,[1] who found an important section near the mouth of the Doré river on the north shore of Lake Superior. Coleman and Willmott[2] further described it in their report on the Michipicoten iron ranges and classified it as Upper Huronian. Bell[3] also considered it Upper Huronian, but Collins and Quirke, as previously stated, moved it down into the Keewatin, and Gledhill later considered it as possibly Timiskaming in age and infolded into the Keewatin. There is very little of the series in the areas studied in detail by the writer, and he, therefore, has some hesitancy in definitely fixing its age. The main formation of the series is a thick conglomerate, which is so similar to the Timiskaming conglomerates of other areas that there are many reasons for regarding it as of that age, but a very careful study by Collins and Quirke led them to place it in the Keewatin between thick bands of volcanics; and their observations must carry much weight in a consideration of the age of this series.

The Doré conglomerate contains numerous pebbles and boulders. These fragments consist of granite, porphyry, diorite, greenstone, green schist, felsite, and iron formation. The granite boulders reach 2½ feet in diameter. Associated with the conglomerate are tuff, lavas, greywacké, and slaty material. The thickness of the series varies greatly in different sections, and Collins and Quirke estimate its thickness in different areas at from 250 to 8,400 feet. In places it overlies granite and gneiss, and the argument for placing it in the Timiskaming rather than in the Keewatin is the great break in sequence necessary to permit a deep-seated rock like granite to be uncovered by erosion and such a thick conglomerate to be deposited. If the Doré series be regarded as Timiskaming, then the granite may be Laurentian and not Keewatin in age.

Algoman

Intruding the Keewatin and Doré formations there is a complex group of igneous rocks that appears to be equivalent to the Algoman of other pre-Cambrian gold-bearing regions. These rocks have been the source of the gold in the Michipicoten and Goudreau areas and they are, therefore, of much economic importance. The intrusions are of all sizes from the great batholiths of granite to the tiny dikes of aplite and lamprophyre. They exhibit a great variety in composition. The varieties of rock of this age so far recognized are: granite, porphyritic granite, granite gneiss, granodiorite, porphyrite, monzonite, syenite, quartz porphyry, feldspar porphyry, alaskite, aplite, and lamprophyre. There are syenites of three types: a normal pink, orthoclase type and the grey nepheline and cancrinite types.

It is evident that all these varieties of rock are derivatives from a single magma, since they are all closely related to one another. The lamprophyres show considerable variation in composition, but there are gradations between the extreme types.

Granite

The eastern part of the Goudreau area is practically surrounded by granite. A large batholith runs from the Algoma Central railroad near the south end of Speight lake eastward through Manitowik lake to the Canadian Pacific railroad south of Dog lake and then northward to the northern border of the area. Where

[1]Geological Survey of Canada, Report of Progress from Its Commencement to 1863, pp. 53-55.
[2]Op. cit., p. 162.
[3]J. M. Bell, "Iron Ranges of Michipicoten West," Ont. Bur. Mines, Vol. XIV, 1905, p. 299.

seen the granite is the quartz-orthoclase-biotite variety. In some sections the contact of the granite with the Keewatin rocks is fairly sharp; in others there is extensive intermingling of these formations with numerous apophyses of granite projecting into the older rocks and much alteration of the greenstones. Dioritic phases of the greenstone, amphibolites, and hornblende schists may be seen in some localities as marginal types along the contact. The granite also varies from a massive, little altered condition, even close to the contact, to a highly gneissic state much richer than the average granite in ferromagnesian constituents. In township 28, range XXVII, on the west side of the outlet of Sherman lake, a very porphyritic phase of the granite occurs. It is a massive reddish rock crowded with crystals of orthoclase up to an inch or more in diameter. On the railroad track a short distance south of Herman lake, there is a small intrusion of muscovite-biotite granite consisting of muscovite, biotite, orthoclase, microcline, albite, quartz, and a little magnetite. There is a little carbonate in stringers and between the feldspar grains.

It appears certain that the numerous porphyry and granodiorite intrusions scattered widely over the Goudreau and Michipicoten areas are genetically connected with a great granite mass underlying much of these areas, as almost all gradations from granite to these rocks may be found. A striking feature of the granites in these areas is the scarcity of pegmatites.

Syenites

On the east side of Herman lake there are several intrusions of syenite that are apparently genetically related. One of these bodies of syenite is at the end of a large tongue of granite, which connects to the northeast with the main granite batholith. This tongue consists of nepheline and cancrinite syenite, a light-grey, coarse-grained rock spotted with dark biotite and pyroxene. Thin sections examined by the writer show no nepheline, but they contain instead considerable cancrinite. The minerals present are microcline, orthoclase, albite, biotite, and a little cancrinite. Thomson[1] described a phase of this rock as consisting chiefly of pyroxene and nepheline with minor amounts of biotite, quartz, apatite, and secondary hornblende and carbonate. He regarded it as a recrystallized Keewatin rock, the nature of which was due to the action of the granite on the older rock. Gledhill[2] considered that this alkali syenite originated from the action of granite on carbonate, since this mineral is mixed freely with biotite in some of the rock and there is a great abundance of it in the neighbourhood as small lenses and veins in the Keewatin schists.[3]

The opinion that alkali syenites commonly originate through the reaction between acid intrusions and carbonate rocks has long been held by geologists as the best explanation for their origin, but Bowen[4] considers that such rocks may originate without the influence of carbonates. According to Bowen, the rock after crystallization has begun is invaded by soda-rich solutions developed from the parent magma by differentiation. These solutions attack and partially replace the minerals already solidified. There is no definite evidence of the previous existence of a large body of carbonate on Herman lake, but there is an unusual amount of carbonate in the greenstones in that area and it is quite probable that carbonate played a rôle in the formation of the alkali syenites. The syenite was not found in actual contact with the greenstone as the intrusion is surrounded

[1]Geol. Surv. Can., Mem. 147, 1926, p. 149.
[2]T. L. Gledhill," Goudreau-Lochalsh Gold Area," District of Algoma," Ont. Dept. Mines, Vol. XXXVI, pt. 2, 1927, p. 59.
[3]For analyses, see T. L. Gledhill, op. cit.
[4]N. L. Bowen, "The Evolution of Igneous Rocks," Princeton University Press, 1929.

by low, drift-covered land. Boulders of the alkali syenite were found in the drift scattered over a considerable area southwest of Herman lake.

On the east side of Herman lake, south of the occurrence of alkali syenite, there are several intrusions of normal syenite in the greenstone. A thin section of this rock contains orthoclase, microcline, albite, biotite, a little zircon, spinel, and apatite. Carbonate occurs in small patches and stringers, and pyrite is associated with the biotite. The rock is veined with quartz, and several mineralized quartz bodies cutting the syenite have been prospected.

Granodiorite, Diorite, and Porphyrite

A number of intrusions of granodiorite occur in these areas. A large boss of this rock is found in township 28, range XXVI, just west of the Goudreau mine. This intrusion shows much variation in texture and mineral composition. Part of it is a coarse, dark-coloured rock; other parts are light-coloured and fine-grained. In some places the rock is a quartz porphyry or feldspar porphyry, and although these porphyritic phases are mostly near the border the coarse-grained rock in many places extends practically to the contact. A specimen taken from claim A.C. 412 close to the eastern contact of the boss and only 100 feet southwest of the most westerly of the pits on the Goudreau mine vein shows the following features in thin section: The rock is coarse-grained, and about 90 per cent. of its volume is plagioclase, orthoclase, and quartz. The plagioclase is more abundant than orthoclase. Muscovite, chlorite, epidote, magnetite, and carbonate are present. Another section taken west of Gutcher lake shows, in thin section, orthoclase, albite or oligoclase, quartz, epidote, and chlorite. There is much chlorite, and it appears to have been derived from biotite. In most cases the epidote occurs in groups of grains surrounded by chlorite. The feldspars, especially the orthoclase, are partly altered to sericite and kaolin.

In township 49, on the northwest side of Lovell lake, there is a smaller intrusion of the dark, coarser-grained granodiorite and there are numerous small intrusions in the Goudreau area that show gradations between the rather typical coarse-grained rock of this type and the acid porphyries.

In the gold-bearing portion of the Michipicoten area, granodiorite is very common and constitutes a large part of the Algoman intrusives extending from Wawa lake southeast to High Falls on the Michipicoten river. Associated with the granodiorite are diorite and porphyrite, apparently derived from the same magma. The diorite appears to intrude the granodiorite. A specimen taken from the southeast shore of Wawa lake, about half a mile from its outlet, is a coarse-grained, speckled rock resembling diorite. Thin sections of this rock show the feldspars much altered and ferromagnesian minerals, apparently all secondary. These are blue hornblende and epidote. There is considerable zoisite and leucoxene, the latter derived from large crystals of ilmenite almost completely altered. There is a little quartz, and the rock seems to be an intermediate type between normal granodiorite and diorite. Gledhill[1] reports several areas of diorite in the Michipicoten area.

Another rock related to the diorite occurs in Michipicoten as the country rock for gold-quartz veins. A specimen taken from the east end of the drift on the 240-foot level of the Parkhill mine shows phenocrysts of feldspar consisting of groups of crystals of plagioclase in a groundmass medium coarse in grain and consisting chiefly of brown biotite, quartz, and serpentine. The biotite

[1]T. L. Gledhill, "Michipicoten Gold Area, District of Algoma," Ont. Dept. Mines, Vol. XXXVI, pt. 2, 1927, p. 12.

appears to have been developed by metamorphism as it is in zones and patches. The quartz seems to have been introduced, and it is a question whether the feldspars have not been rearranged during metamorphism. They are largely altered to zoisite.

Quartz and Feldspar Porphyries

These rocks are very common in the Goudreau area and constitute the majority of the smaller Algoman intrusives as dikes and irregular masses breaking



Algoman porphyry dike running north-south across the strike of the greenstone, south of Miller lake. This dike is faulted or folded in several places under drift.

through the Keewatin formations. They usually follow the strike of the Keewatin rocks, but a few dikes cut these transversely. They are rather monotonous in character, consisting of phenocrysts of quartz or feldspar, orthoclase and albite, with a groundmass containing biotite, hornblende, or chlorite, in addition to feldspar and quartz. Rutile was found in small crystals in a few specimens near quartz veins apparently introduced by hot solutions. Some of the quartz phenocrysts show distinctly the effects of resorption by the groundmass. These

rocks show all variations from a massive to a schistose condition and contain crushed feldspar and quartz phenocrysts. Some specimens are quite fresh; others show much replacement by carbonate and introduction of quartz. Pyrite is a common constituent, and in most cases has been introduced by hot solutions. Tourmaline occurs near quartz veins. The quartz and feldspar porphyries show gradations to granite porphyry, granite, and in a few places alaskite, a rock devoid of ferromagnesian minerals and consisting of quartz and feldspar. In some places the porphyries show phases that practically correspond to aplite in composition. There are a few small aplite dikes in the Goudreau area. They cut the porphyries and granodiorite and are usually highly carbonated, the quartz being almost completely replaced by carbonate. These rocks weather readily to a brown colour. In the replacement of the porphyries by carbonate, there does not seem to be much difference in the ease with which quartz or feldspar is replaced, as it is sometimes one and sometimes the other that has been removed, but in the aplite dikes the quartz seems to be replaced more than the feldspar.

Lamprophyres

Lamprophyre dikes are common in the Michipicoten area as they are in many other gold-bearing areas where Algoman rocks occur. None have been found, however, in the Goudreau area. Gledhill[1] has described two types of these rocks as biotite and olivine lamprophyres. They are narrow dikes, almost always later than the gold veins, and a number of them cut the veins at the Minto mine. They are most common in the vicinity of veins and seem to be connected with post-mineral fracturing; in a few cases they appear to be earlier than the last veins formed. They seem to be a late phase of the granodiorite magma. These dikes are usually highly altered to serpentine and carbonate. A thin section examined by the writer from one of these dikes, which is about a foot wide and cuts the granodiorite on the southeast shore of Wawa lake about a mile from the outlet, shows outlines of olivine phenocrysts that are completely altered to carbonate. The remnants of olivine crystals vary greatly in size and constitute about 65 per cent. of the rock. They lie in a brownish, aphanitic matrix of indefinite composition containing scattered small crystals of reddish-brown biotite. A little quartz occurs with the carbonate. Gledhill called this rock a picrite lamprophyre. It does not seem to correspond exactly to any of the varieties of rock named in the texts on petrography. It is perhaps most like a picrite porphyry, but since there are gradations between this rock and the more typical biotite lamprophyres of the same area it may not be amiss to call it picrite lamprophyre.

Keweenawan

Diabase dikes of Keweenawan age are very numerous in the Goudreau area but less abundant in Michipicoten. Three types of diabase have been recognized: normal diabase, quartz diabase, and olivine diabase. The first two varieties are so far as observed always older than the olivine diabase. They have been intruded in many cases along faults, while the later dikes were usually unaccompanied by faulting. The diabase intrusions in these areas are almost always dikes, very few of them assuming other forms. The dikes nearly all run in a direction between north-south and northwest-southeast, but a few run east-west. Some of the dikes are very wide, and a few of them are several miles in length. The quartz diabase corresponds to the Nipissing diabase of other

[1]Op. cit. p. 14.

areas in Ontario. One noticeable feature of the formation in this region is the uniformity in the diabase and the absence of acid differentiation phases such as "red rock," granophyre, and pegmatite so common in the Cobalt area and along the north shore of Lake Huron, where important mineral deposits occur with the quartz diabase. The complete absence of mineralization of importance with the diabase in the areas under discussion is apparently due to the relatively small size of the intrusions, these being practically all dikes, and the lack of differentiation of the magma that formed the intrusions.

In thin section the older diabases usually show distinct ophitic texture. Some are relatively fresh and contain pyroxene, biotite, and ilmenite. In most of them, however, the pyroxene is partially altered and, in a few cases, completely altered to uralite, and the ilmenite to leucoxene. Where biotite is present it is very commonly associated with the ilmenite and sometimes surrounds it. The feldspars vary from fresh to partially altered, and give rise to the development of zoisite and, in one case, hydrargillite. Epidote is a common secondary mineral in some specimens. The quartz fills interstices between the feldspar crystals, and in some specimens a little micropegmatitic texture is seen.

In the field it is not possible in all cases to distinguish the olivine diabase from the quartz diabases. Under the microscope the olivine type is the fresher of the two, the feldspars, augite, and ilmenite being found in many cases to be unaltered. The olivine is partly altered in many specimens to serpentine, and in one case the reddish serpentine mineral, iddingsite, was found as an alteration product. The olivine crystallized before the pyroxene and in some cases is surrounded by it. In most specimens of olivine diabase, as in those of quartz diabase, there are patches of fine-grained material, which were apparently the last part of the rock to crystallize. This material invariably weathers more rapidly than the well-crystalized portion of the rock.

One body of peridotite was found by Thomson close to Dog lake in the northeastern part of the Goudreau area. It is probably related to the olivine diabase and is regarded as Keweenawan.

Pleistocene

The Goudreau and Michipicoten areas were completely glaciated in the Pleistocene epoch. Evidence of this is found in the polished, grooved, and striated rock surfaces and in the wide distribution of drift. There are in many places two sets of distinct grooves and striations. The older set, which is the one most commonly found, lies in a direction N. 25°-30° E., and the younger N. 15° E. It has been assumed by Parsons[1] that much of the Michipicoten area was not glaciated. He based his assumption on the presence of so much oxidation of the iron minerals, the occurrence of a deposit of kaolin at the old Helen mine, and the relations of the talus overlying smoothed rock surfaces on the bed rock along the railroad at mile 163, below Hawk Junction. As there has been a difference of opinion regarding the glaciation of the area, special attention was paid by the writer to this subject in the field. It was found that in the particular cases mentioned along the railroad, distinct striations running N. 30° E. could be seen on the polished surfaces and further that there were boulders in the talus foreign to the underlying bed rock. A study of the surface of Helen hill showed plenty of definite evidence that the ice had striated the rocks on the very top of the hill not far from the fire tower. Well-marked grooves and striations running in the two directions common to the region were found on the acid rocks on the

[1]A. L. Parsons, "The Productive Area of the Michipicoten Iron Ranges," Ont. Bur. Mines, Vol. XXIV, pt. 1, 1915, p. 194.

hill close to the old mining camp. Much of the acid rock in the higher parts of the hill is too much schisted and weathered to retain good scratches, but the greenstone adjacent to the iron formation is well smoothed and striated. There is no doubt that the ice passed completely over this hill, the highest in the area, and it must have been of considerable thickness since it was not deflected by so prominent an obstruction, as proven by the regularity in the direction of the striations. There is little sign of drift on the sides of the upper part of the hill, but there are plenty of drift boulders foreign to the bed rock about half way down from the top. Glacial action is evident in rounded and striated surfaces on the shore of Lake Superior near Michipicoten Harbour.

The extensive oxidation at the Helen mine must be explained as due to pre-glacial weathering, the products having been left in place when the glacier passed over the area because of the favourable situation of the deposit at the base of the south side of the high hill. The ice may have been overloaded and have ridden over drift dumped on top of the iron ore. The slight difference between the flora of the Michipicoten region and the surrounding area observed by some botanists might be due to the presence of the driftless area south of Lake Superior. From this driftless area plants that continued to grow during the glacial period may have spread northward to the Michipicoten region on the retreat of the ice before the return of the vegetation that had been driven ahead of the ice far down the Mississippi valley.

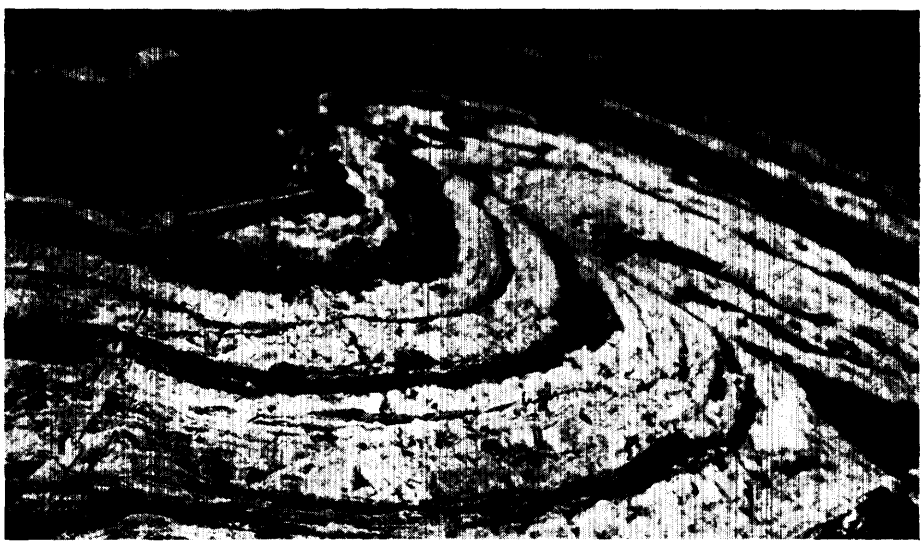
On the low lands around Lake Superior and in the lower parts of all the valleys of streams entering the lake, there is a great thickness of stratified gravel, sand, and silt left by Lake Algonquin, the great lake that covered the Lake Superior basin just after the retreat of the ice from this basin. The remarkable series of terraces that may be seen when ascending the Magpie and Michipicoten rivers from the lake indicate that Lake Algonquin stood at various levels at different periods in its history. The highest terraces extend inland beyond Hawk Junction, over 25 miles by rail from Michipicoten Harbour, and reach an elevation of about 1,075 feet above sea-level and 473 feet above Lake Superior.

On account of the rugged and rocky character of the Michipicoten region, the glacial drift does not cover as large a proportion of the surface, outside of the large sand plains formed in Lake Algonquin, as in the Goudreau area, where the drift is very thick in many places and large sections are covered with comparatively flat sand and boulder deposits. These are very prominent east of Goudreau in the sections west of Goudreau lake and east and northeast of Pine lake, where prospecting by ordinary methods is impossible. These large, flat areas seem to be due to outwash material from the terminal moraines found in the northeastern part of the Goudreau area, where kettle lakes are a common feature of the landscape. It is probable that there were some local lakes in front of the glacier in which considerable material was deposited, as some stratified clay and sand occurs on the south side of Pine lake.

The effects of glaciation have been of considerable interest to the prospectors in the Goudreau area because rich gold-bearing float was discovered a few years ago south of Miller lake and much money has been spent in an endeavour to locate its source. Glaciation has been a dominant factor in the hydro-electric development on the lower portions of the main rivers in Michipicoten. It has dammed up the ancient valleys causing the streams to seek new channels with the result that numerous valuable power sites have been made available. The old channels now filled with Pleistocene lake deposits are sometimes close to these falls, and in the case of the Michipicoten river at High Falls one of them has greatly affected the development of the water-power site. A more detailed account of this situation will be found in the discussion of hydro-electric power.

STRUCTURAL GEOLOGY

The structure of any mineral-bearing area is one of the most important factors in controlling ore deposition. It has been recognized for many years that in the Michipicoten and Goudreau areas gold is widely distributed. Small, rich deposits have been found in a number of places, and there is an abundance of igneous intrusions of a type regarded as favourable for the deposition of gold. Why, then, have not larger commercial ore bodies been found? The only remaining feature that can be considered as the possible dominating factor is the structure of the region. On account of the apparent importance of structure in gold deposition, much attention was paid to this feature in the study of these areas with the hope that major structures that have played a rôle in concentrating gold might be found. Plenty of shear zones and large faults have been found in many parts of the region by previous workers. The large faults described have been shown to be younger than the period of ore deposition and they have,



Folding and faulting in banded siliceous iron formation, Ruth lake, Goudreau area.

therefore, had little or no influence on the formation of the ore deposits. During the past summer, however, one fault of considerable magnitude, between Maskinonge and Pine lakes, Goudreau area, was traced and it is believed that it is pre-ore in age. A detailed account of it is given later in the description of the properties through which it runs. A great number of small faults have been found in the gold deposits, but these have had little influence on the formation of ore. There is some evidence of pre-ore movement along the Jubilee break in the Michipicoten area, but most of the displacement has occurred since mineralization. These two large breaks are the only ones found to date that may have had any material influence on ore deposition.

Folding in these areas has been very extensive and complex but so far as can be seen it has had little effect in controlling ore deposition, unless it be in the case of the pyrite bodies. Shearing has had some influence on gold mineralization, but the shearing near the ore bodies has on the whole been local. It is observed that at innumerable places shearing has occurred in the vicinity

of gold deposits, but it dies out within a relatively short distance along the strike, where schist grades into massive rock. It is true that tremendous squeezing and shearing occurred at several periods in the geological history of this region. There seem to have been extensive movements following the Keewatin and probably again at the time the Algoman rocks began to be injected. There was disturbance again when the gold ores were formed, but apparently not on any such scale within a given area as occurred at Porcupine or Kirkland Lake at the time the gold was deposited there. Great faulting occurred in the Keweenawan period long after ore deposition, and there has been considerable squeezing and deformation of the ore deposits. It is the opinion of the writer that the failure, up to the present time, to find larger gold deposits is due to the fact that there was insufficient disturbance at the time of injection of the ore solutions to concentrate large quantities of gold ore in a great shear zone or along a fault where the rocks have been extensively shattered. It is lack of concentration rather than lack of gold that has been the trouble.

Faulting

As stated above, faulting has occurred in these areas on a very large scale. Except in possibly two cases the large faults are later than the mineralization. They are believed to be Keweenawan in age as most of them were formed at the time the quartz diabase dikes of this age were injected, and, as pointed out by Collins and Quirke,[1] dikes follow many of the faults. The largest faults are, however, not followed by dikes, as for example, the great fault in township 30, ranges XXIII and XXIV; the McVeigh creek fault; and the two large faults along the southeast side of Wawa lake mentioned by Gledhill.[2]

The first of these faults is estimated by Collins and Quirke to have a displacement of 12,000 feet. The McVeigh creek fault, which can be followed from a point about a mile and a half north of Goudreau down the valley of McVeigh creek and the Agawa canyon for 70 miles and probably more, has a displacement between Alden station and Hawk Junction of 3½ miles. The remarkably straight course of the Agawa river is due to this fault and it is possible that the river follows the course of the fault to Lake Superior. The position of the fault for part of the distance between Goudreau and Herman lake to the north is uncertain. The displacement evidently decreases rapidly in this direction. It seems probable that just south of Herman lake the fault branches, one branch continuing through Herman lake and the other turning up a valley to the northeast, where it is followed by a long diabase dike. This direction is contrary to that of the other dikes of the same type in this region. There is definite evidence that the fault has separated the pyrite deposits that occur at Goudreau on the east side of McVeigh creek from those about a mile and a half south of the village on the west side of the creek. Although this great fault is believed to be Keweenawan in age, it appears to be at least somewhat later than the time of intrusion of the diabase dikes, because none of these dikes found on one side of the fault and running towards it could be found in the vicinity on the other side. Since the dikes seem to ignore even major structural features in most cases, it is probable that some of them would have crossed the fault if it had been formed before they were intruded.

The McVeigh creek fault runs, throughout most of its course, almost directly north. Most of the other large faults have a course more nearly northwest, except those on the southeast side of Wawa lake where they have a course nearly

[1]Op. cit., p. 39.
[2]Op. cit., p. 19.

northeast. The Keweenawan faults are all "left-hand" faults, that is when one faces normal to the fault the movement on the opposite side of the break has been to the left. The rocks on the eastern side of the fault have moved northward in all cases.

Further evidence that the faulting in Michipicoten did not all occur at the same time was found in a dike of quartz diabase cutting the second fault scarp of the two large faults running northeast parallel to the southeast shore of Wawa lake. This dike, which is about 12 feet wide, runs northwest-southeast across the fault, without offset, at a point southeast of Mackey point and about the centre of the boundary between claims Y. 104 and Y. 106.

It is probable, however, that all the faulting, with the two exceptions mentioned, occurred during Keweenawan time and that it was connected with disturbances in the crust that led to the injection of the great quantities of diabase forming the dikes of this rock. This disturbance was connected with the development of the great geosyncline of the Lake Superior basin.

Small faults are numerous in and near the gold deposits. These show displacements of a few inches to several feet. They cut the porphyry intrusions associated with the gold and have had little or no influence on ore deposition. Unlike the large faults of Keweenawan age, they do not show uniform displacement in one direction. In other words they are both right- and left-hand faults.

Igneous Intrusions

The form assumed by the igneous intrusions in these areas varies greatly. The granite and the granodiorite near Wawa lake form batholiths with irregular surfaces due to upward projecting masses between which masses of greenstone and schist lie in troughs. The body of granodiorite just west of the Goudreau mine, in township 28, range XXVI, is in the form of a boss, whereas the other Algoman intrusions are mostly dikes and large elongated masses following roughly the strike of the Keewatin rocks. In a few cases they cut these rocks transversely. The Keweenawan intrusions, with the exception of the body of peridotite near Dog lake, are dikes, and unlike the Algoman intrusions they nearly all cut across the strike of the Keewatin formations.

ECONOMIC GEOLOGY

The iron deposits of Michipicoten have been the most important so far discovered in Canada, and the most promising deposit of iron known in Canada to-day, the Helen siderite deposit, is in this area. The most productive single iron mine in the country was the old Helen brown-ore deposit, now exhausted. In addition to the Helen deposits, there are a number of smaller siderite deposits and one of oxide of considerable importance, the Josephine. The Magpie mine produced about 1,500,000 tons of siderite, which was calcined and marketed, and about 725,000 tons still remain on the property.

Closely related to the iron deposits are a number of important pyrite deposits in the iron formation scattered over the Michipicoten and Goudreau areas.

Gold is said to have been discovered on Wawa lake in Michipicoten in 1897 and in Goudreau in 1918. Since the first discoveries were made, thousands of claims have been staked and a large number of properties have been prospected. The majority of these properties have never passed the early development stage, but a number have been developed into mines, such as the Grace, Manxman, Minto, Jubilee, Cooper, and others in the Michipicoten area, and the Goudreau

and Cline Canadian in the Goudreau area. The Parkhill mine in Michipicoten has considerable underground development, and a 60-ton mill has been constructed during the past year. Good showings of gold are very numerous, and the metal is widely distributed over both these areas.

In addition to gold, iron ore, and pyrites, which have constituted the main mineral occurrences so far found, lead and zinc in relatively small quantities have been found in a number of places. Silver in small proportions occurs with the gold and lead deposits. A little copper occurs with the other minerals, and cobalt bloom in very small quantities is reported from at least two places. Arsenopyrite is found in a number of gold deposits and in at least one siderite body, but there is no arsenic of commercial importance.

Gold

There are few regions where gold is so widely distributed as in the Michipicoten-Goudreau region. It is commonly found in the native state, and good samples of visible gold have been found in numerous places. It is also associated with a group of rocks very favourable for the occurrence of gold, judging from experience in other parts of Ontario. These rocks are Keewatin greenstone and schist cut by a series of Algoman intrusions composed of granite, granodiorite, syenite, quartz and feldspar porphyries, alaskite, aplite, and lamprophyre. This series is equal in diversity to the rocks of Kirkland Lake and in part resembles those of Porcupine. In spite of the numerous occurrences of gold and the favourable igneous associations, no large ore deposit has so far been proved to exist. The deposits found to date have been irregular and of limited extent. The only explanation that can be offered for this condition is the lack of major structural features controlling ore deposition. Few large faults or shear zones, capable of concentrating the ore-depositing solutions into a few areas were developed at the time these solutions were released from the underlying magmas. The absence of these controlling factors permitted the solutions to come up all over the region, and as a result at least some gold can be found associated with nearly all of the numerous small intrusions of porphyry or granodiorite scattered widely over the region. The larger deposits so far found are associated with the larger intrusions of the Algoman rocks. There is undoubtedly enough gold in this region to make several large mines if it had been concentrated into a small number of deposits. There are large faults and there has been much shearing, but most of the faults are later than the ore and the major shearing movements preceded the epoch of ore deposition. The shearing accompanying ore deposition was of relatively small extent compared with that preceding mineralization.

Types of Gold Deposits

The gold deposits all have the general form of veins, which vary greatly in width from point to point. The ore bodies are in lenses, and values increase or decrease abruptly in most cases. Some of them are true fissures with distinct walls; others grade into the country rock by replacement of the walls with quartz and ankerite. Where the walls consist of schists, the mineralization may extend into the schists for several feet on either side of the vein. Quartz is the most common gangue mineral, but some veins consist chiefly of carbonate with a little quartz and native gold. In many cases the gold occurs in stringers of quartz cutting the carbonate. The better values occur with the quartz gangue. Specks of native gold are frequently found in veins in which carbonate is predominant,

but the ore is not of commercial grade. Tourmaline is one of the most common accessory minerals in the veins, and some veins contain little but tourmaline and quartz. Pyrite is found in practically all veins, and pyrrhotite and arsenopyrite occur in a few. Chlorite is a constituent of a number of veins. Carbonatization of the wall rocks is a very common feature of many of the veins, particularly in the acid formations. Where the acid rocks are sheared, sericite schist is a typical wall rock. Biotite has been formed by replacement in the walls of many veins, especially in the intermediate rocks.

The veins occur in the sheared portions of the greenstones and acid lavas and in the sheared and brecciated parts of the Algoman intrusives. The majority of the gold deposits are in the Algoman intrusions, because these fractured more readily than the Keewatin formations. On the McCarthy-Webb property, for example, the ore occurs in zones in the porphyry where shearing



Typical lode structure on the McCarthy-Webb property, Goudreau area, showing mineralized zones in a monzonitic formation.

has been more intense than in the intrusion as a whole. The illustration above shows a typical example of mineralized zones in a monzonitic formation. In these zones extensive silicification and sericitization have occurred. Some porphyry dikes are so impregnated with quartz that they are mistaken by prospectors for quartz veins. They may even carry gold, but this is distributed so irregularly that it is of no commercial importance.

Many of the veins show evidence of fracturing and faulting on a small scale following mineralization. This is well illustrated on the Minto property where the vein has been displaced at a number of points and intruded by lamprophyre dikes. Some veins also show evidence of dynamic metamorphism in the granular and recrystallized condition of the quartz. So marked is this condition in some of the veins in the Goudreau area that the vein quartz may be mistaken for quartzite either in the hand specimen or in thin section.

The majority of the veins follow the general direction of the schistosity of the rocks they cut, but a few cut across the general strike and follow local bands of schists or porphyry dikes with which they are associated.

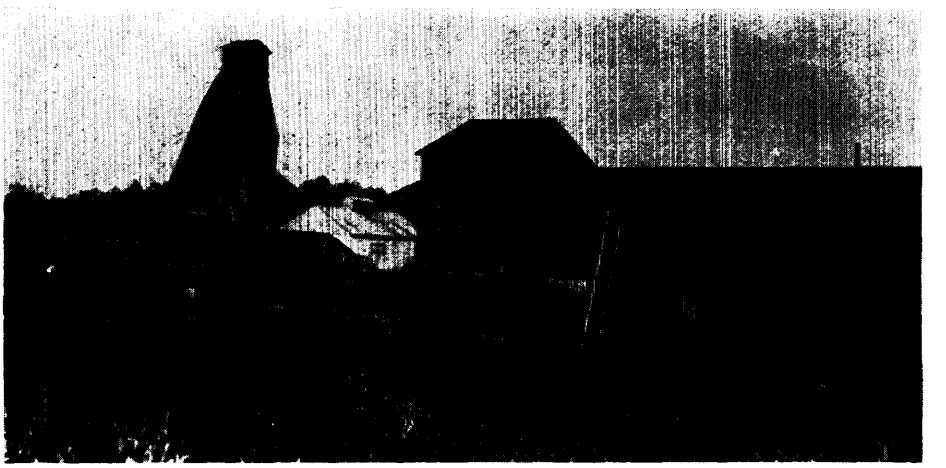
DESCRIPTION OF PROPERTIES IN THE GOUDREAU AREA

The following description of properties in the Goudreau area is confined almost entirely to those on which at least some development work has been done since Gledhill's report[1] was issued in 1927. It is not necessary to repeat the description of all the properties described at that time, as little or nothing has been done on most of them since the report was issued.

Goudreau Gold Mines, Limited, Township 28, Range XXVI

The only gold-bearing property in this area that has been developed into a mine with a mill is that of the Goudreau Gold Mines, Limited, in township 28, range XXVI. This property has been described by Burrows;[2] Thomson;[3] Collins, Quirke and Thomson;[4] and Gledhill.[5]

Gledhill's report contains a detailed account of the operations on this property with a map of the underground workings, but since it was written considerable surface work has been done both to the east and west of the mine.



Mill and shaft-house, Goudreau Gold Mines.

The workings are indicated on the accompanying map of the surface features of the property. During the past summer the Bennett-Pacaud syndicate took a sampling option on the property and pumped out the workings to the 100-foot level. A very large flow of water was encountered. The veins on the surface and the first level were thoroughly sampled. The writer is greatly indebted to J. W. McDonald, foreman for Bennett-Pacaud, for his hospitality while engaged in an investigation of the property.

Gold was discovered on the Goudreau property in 1921 by Thomas Murphy, and the mine is frequently spoken of as the Murphy mine. The property was purchased in the same year for a large sum by the Goudreau Gold Mines, Limited, of which Clement Foster was president. In 1922 shaft-sinking began,

[1]T. L. Gledhill, "Goudreau-Lochalsh Gold Area, District of Algoma," Ont. Dept. Mines, Vol. XXXVI, pt. 2, 1927.

[2]A. G. Burrows, "Goudreau Gold Area, Ontario," Can. Min. Jour., Aug. 5, 1921, p. 621.

[3]Ellis Thomson, "Goudreau Gold Area, Michipicoten District, Ontario," Geol. Surv. Can., Sum. Rept., pt. D, 1921, p. 17.

[4]W. H. Collins, T. T. Quirke and Ellis Thomson, "Michipicoten Iron Ranges," Geol. Surv. Can., Mem. 147, 1926, pp. 130, 160.

[5]T. L. Gledhill, op. cit., p. 65.

and since that time two shafts have been sunk. Shaft No. 1 is 425 feet deep. It follows the vein, which dips southwestward at an angle of 65 to 70 degrees. It is said to end in the diabase dike that runs a little west of north through the property a short distance from the shaft and offsets the vein. Shaft No. 2 is 200 feet deep, and at the bottom level it is connected with the 200-foot level of No. 1 shaft. It is vertical and has been sunk on the vein at a point about 500 feet northwest of No. 1 shaft on the opposite side of the diabase dike. Considerable drifting has been done on four levels.

In 1922 a good road was built from Goudreau to the mine, and a mill was built in 1925. Underground operations ceased in 1926. Electric power was supplied to this property from Steep Hill falls on the Magpie river previous to 1926, when a new power line was brought in from High Falls on the Michipicoten river. Power is still available from the latter source and was used in the pumping operations during the past summer.

Since underground operations ceased, the main vein has been explored on the surface between No. 2 shaft and the point where it ends to the west at the edge of the granodiorite boss. A pit 10 by 10 feet and more than 15 feet deep has been sunk in the vein on the west side of the tiny creek near the claim line between A.C. 408 and A.C. 412. The vein is mostly carbonate cut by stringers of quartz. Between this pit and the west end of the vein, considerable trenching has been done and this reveals the continuation of the vein, although it is very indefinite in places, as far west as the edge of the granodiorite boss where it seems to die out. The surface work east of the mine was done on claim A.C. 407. One very large pit was sunk on a mineralized porphyry intrusion about 80 feet wide. It is said that the work was done with the idea of picking up the continuation of a vein near the mine, but no continuity was established. The pit is about 50 feet long, and at one end it is 6 feet deep. It is stated that it is nearly 40 feet deep in the deepest section, which is now full of water. The work was done by Fred Brandt with the aid of a portable compressor, which greatly facilitated drilling operations. To the east of this pit several trenches have been dug on the same porphyry intrusion.

Five diamond-drill holes, the location of which are shown on the map on page 22, have been drilled on this property.

No. 1 hole dips 45 degrees at 230 degrees and struck the porphyry at 271 feet. It stopped in porphyry at 279 feet.

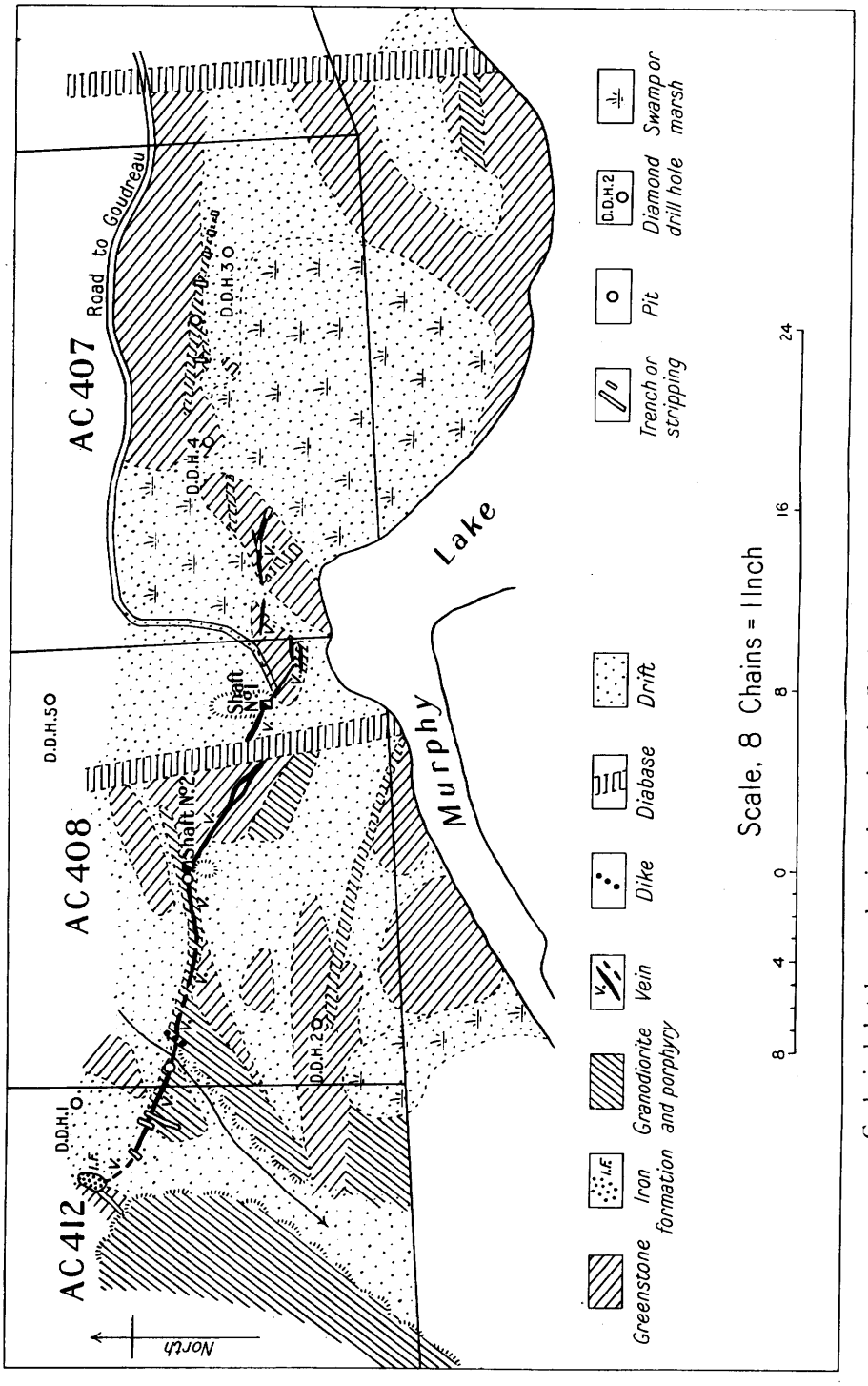
No. 2 hole dips 45 degrees at 340 degrees and reached porphyry at 775 feet. The total depth is 790 feet, and the porphyry became more granitic in character with depth.

No. 3 hole dips 45 degrees at 198 degrees. The total depth is 155 feet, and it ended in greenstone.

No. 4 hole dips 45 degrees at 180 degrees. The total depth is 242 feet. The rock was mostly greenstone, but from 233 to 242 feet it was porphyry.

No. 5 hole has an initial dip of 60 degrees at 176 degrees, but at 1,150 feet the dip is only 30 degrees. The total depth is 1,533 feet. The rock was mostly greenstone with little mineralization.

Geology.—The formations exposed are Keewatin greenstone, schist, and small patches of iron formation; Algoman granodiorite, porphyry, and aplite; Keweenawan diabase dikes; and Pleistocene drift. The bed rock is hidden in many places under drift and swamp; but the drift is apparently not deep, since the diamond-drill holes did not require more than a few feet of stand pipe. The main vein follows high land for the most part.



Geological sketch map showing the main vein, Goudreau Gold Mines, township 28, range XXVI.

The oldest rock is greenstone, schisted in many places. It was intruded by a large boss of granodiorite, which lies a short distance west of the mine and at the edge of which the main vein dies out in a small band of contorted iron formation. This rock is coarse-grained right up to the border in this area and somewhat sheared. There are a number of smaller intrusions of porphyry on the property, and several sections of the vein run through these. They are sheared and extensively carbonated, and while there is some gold in the vein where it cuts this rock the values are low compared with those in the greenstone where the gangue is mostly quartz. The vein varies more in width in the porphyry than in the greenstone. The vein matter has originated in the porphyry and granodiorite magma. The porphyry intrusions are derived from the same magma as the granodiorite and are apophyses of the same body. A dark greyish-blue dike about 3½ feet wide cuts the vein and the porphyry on the hillside near the west side of claim A.C. 408. It is difficult to classify the original rock, as about 50 per cent. of its volume has been altered to carbonate, but it was probably an aplite. It consists chiefly of orthoclase and carbonate with a little chlorite and is fine-grained. It is similar to the small dike found on the McCarthy-Webb property and those cutting small veins in the granodiorite near Lovell lake.

A large olivine diabase dike of Keweenawan age cuts and slightly displaces the vein between No. 1 and No. 2 shafts.

Veins.—The main vein on the surface can be followed for 1,675 feet northwest by west from a point 60 feet from the north shore of Murphy lake. At the southeast end the vein fingers out in schistose porphyry. To the west it cuts sericite schist derived from a small intrusion of porphyry, and here there is a band about 30 feet wide containing much carbonate but little quartz. Apparently the vein also runs out in this porphyry mass on the 100-foot level. The vein then narrows to about 6 inches in width and turns northwest through greenstone, which in places is fairly "tight," and for 75 feet it varies from almost nothing to 4 feet in width. The gangue is mostly quartz. The vein has been trenched to No. 1 shaft, near which a rich shoot of ore about 25 feet long occurs in it. Although the shoot is never more than a few inches wide, it extends almost vertically downward as far as the 100-foot level and possibly beyond it. A splendid showing of native gold was seen by the writer just east of the shaft when this level was recently dewatered. The metallic minerals in the vein are native gold, pyrite, chalcopyrite, pyrrhotite, bornite, and sphalerite, the last two in small quantities. A little niccolite (NiAs) and smaltite-chloanthite (nickel-cobalt arsenide) is mentioned by Thomson[1] as occurring in No. 1 shaft close to the 100-foot level. This is an unusual occurrence of these minerals and it might be suspected, since they are so commonly associated with diabase or norite in other parts of Ontario, that they were brought in by the diabase dike. As previously mentioned a little cobalt bloom was found on the northern edge of the granodiorite boss that lies just west of this mine where no diabase could have been responsible for its deposition, and it is, therefore, quite probable that these minerals were deposited from the solutions that deposited the pyrrhotite and chalcopyrite.

The gangue minerals are quartz and carbonate, apparently ankerite, and some chlorite. Tourmaline is a common constituent of the quartz gangue. The wall rocks are chlorite and sericite schist.

Between No. 1 shaft and the diabase dike, the vein is covered with the rock dump and debris for nearly half the distance, but in the remaining portion the

[1]Op. cit., p. 160.

vein is stripped. It is mostly mineralized quartz with some carbonate and has been sampled for a width of 11 feet. At the contact with the diabase dike it swings a little more to the north, owing to drag. The dike is 65 feet wide and the vein is displaced by it a distance of about 60 feet. This is one of the few cases where faulting accompanied one of these olivine diabase dikes in this region.

On the west side of the dike the lode is 17 feet wide, but this is not solid vein material. A short distance from the dike a horse of greenstone 12 feet wide and about 100 feet long splits the vein into two bands 3 feet and 4 to 9 feet wide, respectively. The gangue here is mostly quartz, but there is considerable carbonate. A porphyry intrusion lies 80 feet to the south of the vein, and stringers of porphyry occur in the vein between the horse and No. 2 shaft. The vein narrows to 3 feet, but in a pit, said to be 40 feet deep, 25 feet west of the shaft it is about 10 feet wide. Here the vein cuts porphyry. The ore at No. 2 shaft shows pyrite, chalcopyrite, and pyrrhotite in quartz and carbonate gangue. From this pit to the next one, which lies near the west boundary of claim A.C. 408, the vein lies in schisted porphyry and is very irregular in width, pinching out in one or more places. There is a sufficient amount of some magnetic mineral, probably pyrrhotite, along the vein to materially affect the compass. The gangue is largely carbonate with stringers of quartz. At the large pit near the west side of the claim, the vein is still in porphyry and consists chiefly of carbonate cut by stringers of quartz. The pit is 10 by 10 feet, and the vein is 12 to 15 feet wide for a short distance. Specks of native gold are fairly common in the vein. The carbonate gangue, which weathers brown, has been analysed for the writer by G. H. Charlewood, University of Toronto:—

	Per cent.
CaO	30.45
MgO	17.15
MnO	.23
FeO	7.20

These results indicate that the mineral is ankerite or ferruginous dolomite. The vein between its west end and the large pit is rather indefinite, but its existence is indicated, where trenching has been done, by a carbonate zone and stringers of quartz in a band 4 to 5 feet wide. The vein ends near the edge of the granodiorite boss in a small body of contorted iron formation surrounded by greenstone.

On the east side of the mine, a vein comes in 200 feet from No. 1 shaft and extends about 400 feet east to a large swamp that runs down to Murphy lake. Near its west end the vein, which lies in greenstone, is only about a foot wide, but the gangue is mostly quartz mineralized with pyrite, chalcopyrite, and considerable native gold. Towards the east the vein runs into a drift-filled depression, and on the east side of this depresson it widens and branches. Tongues of porphyry are associated with the vein in the greenstone. The south branch of the vein is about 10 feet wide where it runs over the hill and down to the swamp. It is mostly carbonate with some bands of quartz.

Gledhill apparently regarded this as a continuation of the main vein offset in the drift-filled depression near the cook camp. The writer does not see sufficient evidence to support this assumption and considers this a separate vein.

It is evident that the gold values are higher in the greenstone than in the porphyry, a condition similar to that in the Porcupine camp. The evidence shows that the veins at this mine are deep-seated and of high temperature origin, and it is improbable that values will increase with depth, especially where the veins cut the porphyry.

East and a little north of the last vein described and about 250 feet south of the road to Goudreau in claim A.C. 407, there is another vein, on which the large pit previously mentioned has been sunk. The pit is about 50 feet long and runs part way across a porphyry intrusion about 80 feet wide and at least 520 feet long. The intrusion ends in greenstone to the west and runs under drift to the east. The rock has been squeezed and distorted and greatly replaced by carbonate. The schist is veined with stringers of quartz and carbonate. There is much light-green chlorite in the rock and some talc as an alteration product. The vein material is very little mineralized, but several specks of native gold were found. There is no definite vein here, and the carbonated and silicified zone fades out into the porphyry in a short distance along the strike. It is not connected with any of the other veins on the property.

Barnes, Township 28, Range XXVI

T. T. Barnes of Sault Ste. Marie controls three claims in the west-central portion of township 28, range XXVI. These lie just east of Irene lake and cover the northwest corner of the granodiorite boss. Considerable trenching and stripping have been done on claim A.C. 570 and several mineralized bands uncovered near the edge of the boss. The rocks in the boss here are quartz porphyry, feldspar porphyry, and a phase more like granodiorite. In places the rock is squeezed into a fissile sericite schist; in others it is massive. The porphyry forms *lit par lit* injections in the greenstone along its border, and there are small roof pendants of greenstone schist in the porphyry. Considerable brecciation has occurred along the contact. The mineralized portions of the rock are in the form of lenses in sheared zones, small veins, and stringers of quartz. Where the mineralized zones run out of the porphyry into the greenstone to the west, they are usually more distinct and form veins with fairly definite walls. The veins strike N. 70° E. and dip to the north with the plunging contact of the boss. They consist of quartz, carbonate, pyrite, which is abundant in some veins, and chalcopyrite. Traces of cobalt bloom were found and possibly nickel bloom. The mineralized bands are short and do not exceed 7 feet in width. Several short lenses may be in line in a schisted band with another line of these in an approximately parallel band.

Kozak, Township 28, Range XXVI

A group of claims was staked by Nick Kozak some years ago between the railroad at South Goudreau and Kozak lake. In the summer of 1927, Kozak discovered a wide mineralized zone on a claim near the lake, and a great deal of excitement was created in mining circles when the Nipissing Mining Company sampled the property and secured silver values across a band over 100 feet wide. The whole of the surrounding area was quickly staked because there was little in the appearance of the formations over a large area to distinguish silver-bearing rock from barren porphyry. Nipissing secured an option on the property, and it was soon tested by cutting rock trenches across the formation that had yielded values in the assays. When the formation was resampled at the bottom of the rock trench commercial values practically disappeared except in mere veinlets, which were insufficient to raise the average metal content to commercial grade. The explanation of the peculiar situation was found when samples of the ore were studied and found to contain secondary native silver. The sulphides, including argentite, galena, sphalerite, pyrite, and chalcopyrite, occur in small veins and stringers in a Keewatin feldspar porphyry. The gangue minerals are

quartz and a little carbonate. The porphyry is schisted and in certain zones is cut by the quartz stringers and impregnated by sulphides. On weathering the silver was enriched to a slight depth below the surface. The formation has not the appearance of a silver deposit. There is no very satisfactory explanation of the source of the metals, but it is probable that they have come from Algoman porphyry intrusives. Some of these were seen to the west and southeast of the claims and some may be present and have been overlooked in the vicinity of the silver deposit, since the Algoman porphyries so strongly resemble those of Keewatin age when both are schisted.

The formation that contains the silver has been offset by the McVeigh creek fault, which has thrown this formation about 1¾ miles north on the east side of the creek.

Kremzar, Township 49

There is a group of 16 claims between Goudreau lake and Miller lake in township 49, known as the Kremzar claims because the main discoveries of gold have been made by Patice Kremzar, a well-known prospector in this area. The group is controlled by the Algoma Exploration Company, of Sault Ste. Marie, Ont.

About six years ago Kremzar discovered some rich gold float beside the old Pic road in claim No. 3,909 (not No. 3,901 as shown on Gledhill's map). This float consisted of boulders of silica ranging in size from a few inches to two feet in diameter. The fact that they were angular and that there were several of them near together led to the supposition that they had not been transported far. Some of them were rusty and friable from weathering of sulphides, and in places the rusty rock contained much native gold. The writer examined this float shortly after its discovery and found that in thin section the rock showed a mosaic of quartz grains with pyrite, limonite, hematite, ilmenite, biotite, chlorite, and epidote. The limonite and hematite are oxidation products of the pyrite, and the gold had been set free by weathering. Some of the quartz was much like the recrystallized silica of the iron formations, and some of it was so much like that of a highly altered quartzite that the rock was considered to be a quartzite. A more recent study of sections of this rock and a comparison of the quartz with that of the recently discovered veins on claim No. 3,901 indicate that the boulders were plucked from one of these veins, the quartz of which is very granular in texture. Much surface work was done in an effort to discover the source of the float, and in 1929 Kremzar discovered a highly auriferous lens just north of the south boundary of claim No. 3,901.

In the spring of 1930, M. J. O'Brien, Limited, took an option on the Kremzar group of claims, and a campaign of diamond-drilling was initiated to thoroughly test the extent of the gold deposits. Drilling was started on the rich lens in claim No. 3,901, where the vein had been exposed by trenching and stripping along its full length of 375 feet. This vein lies in a disturbed zone in Keewatin greenstone and strikes N. 35° E. Just north of the southern boundary of the claim the vein consists of fairly solid granular quartz across 9 feet, the quartz stringers and alteration of the wall rock extending much farther. The wall rock on the east side of the vein is basic and much altered. It contains considerable carbonate, epidote, fine-grained biotite, apatite, tourmaline, zoisite, ilmenite, and some muscovite. Much quartz has been introduced. The feldspars have been almost entirely replaced. The west wall consists of a more acid rock, and the feldspars have not been replaced to nearly as great an extent as they have been in the east wall. It contains much carbonate and it is highly silicified. There is a little epidote, chlorite, ilmenite, and leucoxene, but

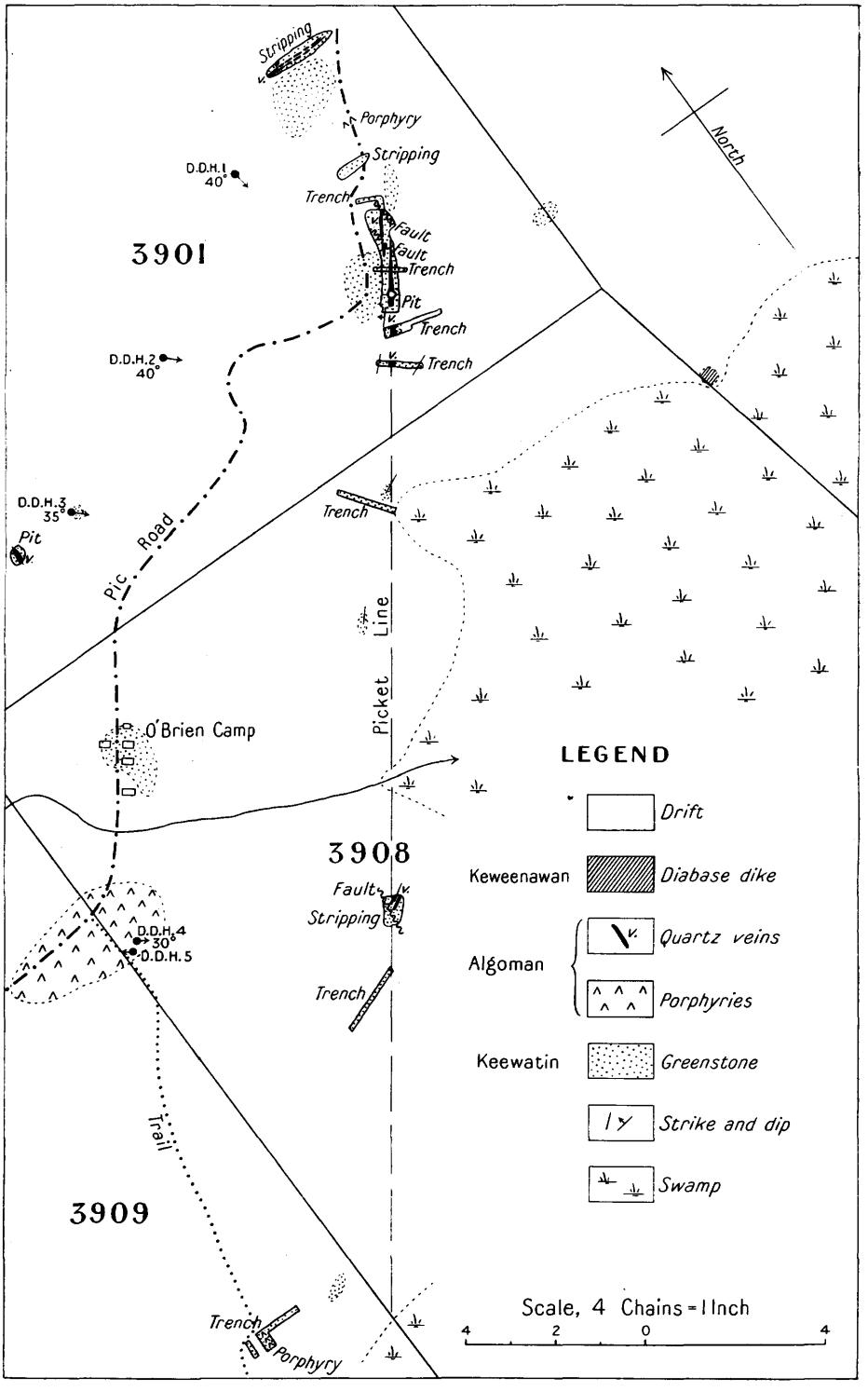
no tourmaline or apatite was seen in thin section. Most of the rock in the vicinity of the vein is coarse, fairly massive Keewatin greenstone, some of which in the field resembles the Keweenawan diabase dikes. Close to the vein the rock is schisted in places, and the strike and dip vary a great deal. One band of chlorite schist, which is considerably decomposed, runs along the strike of the vein and can be followed for a short distance south into the adjoining claim.



Nine-foot vein of high-grade gold ore on claim No. 3,901, Kremzar property. This vein was drilled by M. J. O'Brien, Limited.

As the main lens is followed northward it becomes narrower and pinches out within a distance of 125 feet, but a narrow, nearly parallel vein comes in and can be traced for a few yards. It cuts a rather massive greenstone. This small vein is cut by two small left-hand faults and is considerably distorted by squeezing

In an attempt to follow the vein southward a picket line had been run along the projected strike of the vein for 800 feet into claim No. 3,908, which lies south of No. 3,901. There is little sign of a vein, and most of the rock is covered until a point 650 feet from the north boundary of No. 3,908 is reached. Here a stripping exposes greenstone schisted and veined with quartz across a band



Geological sketch map showing part of the Kremzar group, Algoma Exploration Company, township 49.

20 feet wide, which is cut off within the boundaries of the stripping by a small right-hand fault. The fault was crossed by a diamond-drill hole which cut the veined formation beneath the outcrop. A short distance south of this stripping, there is a long trench on greenstone in which no evidence of a vein was found.

The main lens in claim No. 3,901 is well mineralized with pyrite, pyrrhotite, and chalcopyrite. The mineralization is very fine grained, but specks of native gold may be seen. A grab sample of the good ore was assayed by the Provincial Assayer and gave: gold, $91.20 per ton; silver, 0.34 ounces per ton.

Along the borders of the vein there are bunches of radiating crystals of actinolite. Crystals of the same mineral are seen in thin sections of the quartz gangue and also occur in some of the boulders of the float found in claim No. 3,909. The similarity in composition of the float and the vein material in this deposit convinces the writer that the rich gold-bearing float came from this vein. The direction of movement of the ice, which was S. 25° W., would be on a line between the vein and the float.

The map facing this page shows the location of the diamond-drill holes put down in 1930 by M. J. O'Brien, Limited. In all, five holes were drilled, and the direction and depth of these is as follows:—

No. 1 hole had a direction at the surface of S. 13° E. and at the bottom S. 25° E. The dip at the surface was 40 degrees and at the bottom 29 degrees. The total depth was 1,377 feet. It had a vertical depth below the vein at the surface of about 600 feet. The rock was greenstone.

No. 2 hole had a direction at the surface of S. 60° E.; at 130 feet, S. 87° E.; and at the bottom, S. 56° E. The dip at the surface was 40 degrees and at the bottom 36 degrees. The total depth was 580 feet and the vertical depth below the vein at the surface was 350 feet. The rock was greenstone.

No. 3 hole had a direction of S. 46° E.; the dip was 35 degrees, and the total depth was 580 feet. The vertical depth was 250 feet below the line of the vein on the surface at the northwest corner of the swamp. The rock was greenstone.

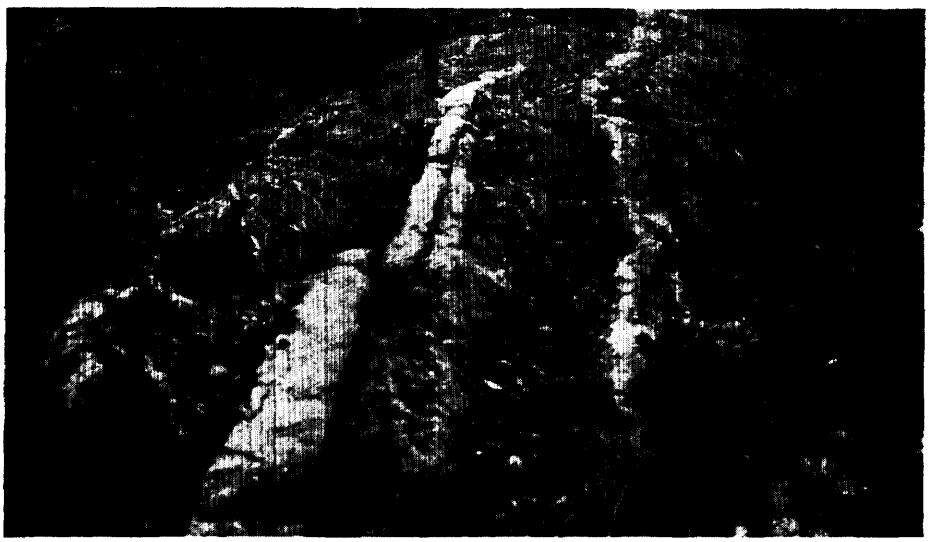
No. 4 hole was started on a body of porphyry. Its position is 35 feet east of the claim line and 396 feet south of the northwest corner of claim No. 3,908. The direction was S. 35° E. and the dip 30 degrees at the surface. It cut the fault and the band of mineralized quartz stringers previously mentioned as occurring in claim No. 3,908. The fault strikes N. 1° 30′ E. A brecciated zone containing magnetite prevented a proper survey of this hole being made. The total depth was 510 feet. This hole was drilled in six days. The rock was feldspar porphyry followed by greenstone.

No. 5 hole was started on the same mass of porphyry as No. 4 at a point 425 feet south of the northwest corner of claim No. 3,908 and 17 feet east of the claim line. The strike was N. 45° W. and the dip 35 degrees at the surface. The hole was down 900 feet at the time of the last visit of the writer to the drill. It was intended to explore the section between the drill and the small lake to the northwest. A short distance west of the drill, quartz veins cross the old Pic road. On the surface these veins are exposed by a stripping running up a hill for 75 feet from the road and rising 25 to 30 feet above the road The country rock is greenstone with a band of schist about 20 feet wide striking S. 15° W. The schist is cut by stringers and two parallel veins of granular quartz about 4 feet apart at the road and converging on the hillside. Where the veins run under drift at the road, there is a lode about 9 feet wide comprised of two veins and a zone of schist cut by stringers of quartz. The quartz shows a little sulphide

mineralization, and the lode appears quite strong where it disappears at the road. It was cut by the drill-hole, and this long hole also cut some porphyry dikes at depth.

There are a number of porphyry intrusions on the Kremzar claims as shown on the accompanying map that are impregnated with quartz and mineralized sufficiently to be confused in places with veins. They carry some gold but this is very irregularly distributed.

The writer wishes to express his sincere thanks to the following officials and employees of M. J. O'Brien, Limited: John G. Dickenson, manager; Robert Bryden, mining engineer; J. Evans, assistant mining engineer; and D. Couillard,



Auriferous quartz veins in green schist on claim No. 3,909, Kremzar property, drilled by M. J. O'Brien, Limited.

foreman at the drilling camp, for their hospitality on many occasions and the generous manner in which information was offered regarding the operations of the company.

Michael Syndicate, Townships 48 and 49

The Michael Syndicate includes a number of citizens of Sault Ste. Marie, Ont., and a group of Detroit men who hold a large interest in the organization. Gordon L. Michael of Sault Ste. Marie has been in charge of field operations. The syndicate controls several groups of claims made up as follows: The McFadden group comprising seven claims, Nos. 4,200-4,203, 4,205, 1,814, and 4,188; the Quartzite group of eight claims, Nos. 4,189, 4,185-4,187, Nos. 3,991-3,994; and the Chitty group with five claims, Nos. 4,190, 4,191, 4,015, 4,016, and 3,936. These claims are situated in townships 48 and 49 along the northern side of the mineral belt around Maskinonge lake and southwest of Miller lake.

One of the most interesting developments on the property of this syndicate has occurred on claim No. 4,200 of the McFadden group (see insert facing this page). On this claim a shaft, 21 feet deep, 5 by 5 feet at the bottom, and dipping 75° W., has been sunk on a brecciated zone along a fault in greenstone. Native gold may be seen in the shaft and where the cap rock has been blasted off just north of the shaft. The gold occurs in the schisted greenstone as well

as in quartz stringers, and there are two streaks in the shaft showing considerable native gold. The brecciated zone is veined with quartz stringers over a width of about 20 feet, and some tongues of porphyry intrude it. There are also several small porphyry intrusions a short distance from the shaft. The quartz and schisted greenstone are quite well mineralized with pyrite. A picket line has been run N. 35° W. from the shaft to follow the mineralized zone and much trenching and test-pitting have been done along this line. There is some evidence of disturbance of the formations for a considerable distance and a number of quartz stringers were found, but the zone is not well defined in this direction. A dike 10 to 12 feet wide runs along the fault 30 feet west of the shaft but can be traced for only a few chains along its strike. It is apparently a porphyritic coarse-grained basalt or fine-grained gabbro in which the feldspars are much altered to zoisite, the pyroxene to uralite, and the ilmenite to leucoxene. It is probably a Keweenawan dike, but it is much more altered than most of the diabase dikes of this age, which is most likely due to its position in a disturbed zone.

Southeast of the shaft there is not much sign of mineralization, and the bed rock drops down under a swamp. A fault running east of south can, however, be traced over a hill south of the swamp and across several claims not included in the property of the Michael Syndicate. The rocks along the fault have been stripped of drift in many places and it can be easily followed. In one place a quartz vein runs along the fault for several yards.

The evidence in support of the existence of a large fault in this area is very strong. At the Michael shaft there is an area of very distinct pillow lava on the west side of the brecciated zone and none of this rock on the east side. A number of porphyry intrusions along the line of the fault end at this line, and an oval-shaped band of iron formation has one end cut off at the fault. A fairly distinct scarp may be seen on the hill on claim No. 4,207. There is no definite evidence of the direction of movement on the fracture because the corresponding portions of the rocks cut by it have not been found on opposite sides of the fault. There is one piece of evidence, however, indicating that the east side is the upthrow side. This is found in the band of iron formation mentioned. Experience has shown that in other parts of the Goudreau area the iron formation lies between Keewatin acid lava below and basic lava above. The same relations are found between the Keewatin rocks and the iron formation in this locality. In this case the body of acid rock is wide on the east side of the fault and disappears entirely on the west side; it is apparently beneath the surface and covered with a cap of greenstone, which has been removed by erosion from the upthrown body of acid rock on the east side.

The determination of the age of this fault is a matter of economic importance. If it was formed after the mineralization occurred, it will evidently be of little importance in prospecting for ore. If it is pre-ore in age, it may have exerted an important influence on the deposition of ore along its course. The evidence regarding its age cannot be considered as very definite, but the writer is of the opinion that it was formed before mineralization for the following reasons: The brecciated zone at the Michael shaft, which is close to the fault, is veined with stringers of quartz and tongues of Algoman porphyry; and on the hillside southeast of the shaft, on the opposite side of the creek and swamp, a quartz vein actually follows the fault for several yards. On the other hand, it is admitted that several Algoman porphyry dikes end abruptly at the fault making it appear that the fault was later and had cut them off at that line. Observation of a large number of these porphyry intrusions in the Goudreau

area shows that they very commonly end abruptly. They tend to follow schisted zones in the Keewatin greenstones, and it is quite probable that a small intrusion following one of these schisted zones would stop against a large fault fissure with a massive body of greenstone on the opposite side.

Assuming that this fault existed when the porphyry was intruded and the ore was deposited, it appears that the most favourable locality for the occurrence of ore will be found in a zone extending from the Michael shaft southward along the fault for several hundred feet. If the large intrusion of porphyry outcropping across the swamp to the southwest of the shaft should continue under the swamp to a point near the fault its presence should be favourable to ore deposition, since in the Goudreau area the large bodies of porphyry seem to have supplied more gold than the small ones.

Work has been done on several other gold deposits on the property of the Michael Syndicate. On claim No. 4,186 there is a fine-grained dike of porphyry, 2 to 3 feet wide, striking east-west and dipping about 65° N. It cuts greenstone, and a band of schisted greenstone runs along the dike. The porphyry is schisted and silicified in places. The sheared zone along the dike is 8 to 10 feet wide, and a band about 2 feet wide heavily mineralized with sulphide lies in this zone. It contains pyrite and some chalcopyrite. At the east end of the section of the dike that has been exposed by trenches in low land for 350 feet, the sulphide band is on the south side of the dike and at the west end it has shifted to the north side. About 350 feet farther west apparently the same dike is exposed in another trench. Here the dike is about 7 feet wide. Both the greenstone and porphyry are sheared, and there is a zone about 10 feet wide along the dike that is heavily mineralized with pyrite. About 60 feet of the vein is exposed in this trench. Mr. Michael found some gold by panning the schisted greenstone. This shear zone is one of the most marked in this section of the Goudreau area.

Just south of Maskinonge lake, a shear zone, about 15 feet wide and lying mostly in porphyry, is impregnated with quartz and pyrite. It is possible that this is a continuation of the porphyry intrusion described above, but this could not be ascertained as the intervening space is covered with drift.

McCarthy-Webb, Township 49

This property, which is located in the south central part of township 49, has attracted attention ever since gold was discovered on it in 1918, when gold was first found in the Goudreau area, but it has not yet been developed into a mine. The property was optioned a few years ago by McCarthy-Webb Goudreau Mines, Limited. Following this it is said that the Consolidated Mining and Smelting Company sampled the ore bodies thoroughly and attempted to secure an option on the property, but negotiations have been delayed owing to litigation regarding control of the right to grant an option.

The gold veins lie in a large intrusion of Algoman rock, which may be classed as granite porphyry grading into monzonite, quartz porphyry, and feldspar porphyry. Most of the rock has been altered considerably by shearing, silicification, and carbonatization. In parts of the intrusion, the rock is quartz and feldspar porphyry; in others, it is coarse-grained, the feldspars are about equally divided between orthoclase and plagioclase, and it might be classed as monzonite; and in still others there seems to be little but quartz and feldspar and the rock is now practically an alaskite, but the proportion of quartz that has been introduced by hot solutions is uncertain. The intrusion is one of the largest of the Algoman intrusions in the Goudreau area. It is exceeded in size

only by the granodiorite boss west of the Goudreau mine and the granite batholiths bordering the area. It cuts greenstone on its southern border, but on the northern side it runs under the edge of a gravel and sand plain. There are veins in several places in the intrusion, but the most interesting are in claims Nos. 2,049 and 2,050. On these claims the rock has been sheared along several zones, which are approximately parallel and no one of which can be followed for more than a few hundred feet. It is evident that some of these are due to bands



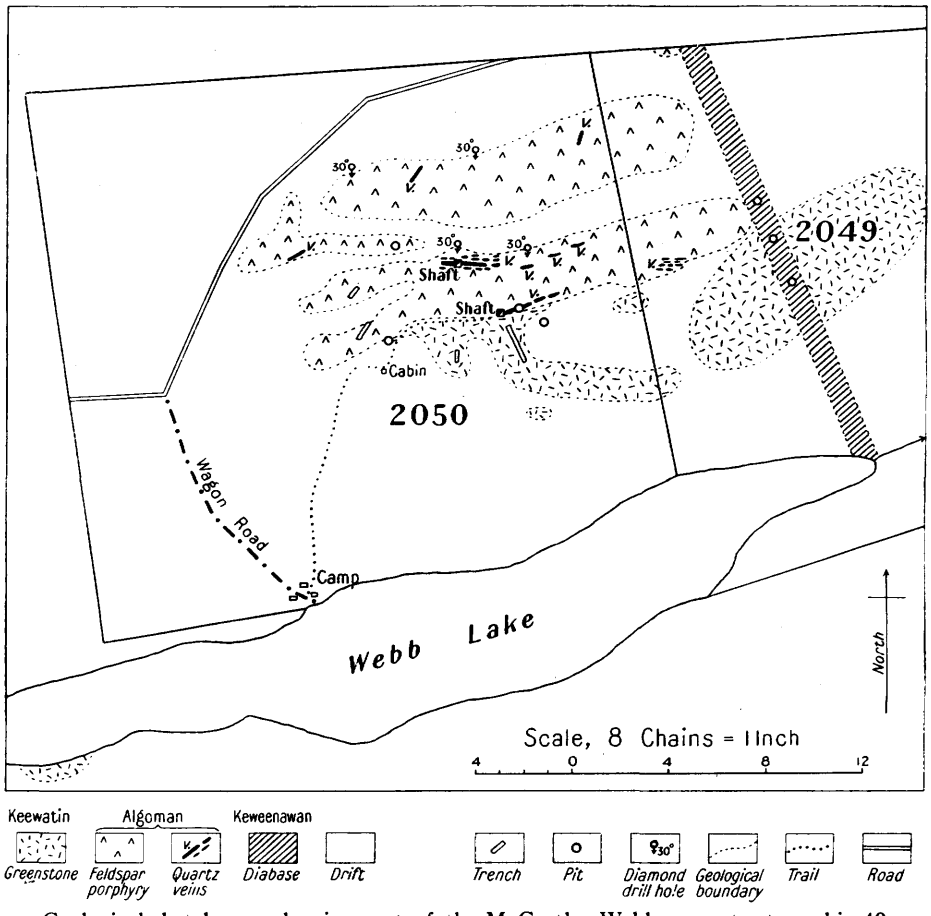
Transverse quartz-tourmaline vein on claim No. 2,051, McCarthy-Webb property, Goudreau area.

of schisted greenstone having been caught in the intrusion, since traces of greenstone may still be found as streaks in the intrusion.

Where the rock has been sheared it is altered to sericite and chlorite schist, highly impregnated with quartz and to some extent with carbonate. Some veins cut across the strike and these contain much tourmaline, but in no place were they found cutting the quartz of the shear zones. In some places these tourmaline-rich veins followed the shearing and seemed to be a part of the other vein system. In claim No. 2,051 to the west a number of these cross veins,

which occur close to the road to Goudreau, are rich in tourmaline but barren of sulphides.

There are two shallow shafts and at least four diamond-drill holes on the property (see map below). The shafts, which are 145 feet apart and on different veins, are both full of water at present, but they are said to be 25 and 30 feet deep, respectively. The more southerly one is vertical and is close to the greenstone contact on a mineralized zone which has a width of about 12 feet. The other shaft dips 60° N. and is on an 8-foot well-mineralized



Geological sketch map showing part of the McCarthy-Webb property, township 49.

zone highly impregnated with pyrite. Gledhill reports an assay by the Provincial Assayer from a specimen of the well-mineralized schist, which gave $30.20 in gold per ton. Assays made by others show values from a few cents to $60 to the ton. In addition to pyrite, which is much the most abundant sulphide, the veins carry chalcopyrite and pyrrhotite.

The ore bodies consist of narrow quartz veins and zones of schist impregnated with sulphides, quartz, tourmaline, carbonate, and chlorite. The larger bodies have indefinite walls, and it is very difficult to determine their boundaries. These will be assay walls in mining and the high-grade ore will be diluted by large quantities of low-grade material. There are some bands of good width

containing excellent ore and there are numerous small bands carrying considerable values that will help to raise the average gold content. It is evident that with this low average gold content a large tonnage of ore will have to be mined to make operation profitable on the property.

Claim No. 2,138, Township 49

On claim No. 2,138 on the northwest side of Lovell lake, township 49, Fred Brandt did considerable test-pitting and trenching during the past summer. The work was done with a portable air-compressor and machine-drills. The formation here is an intrusion of coarse grey granodiorite cut by stringers of



Shafts Nos. 2 and 3, Cline Canadian property, Goudreau area.

quartz carrying a little gold. The veins in turn are cut by small dikes of aplite largely altered to carbonate.

Northeast along the Pic road from Lovell lake, some quartz veins carrying gold have been found by Mr. Brandt.

Cline Canadian, Township 48

A little surface work was done last summer on the Cline Canadian property in township 48. A rock trench about 20 feet long was cut across an intrusion of mineralized porphyry at a point about 325 feet southwest by west from No. 3 shaft, the western shaft on the hill. Most of the porphyry across the 20-foot trench is mineralized, but two bands in the porphyry consisting mostly of quartz are rich in pyrite. It was reported to carry good values in gold. A specimen of the well-mineralized rock assayed by the Provincial Assayer yielded: gold, 40 cents per ton; silver, none.

Jackfish Lake, Township 26, Range XXVI

The writer's assistants mapped the area immediately surrounding Jackfish lake in order to determine whether there were evidences of faulting or other

favourable structural features in that section. No definite evidence of faulting on an appreciable scale was found near the lake, and the quartz veins seen were all small and without promise of economic importance.

Towagmac, Smith Lake, Township 27, Range XXV

An inspection was made of the Towagmac property, which is situated on the southeast side of Smith lake. The buildings stand on the hill about 600 feet back from the lake, and the workings are on a greenstone ridge 15 chains by road beyond the camp. Smith lake is about 5 miles by wagon road, part of which is very rough, from a siding on the Algoma Central and Hudson Bay railroad, south of Alden station. It is necessary to cross Smith lake to reach the property.

The rock formations are Keewatin greenstone intruded by Algoman feldspar porphyry dikes. There are several bodies of quartz and most of these contain tourmaline; the veins, therefore, are similar in character and origin to those in the Goudreau area. Some of the quartz masses take the form of "blow-outs" with large outcrops that extend but a short distance. The main vein runs along the south face of the hill and a large pit has been dug on its widest section. This pit is about 30 feet wide and runs across the strike for 75 feet. In it there are several veins and small dikes of porphyry. In one place there is 14 feet of quartz where two veins come together. The veins are very irregular in width, and they pinch rapidly within a short space. The quartz is well mineralized in places with pyrite and a little galena, and the more barren portions carry considerable tourmaline. Native gold was found on the rock dump.

After the large pit was sunk on top of the hill, a tunnel was driven into the hill from the valley on the south side of the ridge and about 45 feet beneath the pit. Altogether about 700 feet of tunnelling has been done. Very little quartz was encountered in the main tunnel but in one of the branches, of which several were driven in an effort to pick up the vein, a body of quartz was encountered. It varies from a vein of solid quartz 6 to 8 feet thick to a lode about 10 feet thick made up of stringers of quartz. The dip of the vein changes from 20 to 50 degrees within a short space in the tunnel and the width is very irregular. The property has been abandoned and all machinery removed.

DESCRIPTION OF PROPERTIES IN THE MICHIPICOTEN AREA

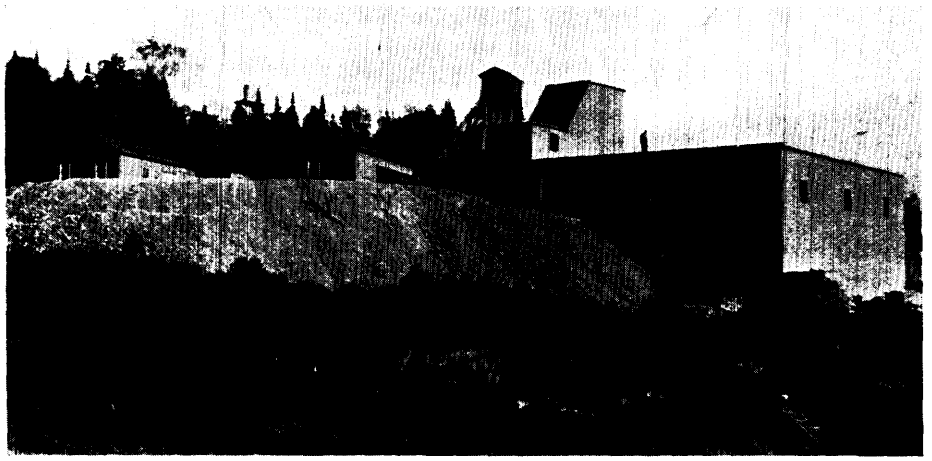
As previously stated time was not available for areal mapping in the Michipicoten area, but some of the new developments at the Minto and the Parkhill were investigated.

Minto Gold Mines, Limited, Township 29, Range XXIII

Minto Gold Mines, Limited, has recently been organized to handle three properties, the Minto, Jubilee, and Cooper. John Knox, Jr., is in charge of operations of the new company in the area and the writer is greatly indebted to him for permission to publish much valuable information regarding the company's activities. According to Mr. Knox, Minto Gold Mines, Limited, have purchased the Minto, Jubilee, and Cooper properties from Cooper Gold Mines, Limited, for $135,000, with the intention of mining and milling the ore that has been developed on these properties. There is not enough ore on any one of them to justify the construction of mills for the individual properties but by combining the reserves and bringing all ore to the Minto mine it is believed that it is possible to develop a successful mining enterprise. The building of a 75-ton

mill was started in August, 1930, and it has been so designed that it may be built and operated at a low cost, which is absolutely essential if success is to be achieved.

The mill building was constructed in a few days. Timber for the frame was obtained near the mine and the building was sheathed with "tentest," a type of wood-fibre board. As the site of the building is on a rocky slope, a solid natural foundation was provided for much of the machinery. Some second-hand machinery is being employed. It is intended to do the mining in one shift, and while part of the mill will operate continuously, power will be conserved by utilizing the load for the ball mills when not required for mining and coarse-crushing. Tables will be used, and about 8 tons of concentrates a day will require fine grinding to probably 300 mesh, certainly over 200 mesh, while the rest of the ore will remain quite coarse. It is expected that only one man will be required to operate the mill at one time, except when milling Jubilee ore,



New mill and shaft-house at the Minto mine, Michipicoten area.

when an extra sampler will be needed. All treatment will be by cyaniding and no amalgamation tables will be provided.

As this may be considered an experiment in mining and milling, the results will be watched by mining men with considerable interest because of the possibility it opens up for operations in other fields where there are several small deposits adjacent to one another which might be handled by one company with a small mill constructed at low cost.

Minto Mine.—A detailed description of this mine is given by Gledhill.[1] An old shaft, known as No. 1 shaft, which was sunk many years ago to a depth of 100 feet, has been deepened to 125 feet. It is inclined and follows the vein, dipping 48° E. A new vertical shaft was sunk about 1,200 feet southeast of the old one to a depth of 345 feet. Levels were estabished at 125, 225, and 325 feet, and about 4,000 feet of drifting and crosscutting has been done. About 2,000 feet of diamond-drilling has also been done in eight holes, the deepest of which is 450 feet. An ore shoot ending at the 3rd level has been developed, and 54,000 tons of ore averaging $11.20 a ton has been blocked out.

[1]T. L. Gledhill, "Michipicoten Gold Area, District of Algoma," Ont. Dept. Mines, Vol. XXXVI, pt. 2, 1927, p. 34.

The Minto vein varies considerably in size from point to point and averages from 5 to 6 feet in width. It consists of quartz and ankerite gangue with pyrite, chalcopyrite, and pyrrhotite. Native gold is rarely seen with the naked eye. The sulphides are massive in parts of the vein. In places there is considerable schist mixed with the quartz, and it is impregnated with or replaced by sulphides. Tourmaline is also a constituent of the vein, which has been crushed, intruded by several transverse lamprophyre dikes, and later faulted on rather a large scale. According to Gledhill, some of the crushing occurred at the time of mineralization and permitted deposition of higher grade ore. The vein cuts sheared diorite near quartz porphyry intrusions, which are mineralized in some places along the vein.

Jubilee Mine.—This mine is situated on the west side of Jubilee lake a little over half a mile north of the Minto. According to Mr. Knox an inclined shaft at 33 degrees on the footwall has been sunk to 546 feet. The 1st level at 185 feet is not developed, but the 2nd level is developed at 285 feet, the



The Jubilee mine on Jubilee lake, Michipicoten area. The "Jubilee break" runs through this lake.

3rd at 410 feet, and the 4th at 535 feet. A 125-foot winze inclined at 60 degrees runs to the 5th level. Drifting and crosscutting on the 2nd, 3rd, 4th, and 5th levels amount to about 8,000 feet. The shaft was started in December, 1927, and mining ceased in April, 1930.

The Jubilee deposit when discovered gave promise of being of much importance. There was an important break in the formations along the lake, and veins were found on both the east and west shores. Diamond-drilling was started and 30 holes were put down on the east side of the lake, the deepest being 800 feet. A number of good bodies of quartz were found, but the drilling results did not check up well when underground work was performed. Several large lenses of quartz were found by underground operations, one of which contains about 35,000 tons of ore carrying $7 in gold. This lens has a maximum width of about 75 feet and it is about 250 feet in length and the same in height. It dips 45 degrees and is sheared at 33 degrees. Another body about 100 feet long and 4 feet wide was intersected at the 3rd level. It carries about $9 a ton across this width. Eight vertical diamond-drill holes were drilled from the 4th

level to an average depth of about 250 feet. Little quartz was encountered at depth.

It is planned to construct an aerial tram to transport the ore from this mine to the mill at the Minto.

The formations on Jubilee lake are greenstone, dioritic rocks, and porphyry. Some of the porphyry is very much silicified and exceedingly hard to drill. A thin section from a specimen of this hard rock shows that it is a silicified feldspar porphyry with crushed and recrystallized phenocrysts of orthoclase and plagioclase in a groundmass rich in quartz, in which the grains are highly intergrown. The rock contains a little carbonate. There is a very blue rock in this mine similar to that on the Parkhill property. It is a fine-grained, highly altered igneous rock consisting of feldspar, quartz, carbonate, biotite, tourmaline, chlorite, and a blue mineral that corresponds closely to glaucophane and imparts the blue colour to the rock. The colour of this mineral is similar to much of the tourmaline in the veins and country rocks of the area.

There has been a great deal of shearing along the Jubilee break since the time of ore deposition. Faulting and shearing have broken up the quartz bodies and displaced them, giving rise to the difficulties in developing the mine. It is the writer's opinion that there was some movement along this disturbed zone before or at the time of ore deposition, but most of the movement occurred later, in the Keweenawan, when the large faults along Wawa lake were formed. This break can be traced into one of these faults.

Cooper Mine.—The Cooper and Ganley veins are on a property known as the Cooper, situated about 1.7 miles northeast of the Minto mine. A small inclined shaft has been sunk on the Ganley vein. The vein at the shaft is about 4 feet wide and dips about 45° N.E. It carries considerable pyrite, chalcopyrite, pyrrhotite, and tourmaline. Stripping exposes the vein for 100 feet or more from the shaft, and it appears quite strong. The dip flattens towards the end of the exposure to about 25 degrees, and a relatively large quantity of the ore can be recovered at shallow depth.

The Cooper vein runs parallel to the Ganley a short distance to the north. Where exposed it is about 1½ to 4 feet wide and quite well mineralized.

Mr. Knox estimates that about 6,000 tons of ore, averaging $10 a ton, can be mined on this property at a low cost and that it can be hauled to the Minto mill in winter.

Parkhill, Township 29, Range XXIII

The Parkhill property, formerly known as the Longbottom, comprises five claims, Nos. 3,129, 3,124, 301, 3,109, and 3,493. It lies about half a mile southeast of the Minto mine on the road from the Grace mine to the Minto. There is wagon road connection with the railroad at Wawa, via the Minto and Jubilee mines, and with the Mission, near the mouth of the Michipicoten river, via the Grace mine.

The writer and his party are indebted to J. A. S. Roussac, engineer and manager, for hospitality while visiting the mine and for data regarding the operations. The surface development work accomplished at the time of the writer's visit consisted of considerable trenching, stripping, and test-pitting. Shaft-sinking began on May 1, 1930, and an inclined shaft dipping 40° S., had been sunk on the vein to 240 feet. Two levels had been opened at depths of 125 feet and 240 feet, and about 600 feet of drifting had been done. The Pioneer Mining Company, when they controlled the property, drilled 3 holes, said to be about 400 feet deep, on the south side of Trout creek. The writer is informed

that a 60-ton mill has since been constructed. The insert map facing this page shows the position and extent of the workings and the geology of the property.

The ore occurs in veins which vary greatly in width. Lenses of ore connected by stringers or separated by barren sections of rock are characteristic of the veins. Underground there are zones as wide as the drift composed of shattered rock, which breaks up on blasting into very angular fragments a few inches to a foot or more in diameter. One lens of ore was cut in the shaft and again on the 100-foot level. This lens is about 60 feet long and is said to carry good values for a width of 3 feet. The widest lens seen underground consisted of about 5 feet of solid quartz. Evidences of shearing and displacement may be seen in the workings. Most of the shearing is roughly parallel to the direction of the veins.

There are several rock formations on the property. The country rock is mostly dioritic in character. A specimen taken from the east end of the drift on the 240-foot level is a porphyrite, a thin section of which shows patches of feldspar usually with several crystals in a group and more or less radiating. The feldspars are altered to zoisite. There is much brown biotite in zones and patches as if it had been developed by metamorphism. It is probable that the arrangement of the feldspar crystals is due to the crushing and recrystallization of phenocrysts of feldspar. There is considerable quartz that has been introduced into the rock by hot solutions. The groundmass is medium coarse in grain.

Streaks of greenstone in the diorite apparently represent remnants of Keewatin greenstone caught as roof pendants in the intrusion. There are several exposures of agglomerate consisting of angular fragments of what appear to be a Keewatin acid rock.

The quartz veins, which are almost entirely in the dioritic rock, are cut by a number of small dikes, which apparently belong to the lamprophyre group, although in many places they are so altered that it is practically impossible to recognize the original rock. In a pit 150 feet east of the shaft, a dike about 2 feet wide runs parallel to the main vein. It is cut by stringers of quartz and replaced by that mineral. The rock has a very striking blue colour, especially where altered. A thin section shows that it is fine grained and contains quartz and much carbonate, and also what appear to be remnants of crushed and largely replaced phenocrysts of feldspar and considerable strongly pleochroic biotite showing very distinct haloes and blackened patches. The blue colour is due to a large proportion of a felty, light-blue mineral about the colour of some of the blue tourmaline common in this region. Part of the mineral is distinctly pleochroic, strong blue to slightly violet or lavender, and grey blue to almost colourless. The axis of strongest absorption is at right angles to that of tourmaline. It is a difficult mineral to determine accurately, because it is in a fibrous and felty condition, but it is apparently glaucophane or an amphibole very close to it. The writer is indebted to Dr. T. L. Walker for his opinion on this mineral, which he regards as glaucophane. The mineral is secondary, as it cuts and replaces some of the biotite. It is similar to the blue mineral mentioned as coming from the Jubilee mine.

A dike on the 240-foot level from 6 inches to a foot wide is almost completely replaced by carbonate, which makes up about 95 per cent. of its volume, the rest being quartz. There are two vertical dikes of this type in the workings.

The veins consist chiefly of quartz with some carbonate. They contain pyrite, pyrrhotite, chalcopyrite, a little arsenopyrite, and native gold. Gold was visible in a number of the pits. The main vein, which has a maximum

width of about 4 feet of solid quartz, is irregular and not continuous. Lenses of good ore alternate with barren sections, and the conditions on the surface are similar to those underground. Near the road, close to the bridge over Trout creek, a short section of a vein is exposed in a pit from which some ore has been shipped for a test. It has been suggested that this is a section of the main vein displaced by faulting, but there does not appear to be much evidence of faulting and the writer regards it as a separate parallel lens.

West of the shaft about 500 feet, the vein is lost in a drift-filled depression, which extends a considerable distance along the strike of the vein, S. 70° W., as a distinct topographic feature. Considerable shearing has occurred along the zone in which the vein lies, and this apparently accounts for the depression.

Claim A.C. 2,301, Township 28, Range XXIV

Last September a discovery of gold was reported from what is commonly known as the Reid property about 2¼ miles by trail northwest of Hawk Junction on the Algoma Central and Hudson Bay railroad. An examination of the discovery, which is on claim A.C. 2,301, revealed a stripping about 45 feet long and nearly 25 feet in maximum width.

In this stripping a band of sheared greenstone is cut by veins and stringers of quartz, the widest of which is about 4 feet in width. The lode strikes N. 72° E. and has a dip of about 45° S. In places the veins dip as much as 60 degrees. Native gold was seen in a vug in the vein in one place, and sections of the quartz are well mineralized with rather coarse-grained pyrite. The vein has been exposed for about 80 feet to the east, where it runs into low land.

To the west of the main stripping the vein was covered for 50 feet to another stripping 40 feet long showing the vein varying from 3 feet of solid quartz to a band of the same width composed of stringers of quartz. Here the vein is in Keewatin acid lava instead of green schist. The hanging wall is very little sheared; the footwall shows considerable shearing and much carbonatization. There is a little mineralization in the vein on the hanging-wall side.

Still farther west, the strike and dip of the vein where exposed in strippings vary a good deal, and it is not always clear whether it is the same vein that is exposed. Some 75 feet to the north, another vein from 2 to 4 feet wide is exposed in pits and trenches. It is mineralized in places with pyrite, chalcopyrite, and pyrrhotite, and the quartz carries tourmaline, but it does not appear to be a very strong vein. The rock associated with the veins are Keewatin acid and basic lavas intruded by Algoman porphyry. The property is not far from the granite-greenstone contact.

On claim No. 2,303, about 25 chains along the trail in a general direction southeast of the vein described, there is another large vein, which is 15 feet wide where crossed by the trail and well mineralized with chalcopyrite. It is stripped in several places as far west as the shore of a small lake, a distance of about 425 feet. It maintains its width, but much of the vein is white quartz very little mineralized. It contains some carbonate and tourmaline.

It is reported that since the writer's visit another discovery of gold has been made west of the Reid property.

Lead

There are several properties in the Michipicoten area on which lead has been discovered, and attempts have been made to develop some of these properties. Mammoth Metals, Limited, sank two shafts on a property north

of Wawa lake about 1⅓ miles from the northeast end of the lake, in township 29, range XXIV. A great deal of money was spent on costly buildings, and a few tons of galena were hauled out to the railroad before the operation was abandoned. There is a nice showing of galena with a little sphalerite but there was difficulty in following the vein.

In township 30, range XXII, just south of the Michipicoten river and about 1½ miles east of Lake Superior, J. P. Legard and Frank Dubois have staked several claims on properties showing galena veins. The country rock is red, pink, and grey granite, and the veins contain galena, sphalerite, chalcopyrite, and pyrite. There are old pits on some of these claims, the dumps of which are now overgrown with small spruce. Some of the veins are practically barren white quartz, but those recently discovered are well mineralized with sulphides. One vein, apparently on claim No. 6,750 (the claims have been restaked more than once), is exposed for 200 feet in trenches and pits along the north face of a small granite hill. It is about 3 feet wide at the west end where it runs under drift and 5 feet wide near the centre; it pinches out at the east end. Parts of the vein are heavily mineralized with galena, chalcopyrite, and pyrite. The sulphides run mostly in streaks and patches. One band of galena 2 to 6 inches wide runs through the vein parallel to the dip and tends to follow the hanging wall.

On top of the hill about 15 feet south of the main vein, a parallel vein runs through the hill. It runs out into stringers at the west end and is about 5 feet wide where it disappears under the drift cover to the east. It is not so well mineralized as the main vein, but it carries some sulphides. Between the two veins the granite is somewhat fractured, and the spaces between fragments are filled with quartz, which is mostly barren.

A sample of the better mineralized vein material was assayed by the Provincial Assayer and gave the following results: gold, $9.60 per ton; silver, 3.34 ounces per ton; lead, 7.39 per cent.; copper, 1.80 per cent.

There are a number of other small, mineralized veins on the properties, but the one described is the most interesting that was seen.

Iron Ore and Pyrites

Nature and Origin of the Iron Ranges

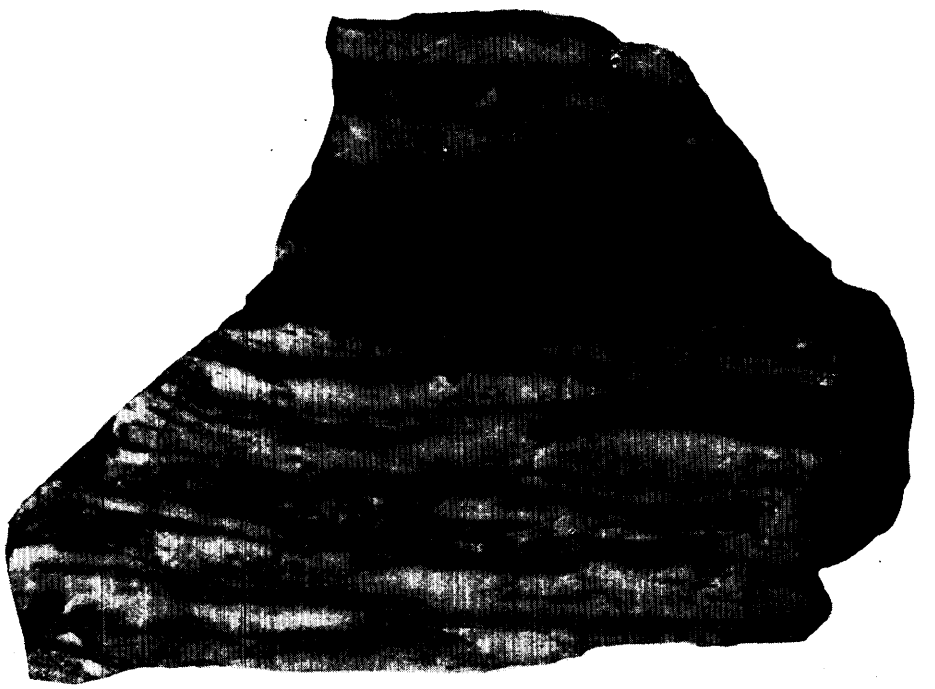
Most of the iron ranges of the Michipicoten and Goudreau areas differ from the majority of those in the pre-Cambrian shield in containing a much greater proportion of pyrite and siderite than of jasper. The banded silica is present in most of the deposits, but there is relatively little jasper, hematite, or magnetite in most of the larger ranges. The silica in many cases is a white to grey, granular type interbanded with carbonate. As pointed out by Collins and Quirke,[1] the following association is a very characteristic one: acid lava or tuff, carbonate, pyrite, banded silica, and basic lava in ascending order. There is much evidence to show that the carbonate in many places is a replacement of the acid rock that underlies it, as remnants of some of the minerals of this rock may still be seen in the carbonate. There are a few carbonate formations without banded silica and of such a nature that they appear to be more like ordinary limestone or dolomite than siderite of an iron range. They are massive carbonate bodies recrystallized and of considerable extent. One of these is the dolomitic formation on the Gibson claims, which lie across the northern part of the east

[1]Op. cit., p. 71.

boundary of township 29, range XXIII, in the Michipicoten area. The rock contains traces of manganese and about 7 per cent. of metallic iron and, where weathered, gives a coating of high-grade hematite.

Another body of carbonate without banded silica or pyrite lies just northwest of Nicho lake in the Goudreau area; according to an analysis made for the writer by G. H. Charlewood, of the University of Toronto, it has the following composition:—

	Per cent.
CaO	53.80
MgO	.38
MnO	.22
FeO	1.01
Fe_2O_3	.80

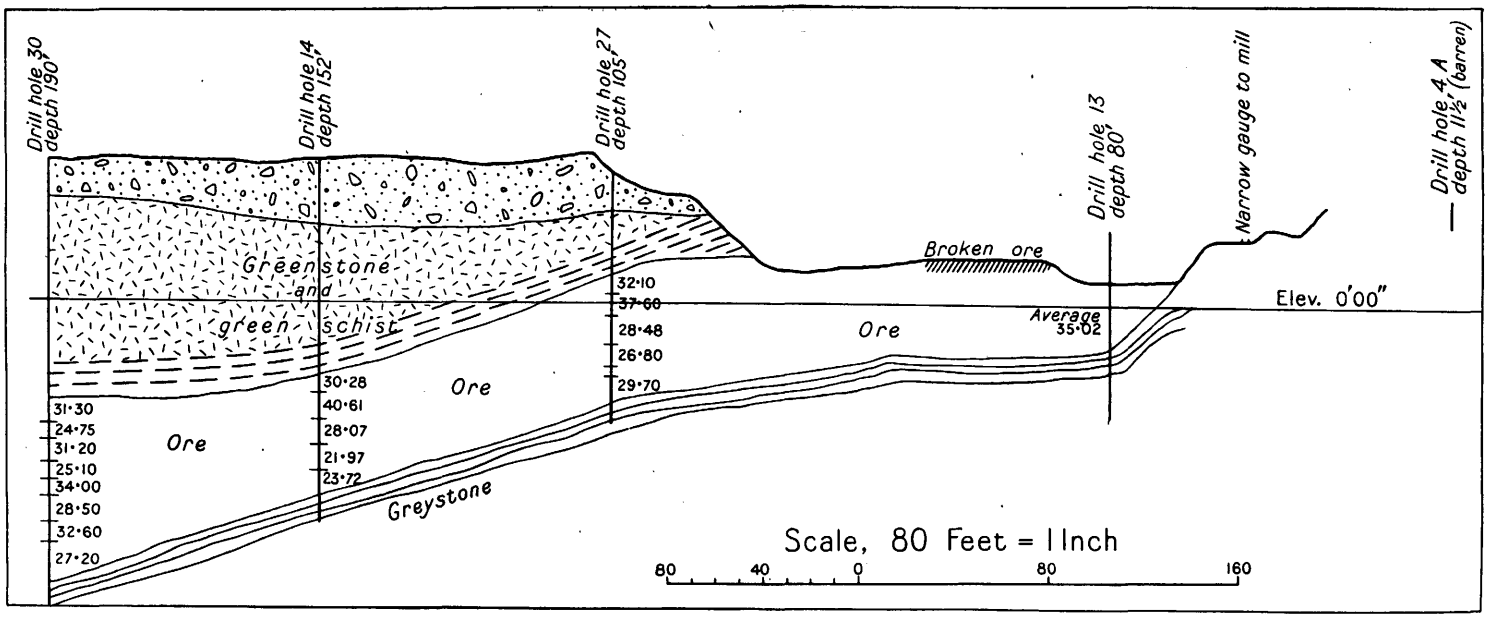


Specimen of brecciated silica of the banded iron formation showing silica replaced by pyrite, taken from "C" pit, Nichols Chemical Company, Goudreau area.

This rock, from the analysis, is practically calcite. It is very coarse grained and contains practically nothing but large crystals of carbonate and a few grains of quartz formed by replacement at the borders of the grains.

Collins and Quirke have suggested a hot-spring origin for the silica, carbonate, and pyrite of these ranges, although they point out that this theory would not be applicable to those iron ranges in other pre-Cambrian areas that are associated with ordinary sediments, such as slate, greywacké, and arkose, rocks practically absent in the Michipicoten and Goudreau ranges.

According to the hot-spring theory, banded silica was deposited on land and in local bodies of water on the surface of a volcanic region. Beneath the surface the ascending waters from the underlying, still hot rocks attacked the acid rocks and replaced them with carbonate. The carbonate in turn was replaced



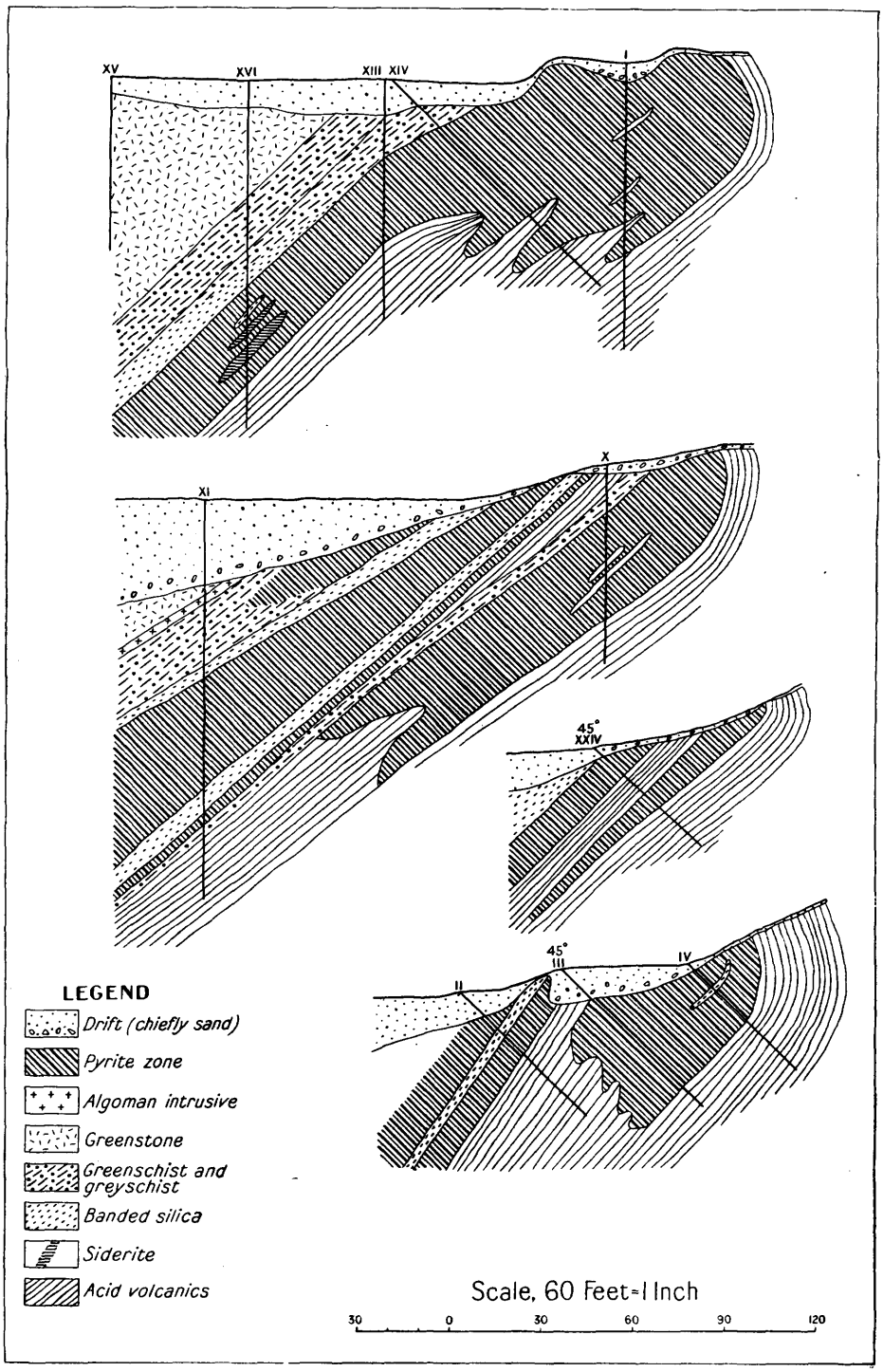
Cross-section through "C" pit, Nichols Chemical Company, Goudreau area.
Figures indicate percentage of sulphur.

by pyrite. The typical association of the carbonate with the Keewatin acid rocks indicates that the acid rocks were undoubtedly responsible in some way for the formation of most of the carbonate. A similar relation between carbonate and acid rocks is seen in the very large amount of carbonate found in the Algoman acid rocks, where veins of carbonate up to 15 feet in width have been formed largely by replacement of the walls by hot waters, although these were not hot-spring waters. Where the iron formations occur entirely within basic lava flows, the carbonate is in much smaller amount or lacking. The carbonate has replaced the banded silica to a large extent in some of the ranges. The replacement of silica by carbonate is also a common feature in many places near veins and in sheared zones in the Algoman acid rocks.

The deposition of silica on the surface and the replacement of acid rocks by carbonate and pyrite around hot springs of the present day is demonstrated in Yellowstone Park, Wyoming. Arthur L. Day, Director of the Geophysical Laboratory, Washington, D.C.,[1] states that in boring in Old Faithful basin, about 20 feet of silica sinter was found. This was followed by 200 feet of glacial deposits and below this 200 feet of greatly altered rhyolite. In the Norris basin, there is little siliceous sinter; the rhyolite is altered more or less and traces of pyrite are found in it. Carbonate is found at many points throughout the hot-spring region, though abundantly only at Mammoth Hot Springs. The carbonate is apparently mostly calcium carbonate, whereas in the iron ranges under discussion the carbonates are mostly rich in iron. Around the hot springs on Mount Tarawera, New Zealand, the writer has seen considerable pyrite being deposited at the surface. The existence of hot springs carrying much iron might help to explain the presence of the large amount of pyrite in these ranges. Further, the discontinuous and lens-like form of the bands in the banded silica member of the iron ranges is a characteristic feature of a colloidal silica deposit formed in hot water.

In some ways the hot-spring theory furnishes the most satisfactory explanation of the formation of these peculiar iron ranges that has yet been suggested. Certain objections have, however, been made to it. One of these raised by Grout[2] is, in the mind of the writer, the most important. Grout points out that the formation of the silica on the surface, and the carbonate and pyrite accompanied by pyrrhotite just beneath the surface, by the same waters and at the same time does not seem quite reasonable. Carbonate replacement on a large scale is generally a characteristic of at least moderate depths, and pyrrhotite is generally regarded as of still deeper origin. Grout suggests that the banded silica might have been deposited on the surface, and if the rocks were then buried to considerable depth the carbonate and sulphide might have been deposited by waters of higher temperature and under greater pressure than those depositing the silica. The writer regards this as a more satisfactory theory. The banded silica would form a barrier that would help to impound rising solutions, and its presence would, in many cases, control the location of the carbonate and sulphide bodies. The banded silica in most of these ranges has been brecciated, and the pyrite and carbonate have filled the spaces in the fractured silica. The pyrite has replaced the carbonate on a large scale, as this is an easily replaced rock, but it is not certain whether the pyrite was deposited by the hot waters that formed the carbonate. It seems quite probable that the carbonate was formed during the Keewatin period by hot waters from the deeply buried, still hot lavas and that the pyrite was brought in by the Algoman

[1]Personal communication.
[2]Frank F. Grout, "Michipicoten Iron Ranges," review in Econ. Geol., Vol. XXI, 1926, p. 813.



Sections illustrating the form of the pyrite deposits on Morrison No. 3 property, Goudreau area. (Interpretation of structure by Nichols Chemical Company from diamond-drill holes.)

intrusions. The wide distribution of pyrite deposited from hot waters derived from these intrusions; the presence of considerable arsenopyrite in the carbonate of the Long Lake iron range between Leg and Cuthbertson lakes, Michipicoten; the presence of traces of gold, nickel, cobalt, zinc, and lead, metals found elsewhere with Algoman intrusives; and the geographical relations between the Algoman acid intrusions and the pyrite deposits, suggest that these intrusions may have been the source of the pyrite. The common association of pyrite lenses with acid intrusions in many other parts of the pre-Cambrian shield also supports this idea for the source of the sulphides. It would account for the occurrence of such pyrite deposits as those on the Holdsworth property, with which there is no banded silica and relatively little carbonate.

An examination of the geological maps will show that the pyrite deposits in the Goudreau area are situated in a zone in which there are several fairly large intrusions of Algoman porphyry and related rocks, and there are none found far from Algoman intrusions. In Michipicoten, the deposits are nowhere far from the granite. The deposits near Smith lake, in townships 26 and 27, range XXV, are near the granite. Where banded iron formation and carbonate are present, the brecciated iron formation and the easily replaced carbonate, particularly where it is situated in anticlines, served to control the location of the pyrite deposits. The sections (pages 44 and 46) of the pyrite deposits on Morrison No. 3 range in the Goudreau area illustrate the occurrence of the pyrite deposits and their replacement origin. The sections were prepared by D. C. Wysor, Nichols Chemical Company, Limited, from a large number of drill logs, and the writer is indebted to G. S. Cowie, of the Algoma Steel Corporation, for permission to use them in this report.

DESCRIPTION OF THE IRON DEPOSITS

An excellent description of the iron and pyrites properties in the Michipicoten and Goudreau areas has been given by Collins and Quirke[1] from data secured in the field at a time when many properties were under development and some mines were actively producing pyrite. It is unnecessary, therefore, to give a detailed description of many of these properties in this report. A brief account of a few of the recent operations in the region will, however, be given.

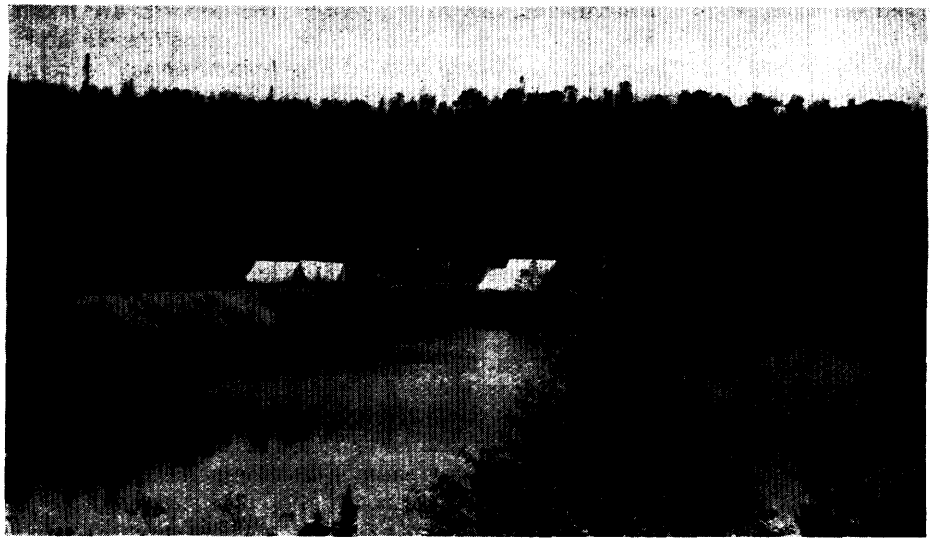
There has been renewed interest in both the iron ore and the pyrites deposits of the region during the past year. The bonus of one cent a unit on beneficiated iron ore granted by the Ontario legislature and a public sentiment in favour of developing a domestic iron-mining industry have stimulated interest in the carbonate deposits of Michipicoten. The new Helen siderite deposit is unquestionably the most promising iron deposit for development at present in sight in Canada. The ore requires sintering, but the bonus, which will amount to about 50 cents a ton on the beneficiated ore, will help to defray the extra cost of beneficiation. That the mining and sintering of such an ore is regarded as an attractive commercial operation is indicated by the fact that the Bethlehem Steel Corporation last summer drilled the Ruth property on the Long Lake range in Michipicoten with the expectation of mining and sintering the siderite, even though the deposit was not expected to contain anything in ore reserves comparable in size to those of the Helen. The project unfortunately ended suddenly because the drilling showed that the siderite contained, in places, considerable arsenic and in addition the ore body was not as large as was anticipated from the surface exposure. Fortunately, it has been found on

[1]Op. cit.

reinvestigation of the Helen siderite that it is free of arsenic in injurious quantities. Normal sintering will not remove this element entirely and it is probable that it can be eliminated sufficiently for commercial purposes only by much more elaborate treatment entailing additional expense. It would have been a great national loss if the 100,000,000 or more tons of ore in the Helen had been found to contain injurious quantities of this element. It is hoped that arrangements may be made in the near future by the Algoma Steel Corporation, owners of this property, to operate the Helen mine, as the operation of an iron mine would mean much to this part of the country.

Ruth, Long Lake Iron Range, Township 28, Range XXIV

The Long Lake iron range lies between Cuthbertson (formerly Long) and Leg lakes, 5½ miles from Hawk Junction on the Michipicoten Harbour branch

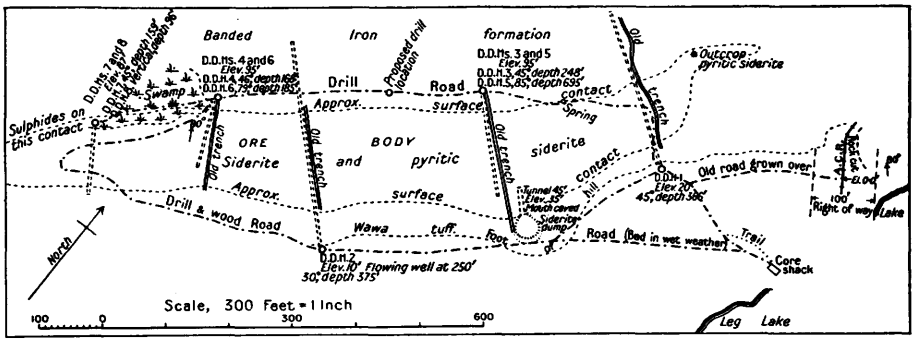


Bethlehem Steel Corporation's diamond-drill camp on Leg lake, Michipicoten area. A hill of siderite can be seen in the background.

of the Algoma Central and Hudson Bay Railway. The claims covering the main section of the range constitute the Ruth property held by Alois Goetz, of Sault Ste. Marie, Mich. Many years ago, much development work was done on this range, which revealed a large body of siderite with considerable pyrite and some iron oxides. Collins and Quirke[1] have described the surface features of the property, and according to these writers the range consists of a zone of banded silica on the northwest side from 200 to 400 feet wide and overlain by dark lavas. Below the silica zone there is a pyritiferous zone containing siderite, which is said to have a maximum width of about 200 feet, and this is followed by siderite ore, which lies on Wawa tuff and acid lava. The sketch map on page 49, prepared from data gathered by the Bethlehem Steel Corporation and kindly furnished by Mr. Goetz, shows the outline of the ore body on the surface and the position of surface workings and drill-holes. This property is particularly well situated, as the ore outcrops in a high ridge close to the railroad track.

[1]Op. cit., p. 89.

During the past summer the Bethlehem Steel Corporation secured an option on the Ruth property and put down eight diamond-drill holes to test the ore body. Unfortunately, it did not maintain the width indicated on the surface and a considerable amount of arsenic was found in the ore. The arsenic is carried in arsenopyrite, which occurs in streaks and patches in parts of the



Sketch map of the Ruth property, township 28, range XXIV, showing a portion of the surface outcrop of the ore body. (Copied from a plan of the geological department of the Bethlehem Steel Corporation.)

ore body and is disseminated in small quantities throughout the remainder. The conditions encountered led to the abandonment of operations, since the arsenic can be only partially eliminated by sintering the ore.

The following summary of the results of the diamond-drilling indicates the nature of the ore body, and it is published by courtesy of Mr. Goetz.

SUMMARY OF RESULTS OF DIAMOND-DRILLING ON THE RUTH PROPERTY

Hole	Depth	Dip	Formations and width in drill-hole	Iron content
	feet			per cent.
No. 1.....	366	45°	Tuff 65 feet.	
			Siderite 65 to 125 feet.....	12.08 to 33.92
			Siderite and sulphides 125 to 170 feet.....	32.35 to 43.48
			Banded silica and sulphides 170 to 180 feet.	
			Banded iron formation 180 to 366 feet.	
No. 2.....	375	30°	Tuff and schist 179 feet.	
			Iron formation 179 to 228 feet.	
			Siderite 228 to 280 feet.....	34.87 to 40.76
			Iron formation 280 to 375 feet.	
No. 3.....	248	45°	Iron formation 38 feet.	
			Siderite 38 to 230 feet.....	21.44 to 40.24
			Tuff 230 to 248 feet.	
No. 4.....	168	46°	Iron formation 24 feet.	
			Siderite 24 to 120 feet.....	30.17 to 40.36
			Tuff 120 to 168 feet.	
No. 5.....	677	85°	Iron formation 155 feet.	
			Siderite 155 to 677 feet.....	16.73 to 42.56
No. 6.....	185	79°	Iron formation 55 feet.	
			Siderite 55 to 177 feet.....	17.92 to 39.16
			Tuff 177 to 185 feet.	
No. 7.....	159	45°	Iron formation 15 feet.	
			Siderite 15 to 92 feet.....	28.49 to 40.70
			Schist and tuff 92 to 159 feet.	
No. 8.....	96	Vertical	Iron formation 43 feet.	
			Siderite (record incomplete).....	23.43 to 40.59

The figures given above for the siderite zones are chiefly analyses for 5-foot or 10-foot sections. Most of these sections run over 25 per cent. iron, and in many cases for considerable widths there are no analyses showing less than 30 per cent. iron. The following figures show the variations in percentage of other constituents in the ore from various holes:—

	Per cent.
Mn	0.55 – 2.08
S	.31 –33.65
P	.008– .048
As	.01 – 5.18
SiO_2	2.59 –46.98
CaO	1.22 –14.83
MgO	2.81 – 5.81
Ignition loss	12.07 –34.26

The manganese content is usually over 1 per cent., and that of the arsenic reaches one-half of one per cent. only in a few places, where zones rich in arsenopyrite occur. The combined oxides of lime and magnesia usually amount to between 6 and 11 per cent. of the ore. The presence of the manganese enhances the value of the ore, and the lime and magnesia are valuable fluxing ingredients. The sulphur in this ore body is high, as very little of it carries less than 3 per cent. and most of it much more, but most of this would be removed in sintering. The arsenic is the most objectionable constituent.

PYRITE PROPERTIES

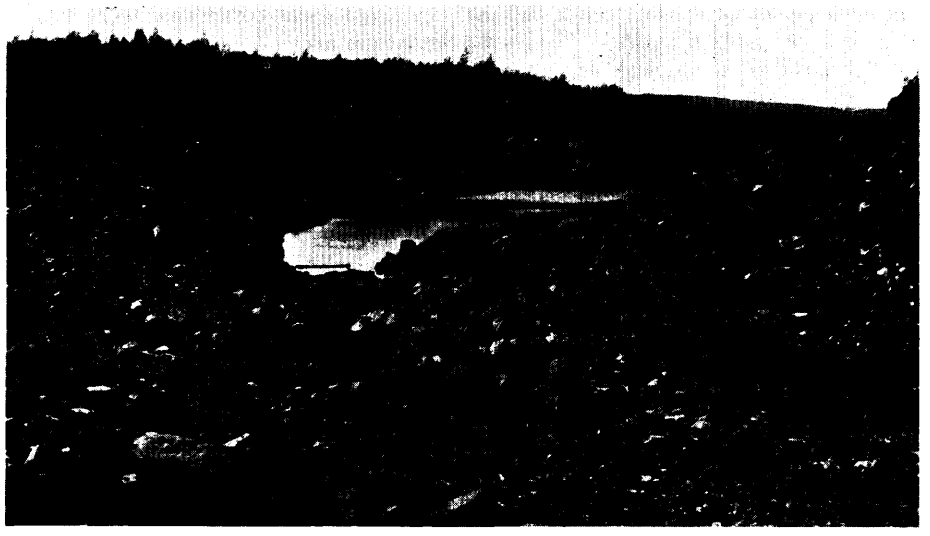
The Nichols Chemical Company, which operated several properties east of Goudreau previous to 1921, dismantled their plant two miles east of Goudreau last spring and relinquished their leases. The fine village which they had constructed has also been completely destroyed. The abandonment of their operations, which had involved an outlay estimated at over a million dollars, has been due to the competition with pyrite of native sulphur from the southern States. It is hoped that with the development of the new Freeman process or other processes for burning pyrite, the deposits in the Goudreau and Michipicoten areas, which contain several million tons of pyrite, may in the not far distant future be required as a source of sulphur.

There are evidences of an interest in pyrite in this region in the operations of the Canadian Pyrites Company, a subsidiary of the Grasselli Chemical Company. This company owns the Holdsworth property about 2 miles northwest of Hawk Junction on the Michipicoten Harbour branch of the Algoma Central and Hudson Bay Railway. This property was drilled several years ago and a large tonnage of pyrite blocked out. Last summer an electrical survey of the property was made in order that the results might be checked with those obtained by drilling. A survey was later made of the property controlled by the company on the west side of Smith lake, which is situated northwest of Manitowik lake in township 27, range XXV. This property was afterwards diamond-drilled, but since this work was done after the writer left the field he has no information regarding the results. The Holdsworth deposits are fully described by Collins and Quirke.[1] The writer visited both properties in company with Charles M. Hicks, mining engineer in charge of operations, and he is greatly indebted to Mr. Hicks for hospitality at his camp and for much information regarding the operations of the company. Thanks are also due to William Irby, field engineer of the Radiore Company, for hospitality extended on several occasions.

[1]Op. cit.

There are a number of exposures of iron formation on the Smith lake property and one of very high grade pyrite, 20 feet wide, on the northwest shore of the lake. This outcrop carries over 50 per cent. sulphur. The deposit appears to have a flat dip, only about 30 degrees. Altogether, three parallel conductors were indicated by the electrical survey.

The iron ranges on this property contain some banded silica but little carbonate, much less apparently than those on the Hamilton claims northeast of Smith lake which were prospected about 25 years ago. The exposures of iron formation are not large, as much of the property is drift-covered. The relations between the iron formation and the Keewatin acid and basic rocks are not as definite as they are in the Goudreau area, as the acid and basic lavas are



Nichols Chemical Company, "C" pit, near Nicho lake, Goudreau area. The pyrite zone is exposed on the left side of the pond.

considerably interbedded and in some cases the acid rock lies above the banded silica.

It is improbable that this company will start mining operations in the near future unless some unexpected development occurs in the sulphuric acid industry, but it is a hopeful sign when such an organization as the Grasselli Chemical Company is seeking reserves in pyrite that may be available at any time.

Suggestions to Prospectors

In prospecting for pyrites, the most favourable conditions are found along the contact of the light-coloured, acid Keewatin rocks and the dark-coloured, basic greenstone. In the writer's opinion (one not shared by all geologists who have worked in the region), the pyrites deposits will be found not very far removed from intrusions of Algoman granite or porphyry.

The main siderite deposits also occur along the contact of Keewatin greenstone and the light-coloured, acid tuffs, but iron formation is found in a few places entirely in the greenstone. Near the granite the presence of an iron range is usually indicated by disturbance of the compass produced by magnetite.

The magnetite is developed by the metamorphic action of the granite on the iron minerals in the range.

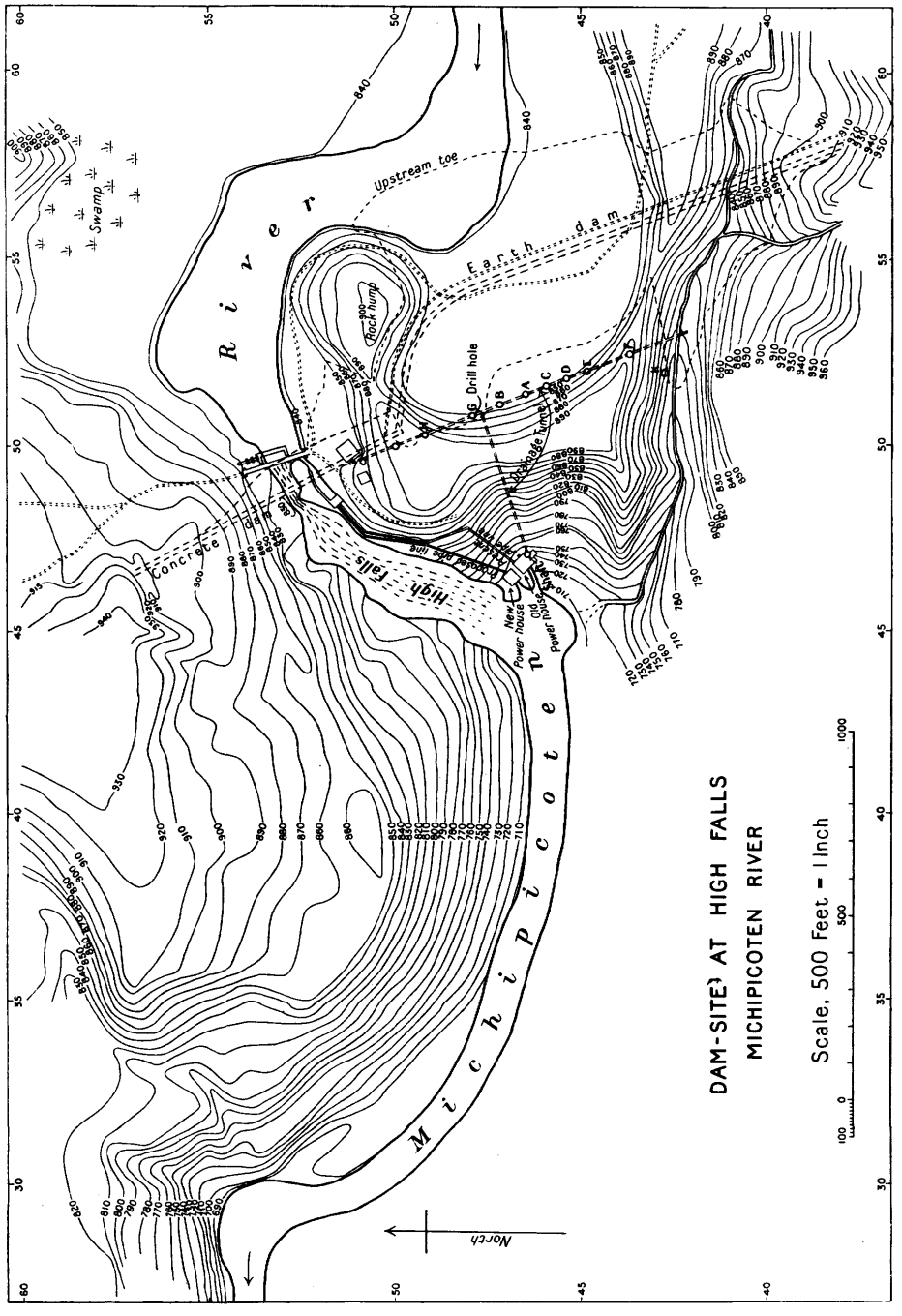
The gold deposits of economic importance so far found in this region are in or near the large intrusions of Algoman rocks, excepting the granite batholiths surrounding the mineral zones. The granite batholiths themselves are unlikely to be productive, but in the vicinity of smaller granite intrusions in greenstone geological conditions are favourable. The porphyry and granodiorite masses where sheared and brecciated very commonly carry values; and where bands of schisted greenstone occur in the Algoman porphyries and granodiorite, conditions should be favourable. Well-schisted greenstone near porphyry intrusions should be investigated, also any faulted areas if it can be proved that the faults are not later than the ore. Unfortunately few faults older than the ore have been found in the region and no very large shear zones that were formed at the time of mineralization. Sheared greenstone areas are on the whole much more favourable than areas of schisted Keewatin acid rocks, and mineralized veins with quartz gangue are much more promising for gold than those consisting chiefly of carbonate. Areas of greenstone, especially if sheared, lying along the strike between two bodies of Algoman rocks of considerable size should be carefully prospected for signs of mineralization.

Hydro-Electric Power Sites

There are several valuable water-power sites on the Magpie and Michipicoten rivers in the Michipicoten area. Electric power can be made available for all developments that are likely to occur in the mining industry. Two hydro-electric sites have been developed, one at Steep Hill falls on the Magpie and the other at High Falls on the Michipicoten. The Algoma Steel Corporation operated a plant at Steep Hill falls to supply power for the Helen and Magpie mines, and later to the Goudreau gold mine, but it is now idle. It was capable of furnishing about 2,600 horse-power. There are two other sites on the Magpie river that are capable of producing together about 7,175 horse-power.

The plant at High Falls on the Michipicoten river, owned and operated by the Algoma District Power Company, is the only one in the region that is now in operation. Power is now transmitted to Sault Ste. Marie and to all the mines in the Michipicoten area. A line runs to Goudreau and the Goudreau mine, and power is supplied to all the villages in the intervening areas. A new power-house has recently been constructed, and a dam was under construction in the autumn of 1930. The river has a fall of 128 feet at this place, and it was intended by means of a concrete dam to raise the water nearly 100 feet higher. The original falls was capable of producing about 7,500 horse-power, but it was hoped to develop about 35,000 horse-power. There is good storage capacity on the upper part of the Michipicoten river, as Manitowik and Dog lakes on its course are two of the largest lakes in this part of the country. In preparing for the dam, a very peculiar geological condition was encountered. It was found that, although the river tumbles over solid rock at the falls, a short distance to the east there is a pre-glacial valley, the bottom of which lies 88 feet lower than the foot of the present falls. This valley is full of glacial drift and stratified silt, sand, and gravel. The glacier in passing over this area in Pleistocene time piled drift into the valley and on the retreat of the ice the waters of a great lake, Lake Algonquin, worked over the drift and deposited on top of it stratified silt, sand, and gravel carried into it by streams. It was necessary to revise the plans for the dam and it was decided to construct a concrete dam with a rock

foundation at the head of the falls and build an earth dam across the ancient valley. This dam is 32 feet high; and instead of the head of over 200 feet contemplated, there is one of 150 feet.



It is a marvel that the existing falls has not been destroyed. In times of flood the river has swung in a big eddy behind the humps of rock which project along the east side of the falls and cut away all but a narrow ridge of gravel,

which prevented it from rushing over the gravel embankment. If it had only once topped this ridge, it would have very quickly cut away the gravel and silt to the foot of the falls and they would have disappeared.

In building the earth dam, a wide trench was cut across the ancient valley sufficiently deep to remove most of the gravel and coarse sand and secure a foundation in a bed of less porous, fine, stratified silt. On this the earth dam was constructed. To prevent excess seepage from weakening the silt and gravel barrier between the dam and the valley below, an ingenious method was adopted. A shaft 163 feet deep was sunk in solid rock under the old power plant at the foot of the falls. From this shaft, near the bottom, a tunnel was driven north to a point well under the gravel bank and a short distance south of the earth dam. From the north end of this tunnel, drifts were run east and west in solid rock beneath the ancient valley and transverse to it. A row of holes was drilled



Old and new power-houses of the Algoma District Power Company, High Falls. The Michipicoten river falls over solid rock, but in the upper right-hand corner may be seen the bank of sand and gravel that fills the ancient pre-glacial valley. The drainage shaft is beneath the old power-house.

across the valley from the surface through the gravel and to a sufficient depth into solid rock to reach the drift. These holes are screened and they drain the water from the silt into the drift, from which it flows through the tunnel into the sump at the bottom of the shaft. It is pumped from the sump to the surface.

The accompanying diagram and photograph illustrate the conditions at the falls, and the writer is greatly indebted to A. E. Pickering, general manager of the Algoma District Power Company, for the data contained in the diagram and permission to publish it.

The bottom of the pre-glacial valley lies at an altitude of 628 feet, which is only 26 feet above the present level of Lake Superior 6 miles distant in a straight line. This indicates that in pre-glacial time the Superior basin was not filled with water as it is to-day. It indicates further that all streams flowing into that basin before glaciation must have had similar deep valleys which are now filled with drift and lake deposits. Where the present streams follow these ancient valleys, there is always danger of trouble from them when power sites are being developed.

Kowkash-Ogoki Gold Area, District of Thunder Bay

By L. F. Kindle

INTRODUCTION

The Kowkash-Ogoki area embraces a territory of about 3,000 square miles lying immediately northeast of Lake Nipigon and traversed across its southern part by the Canadian National railway between Nakina and Ombabika. The height-of-land dividing the waters of Hudson bay and Lake Superior crosses the railway at Redmond. The chief mineral discoveries adjacent to the railway have been, first, the Onaman iron ranges, of a few square miles in extent, followed by a gold discovery on August 21, 1915, at Howard falls on the Kawashkagama (Kowkash) river by E. W. King-Dodds. At present the most promising of a number of gold prospects on which work is progressing is that of the Tashota Gold Mines, Limited, situated about 14 miles southeast of Tashota.

The geology of certain parts of the area has been previously described and mapped by E. S. Moore in 1909, P. E. Hopkins in 1917, and T. L. Gledhill in 1925. The present geological work has required two field seasons, 1929 and 1930. The accompanying map, No. 40*f*, is drawn to a scale of 2 miles to the inch.

Acknowledgments

Valuable aid was given in this work by the field assistants: in 1929, A. H. Stewart, J. P. Nowlan, and L. C. H. Jenkins; and in 1930, by G. H. Charlewood, H. F. Zurbrigg, and F. H. Burnaby. The writer wishes to acknowledge the helpful co-operation given to the party by the prospectors who were in the field, and the kind hospitality shown by W. A. Coughlan, resident engineer at the Tashota Gold Mines, and by Colonel Edward A. Deeds at Marshall lake. On more than one occasion the aviators of the Ontario Forestry Branch proved very helpful by bringing in supplies from Nakina.

The exact geographic location of a point on Ogoki lake was established by W. Christie, D.L.S., of the Topographic Surveys Branch, Ottawa, in the summer of 1930, and this information has been used on the accompanying map. The writer wishes to thank the Ontario Forestry Branch for permission to use their aerial sketch maps, which cover much of the country north of the railway.

The thanks of the writer are offered to Professor A. F. Buddington, Princeton University, and Professor E. S. Moore, Toronto University, for their examination of certain rock slides and critical reading of the manuscript of this report. The majority of the polished sections of the ores were made by the writer in the laboratory of economic geology, Princeton University, through the courtesy of Professor E. Sampson. The judgment of A. G. Burrows, Provincial Geologist, has been called upon in all cases of doubtful correlation. The care given by P. A. Jackson and A. Braidwood in the drawing of the maps adds greatly to their value. The careful work of Miss D. J. Ferrier, Editor of the Department of Mines, is much appreciated.

Previous Work

In 1870, Robert Bell for the Geological Survey of Canada explored the region north of Lake Superior as far as the present site of Cavell. In 1871, he surveyed the Ombabika river, en route to the Albany river.

In 1900, E. V. Neelands reported for the Department of Crown Lands as far north and east as Howard falls. In 1902, W. A. Parks made track surveys for the northeast corner of the Nipigon sheet. During 1903, W. J. Wilson surveyed on the Little Current river. The following year the survey was continued upstream to O'Sullivan lake by W. J. Wilson, assisted by W. H. Collins.

Trial lines for the National Transcontinental railway were run through the area between 1903 and 1908. The line, now the Canadian National, was completed in 1913.

E. S. Moore mapped the Onaman iron ranges in 1907 and 1908. In the autumn of 1915, P. E. Hopkins examined gold discoveries on the Kawashkagama (Kowkash) river, and the following year he mapped the country along the railway and the larger streams to O'Sullivan lake and Marshall lake. The south Onaman country was largely mapped by T. L. Gledhill in 1924. The geology shown north of the Kapikotongwa river on the west side of the map was taken from E. M. Burwash's map, which accompanies his report on the Fort Hope gold area.

Bibliography

The following list comprises the principal reports that deal with this area:—

ROBT. BELL, "Report on the Country North of Lake Superior, between the Nipigon and Michipicoten Rivers," Geol. Surv. Can., Rept. of Progress for 1870-71, pp. 322-351; "Report on the Country between Lake Superior and the Albany River," Geol. Surv. Can., Rept. of Progress for 1871-72, pp. 101-114.

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T. L. GLEDHILL, "Tashota-Onaman Gold Area, District of Thunder Bay," Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, pp. 65-85.

P. E. HOPKINS, "The Kowkash Gold Area," Ont. Bur. Mines, Vol. XXV, pt. 1, 1916, pp. 264-274; Ont. Bur. Mines, Vol. XXVI, 1917, pp. 190-226.

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E. V. NEELANDS, Report of the Geologist, Party No. 5, Report on the Exploration of Northern Ontario, Ont. Dept. Crown Lands, 1900, pp. 147-157.

W. A. PARKS, "Region Lying Northeast of Lake Nipigon," Geol. Surv. Can., Vol. XV, 1902-03, pp. 213-222A; "Report of 1902 on the Geology and Natural Resources of the Northeastern Lake Nipigon District," Geol. Surv. Can. (unpublished).

A. H. A. ROBINSON, Report of the Geologist, Party No. 6, Report on the Exploration of Northern Ontario, Ont. Dept. Crown Lands, 1900, pp. 162-172.

A. W. G. WILSON, "Geology of the Nipigon Basin, Ontario," Geol. Surv. Can., Mem. 1, 1910.

W. J. WILSON, "Geological Reconnaissance of a Portion of Algoma and Thunder Bay Districts, Ontario," Geol. Surv. Can., Pub. No. 980, 1909, pp. 1-45; "The Nagagami River and Other Branches of the Kenogami," Geol. Surv. Can., Vol. XV, 1902-03, pp. 109-120AA; "The Little Current and Drowning Rivers, Branches of the Albany, East of Lake Nipigon," Geol. Surv. Can., Vol. XVI, 1904, pp. 164-173A.

Access

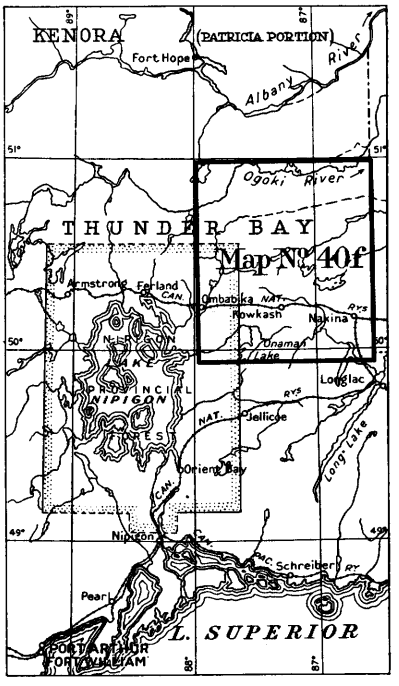
The office of the Mining Recorder for Kowkash Mining Division is at Tashota, which is also a convenient outfitting centre, as there are about as many mining claims north of the railway as there are south of it.

Waterways for canoe travel are everywhere good, and the portages are well cut out. The Kawashkagama (Kowkash), which flows into O'Sullivan lake, is the main river to the north. It is best reached by canoe from Kowkash station by way of Johnson creek. The return trip from O'Sullivan lake may be made in one day by travelling light and using a route which ends at the Kawashkagama river at a stream two miles below Johnson creek and passes

through several lakes, connected by portages. The route to Muriel lake leaves O'Sullivan lake from the end of one of the long northeasterly bays. In the winter Muriel lake may be reached by following a trail that has been cut from Cavell.

The only trading posts off the railway are at Briarcliffe lake, one an outpost of the Hudson's Bay Company and the other that of F. Gagnon.

South of the railway the Onaman country may be reached most conveniently by way of Paska at the headwaters of the North branch of the Onaman river. The river below Barnum lake is connected with the Tashota Gold Mines by a road. From the lower reaches of the Onaman river the nearest way to Tashota



Key map showing location of the Kowkash-Ogoki gold area. Scale, 70 miles to the inch.

is by Elbow lake and Tashota creek, which was cleared of fallen logs some years ago. The stream, however, is only navigable when the water is fairly high.

Physiography

The average altitude of the country is about 1,000 feet above sea-level. The topographic relief is low, and there is rarely more than 100 feet difference in altitude between the hills and valleys. A high conical hill of glacial sand and gravel lies three miles to the west of O'Sullivan lake (see sketch on page 59). The kettle lake on the summit was partly filled even in the extraordinarily dry summer of 1929. Unusually rugged granite terrain fringes the south shore of Toronto lake, and a high ridge of volcanic tuff lies half way between Deeds creek and Sollas lake. The generally subdued relief of the topography is the

result of peneplanation, the approximate reduction to one level of rocks of varying resistance.

The topography is in a youthful stage, characterized by deep, undrained depressions and abundant steep, conical hills of sand and gravel, which have been only slightly affected by erosion. The distinct irregularity in topography is formed by deposits of glacial drift associated with depressions scoured out by glaciers. The height-of-land south of Paska and Kowkash is formed of terminal moraine eskers, kames, outwash plains, and kettle lakes. The sand and gravel reaches a thickness of more than 100 feet at Tashota and Cavell and an even greater thickness between Kawashkagama and O'Sullivan lakes. A good forest growth generally covers the many low boulder ridges common throughout the region.

Hopkins[1] describes the area as follows:—

The continental divide, separating the waters of the Great Lakes from those of Hudson bay, runs in a sinuous course through the region, but nowhere is it conspicuous as a ridge. . . .



Sand cliff on the northeast shore of Marshall lake. A sand plain extends north to Meta lake.

A boss of granite three miles wide occurs at the divide, altitude 1,118 feet, at Redmond. A large swamp with streams emerging from either side often forms the watershed. Towards the northwest of the map-sheet is Summit lake, a shallow, muddy lake three miles long by a mile wide, which discharges water both ways. The Pawitik river flowing northward towards the Albany carries probably a larger volume of water than the Ombabika, the southern outlet, which is shallow and almost choked with wild rice. It seems probable that the Pawitik river channel will cut still deeper and close the southern outlet of Summit lake; thus the waters from Marshall and Summit lakes may finally flow northward, in which case the Ombabika river would have its source in the large swamp between Summit and Cross [Toronto] lakes.

Hopkins[2] reports the average magnetic declination in the area as ranging from 0° 45′ to 1° N.W.

Forests and Fires

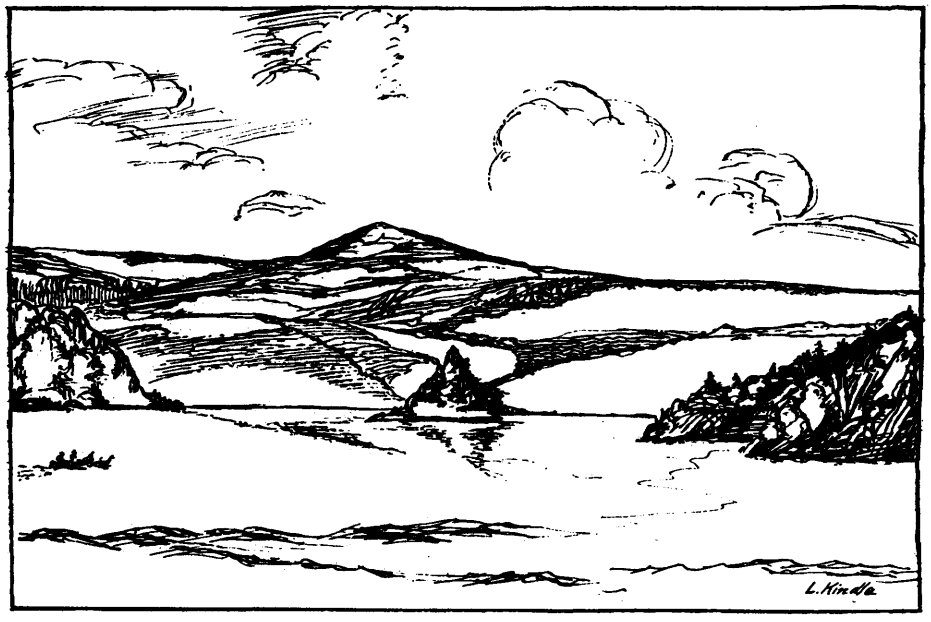
The forests of the country north of the railway have been described by Hopkins[3] as follows:—

The trees are mostly second growth and consist of small spruce, poplar, balm of gilead, jackpine, balsam, white birch, cedar, and tamarac, usually up to 8 or 10 inches in diameter,

[1]P. E. Hopkins, Ont. Bur. Mines, Vol. XXVI, 1917, p. 195.
[2]Ibid, p. 196.
[3]Ibid, p. 197.

and occasionally attaining a diameter of 2 feet or more along parts of certain rivers and lakes. Scrub ash occur on the shores of many lakes. Large portions of these forests are suitable for pulpwood, and locally for ties, posts, mining, and small timber. However, much of the forest along the railway and for several miles inland in places has been completely destroyed by fires, many of which probably occurred during the time of the construction of the railway. Because of these fires the amount of timber and pulpwood determined by the timber estimators in 1900 has been considerably reduced. Charred stubs and pieces of burned wood under the moss are relics of old fires. The best timber seen occurs on the portage between Marshall and Meta lakes. In this locality there are numerous spruce, jackpine, poplar, and birch, 18 and 24 inches in diameter.

The most extensive fire of recent years prevailed in June, 1930, around Marshall lake and to the northwest beyond the edge of the map-sheet.



View of the cone hill between Albert falls and O'Sullivan lake as seen from the bay where the lake is connected by portage with Hanover lake.

Agriculture

Localities favourable for agriculture occur in the area, but in general the region is not conducive to farming because it lies west of the great Northern Ontario clay belt. Isolated tracts of clay loam suitable for farming occur along Johnson creek, Ombabika river, Powitik river, and in other parts of the area. Potatoes, beets, carrots, turnips, lettuce, onions, and radishes have been successfully grown by prospectors. A farming community is growing up in the vicinity of Nakina.

Fish and Game

The rivers and lakes are, in general, well filled with fish. The notable localities for trout are Deeds creek and Howard falls on the Kawashkagama river. Pickerel and pike are almost ubiquitous. Lake trout are taken by the Indians from the deeps of O'Sullivan lake, and whitefish from Abamasagi

lake and the waters near the Briarcliffe lake trading posts. A fish thought to be sturgeon was obtained in trade from Indians on Ogoki lake.



Falls with a 22-foot drop on the Kapikotongwa river, three miles above Percy lake. The island is composed of rock of the Marshall Lake series.

The big game noticed in the area includes abundant moose in the South Onaman country. Their tracks were also seen in the northern terrains. Deer were seen south of Meta and Muriel lakes.



Part of the potato garden at Frank Gagnon's trading post, Briarcliffe lake.

Spruce partridge and duck occur in fair number throughout the area, as does the loon. A few geese were noticed over the waters of the Esnagami river in the autumn.

Water-Power Sites

Waterfalls of a score or more feet are common on all the larger rivers. Closest to the railway is Rupert falls on the Kawashkagama river, which drops 16 feet in 240 yards. Twelve miles downstream in a straight line is Howard falls in a 20-foot chute, 310 yards long, through a hornblende-chlorite ridge.

More abrupt and higher falls occur on the Kapikotongwa river, of which the highest is a chute of 37 feet drop in a quarter of a mile. The brink toward the centre of this gorge consists of granite gneiss.

The highest fall, 96 feet, is on the Onaman river, 6 miles above the outlet into Lake Nipigon. Six miles farther upstream, the North branch of the Onaman river falls 30 feet over a diabase dike.



Falls with 26-foot drop, four miles above Percy lake, showing the Little Current river channel cutting the Marshall Lake series.

The structural relations are not sufficiently known at the waterfalls to determine whether they mark the sites of lines of faulting.

GENERAL GEOLOGY

The solid rocks of this area are all pre-Cambrian, a part of the vast Canadian shield, which is chiefly composed of granites and ancient lavas greatly altered by metamorphism. In this area the pre-Cambrian complex consists of a succession of sediments and volcanics, mostly flows, which were repeatedly intruded by igneous rocks of various kinds.

Four series of rocks have about an equal distribution in the area; in order of age, they are the Marshall Lake series (meta sediments); Keewatin greenstones, in which all the mineral deposits occur; and the Laurentian and Algoman granites.

The successive formations are arranged in the following table with the oldest at the bottom.

Table of Formations

QUATERNARY

RECENT:	Peat bogs, swamp deposits, river silts, beaches.
PLEISTOCENE:	Stratified lake sands, sand, gravel, clay, and glacial drift

Great unconformity

PRE-CAMBRIAN

KEWEENAWAN:	Olivine diabase. Quartz diabase.
MATACHEWAN:	Porphyritic diabase.

Intrusive contact

ALGOMAN:	Pegmatite and aplite dikes, quartz porphyry, feldspar porphyry, lamprophyre, hornblende syenite, massive pink granite.

Intrusive contact

TIMISKAMIAN:	Schistose slate, greywacké, and conglomerate.

Unconformity(?)

LAURENTIAN:	Quartz porphyry(?), granite gneiss (rusty-weathering), hornblende and biotite granite.

Intrusive contact

KEEWATIN:	Iron formation. Rhyolite tuff, agglomerate, slate, and conglomerate. Rhyolite. Diabase, gabbro, granodiorite, and quartz diorite, serpentine. Basic greenstone (basalt, andesite, pillow lava) with lenses of rhyolite and quartz-mica schist.
MARSHALL LAKE SERIES:	Massive and schistose, whitish, quartzose rocks with mica, hornblende, chlorite, garnet, and staurolite; some iron formation and volcanic breccia.

Geological History

The oldest rocks of the region are termed the Marshall Lake series, a quartz-biotite schist that is thought to be of Coutchiching age. However, these metasediments may in some places be contemporaneous with volcanics related to Keewatin flows. The basal position of these rocks has been determined in other localities in Ontario, and E. L. Bruce[1] has proposed to keep "Coutchiching" for "this series of sediments beginning in earliest known times, antedating the period of Keewatin volcano activity, and possibly continuing after its close." Bruce describes a great delta of impure sands which covered Ontario as far north as Hudson bay in earliest known geological time as the probable source of the Coutchiching beds. Sedimentary iron formation constitutes a part of the Marshall Lake series.

The Coutchiching beds are followed by volcanic flows of pillow lava, basalt, and rhyolite, which have a wide distribution across Northern Ontario and were formed in the Keewatin period. During the latter part of Keewatin time the rocks formed were chiefly agglomerates, tuffs, shales, and iron formation.

The next major event was that of mountain-building accompanied by batholithic intrusion of granite, an incident described as the Laurentian revolution.

No definite unconformity has been found below the Timiskaming group of slates, greywackés, and conglomerates. These were laid down as sediments

[1]E. L. Bruce, "Coutchiching Delta," Bull. Geol. Soc. Amer., Vol. 38, No. 4, 1927, p. 781.

on the submerged flanks of the Keewatin terrain, which was undergoing denudation as a sequel to the Laurentian crustal deformation.

A second revolution, termed the Algoman, accompanied by granite intrusions, and quartz and feldspar porphyry dikes, which invaded vast portions of Northern Ontario, involved the Kowkash region intensely in the throes of mountain-making. The gold mineralization, which to date has been found only in shear zones in Keewatin country rock, is attributed to magmatic solutions. These are believed to have emanated from the interior of the granite magma and followed closely the same fissures as the granite forerunners, the porphyry dikes. The history is the same as that of the Porcupine and Kirkland Lake gold deposits.

No post-Algoman sediments occur in this part of Ontario of an age earlier than the shale, sandstone, and dolomite of the Keweenawan group, which borders the shores of Lake Nipigon. The Keweenawan is well represented by diabase dikes; and the large dikes of porphyritic diabase are believed to be of Matachewan age.

Pronounced glaciation in Pleistocene time just before Recent time has left its imprint in the form of deeply scoured depressions and a mantle of morainal deposits with consequent disarranged drainage. The level of Lake Nipigon was raised, and on its retreat the sands and gravels of its strand line were left in the Onaman river valley.

Within a few thousand years the present form of topography was completed by the growth of peat bogs and muskegs and the erosion of moraines to form the present river silts and lake beaches.

Structure

The structure of the southern half of the region is essentially that of a Keewatin basin compressed between batholiths of granites of two ages. Neither granite is confined to one part of the map-area. The sedimentary rocks and volcanics, as now exposed by erosional bevelling, dip at high angles. Northward a vast expanse of isoclinally folded remnant sediments is held in part of the granite batholith bordering the Kapikotongwa river valley.

Folding

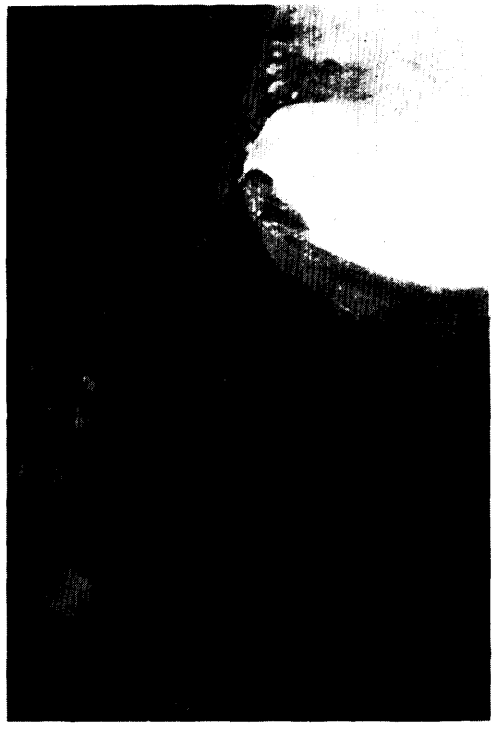
As an indication of the major structure, two bands of volcanic tuff striking east-west occupy positions to the north and south of the Keewatin portion of the basin. These horizons may be interpreted respectively as the northern limb of the syncline appearing in the tuff ridge south of Sollas lake and the southern limb appearing along the South branch of the Onaman river. This conclusion is strengthened by a study of the structure between Marshall lake and Deeds lake (see section on map No. 40 *f*). Here the metasediments appear to underlie the volcanics. This relation may be found also in the mica schists on the Kapikotongwa river north of Saga lake, in which are lodged minor bands of volcanic rocks (see section on map No. 40 *f*). The Timiskaming sediments at Conglomerate lake should be interpreted as an infolded syncline within the Keewatin system, as shown by Gledhill (see section on map No. 40 *f*).

The conspicuous northeast-southwest direction of the line of drainage seems related to the position of structural weakness in the rocks regionally. Typical of this relation the Onaman river occupies a valley between two granite batholiths in greenstone country.

Fracturing and Shearing

Contrary to the idea that northeast-southwest might be the direction of major shearing of the strata, the zones of more intense shearing and mineralization are found to lie mostly in an east-west direction. The more notable of these are, from north to south, the pyrrhotite zone at Colpitts lake; the chalcopyrite zone at Muriel lake, which is 5 miles long; the King-Dodds gold-bearing shear zone at Howard falls; and that of the Tashota Gold Mines, south of the Onaman river.

Near the edge of the batholith, however, the shearing more or less parallels the direction of the contact. Good examples of this are the mineralized veins



Deep slickenside groove in the quartz porphyry dike at the main break on the Cameron-Picotté claims, Tashota lake. This indicates vertical displacement along the fault plane.

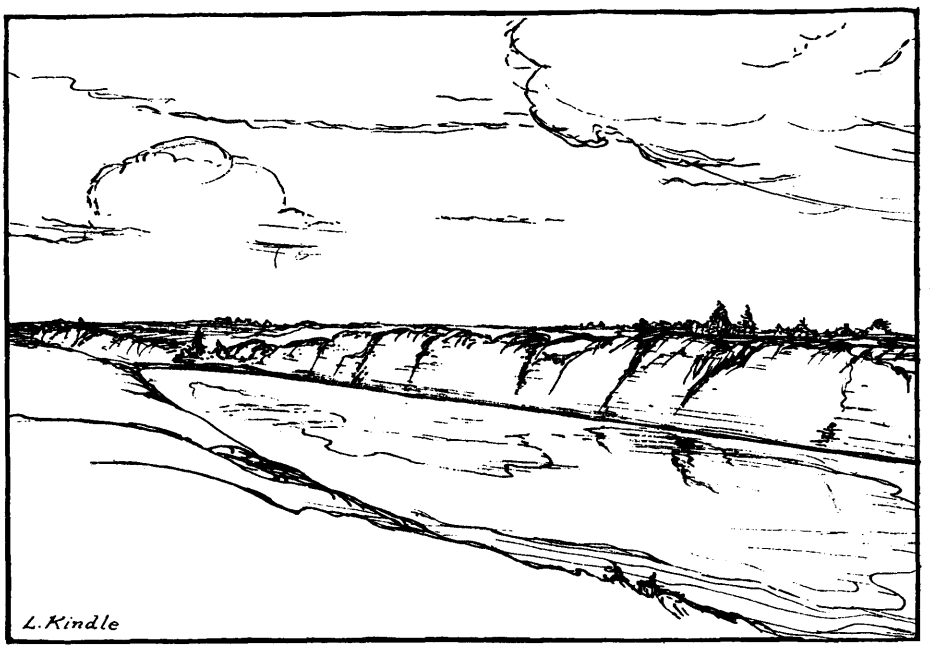
north of Tashota lake, the Adair zone of shearing, in which the strike ranges from north to 20 degrees, and the Kipper-Tashota veins three miles east of Tashota, which strike about 340 degrees, parallel to granite bosses to the east and southwest. The prevailing strike of the Keewatin volcanics and slates that nearly surround the Redmond granite and syenite boss is parallel to the periphery.

The fracture planes of the granite and syenite in the central part of the area have a north-south direction, which is true also of the narrow syenite dikes in those rocks. The pink Algoman granite half a mile south of Chaucer lake is exceptionally undistorted, but freshly massive. Two faintly marked jointing planes have a direction of 3 and 140 degrees. Abundant fracture-jointing planes

in the complex of older and younger granite of the north arm of Abamasagi lake assume many divergent directions. The conclusions as to structure drawn from the evidence here is that the granite has undergone compression from a north-south direction and a consequent widening to east and west.

Rhombic blocks have been developed in the greenstones and rhyolites by yielding to compression along fracture planes. In zones of greater pressure in the rhyolites the grinding of the edges of these blocks has developed a pseudo-conglomerate. The rhyolites have been rendered schistose, but on account of the nearly equidimensional nature of the feldspar and quartz crystals these do not show a parallel arrangement.

Schisted quartz porphyry from a shear zone in greenstone, claim K.K. 413 near the Nipigon Provincial Forest line, mileage 62, shows large "blue eyes"



Garnetiferous schist and pyrrhotite gossan at Iron lake, looking southeast. The fault slickensides on the Colpitts lake portage occur in the left background.

of quartz embedded in a green, cryptocrystalline, platy groundmass, which appears to have flowed around the hard phenocrysts. The zone of flowage in which this and other highly schisted rocks were deformed at that time lay beneath a deep burden of rock. All took part in mountain-making earth readjustments.

Faulting

Visible lines of faulting of magnitude were rarely seen, and faults observed reveal no great horizontal movement.

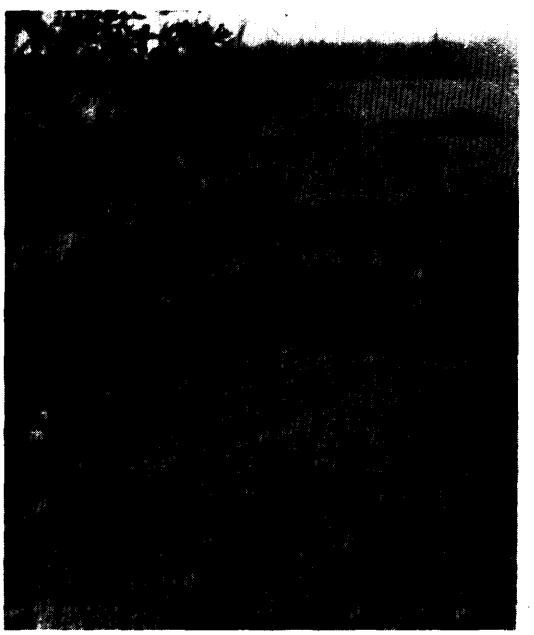
Movement to the south of a portion of the main ore vein of the Tashota Gold Mines appears to have occurred between pits Nos. 1 and 2 on the stake line. Faulting has apparently offset the western end of the pyrrhotite zone at Iron lake to the north, the horizontal displacement being less than 100 feet. The slickensides on the cliff just east of the Colpitts lake portage are evidence of vertical faulting in this zone. The slickensides dip 15° to 20° E. on the

cliff face, which dips 80° N. and extends east and west for more than a mile. This is evidently a steep normal fault.

Moore[1] describes a number of normal faults within the iron ranges, where, in one instance a large block of ellipsoidal greenstone had risen through the iron formation. Moore believes that the diabase dikes have filled fissures produced at the time of widespread faulting.

Metamorphic Derivatives

The Keewatin rocks early underwent intense alteration in the process of being turned up on edge. Thus a rock examined by Hopkins[2] from half a mile south of mileage 22 on the railway is typical of numerous others composed



Garnet schist between the south and north pyrrhotite deposits, Iron lake. The garnets (showing in the foreground) are fairly uniform in size, being about half an inch in diameter.

entirely of secondary minerals. This rock under the microscope showed a network of laths of albite in a groundmass consisting largely of calcite with small amounts of chlorite, leucoxene, and iron oxide. The more common chlorite schists are altered in the vicinity of granite and porphyry by contact metamorphism to biotite schist or to a coarser-textured recrystallized hornblendic rock, which resembles a diorite in the weathered outcrop.

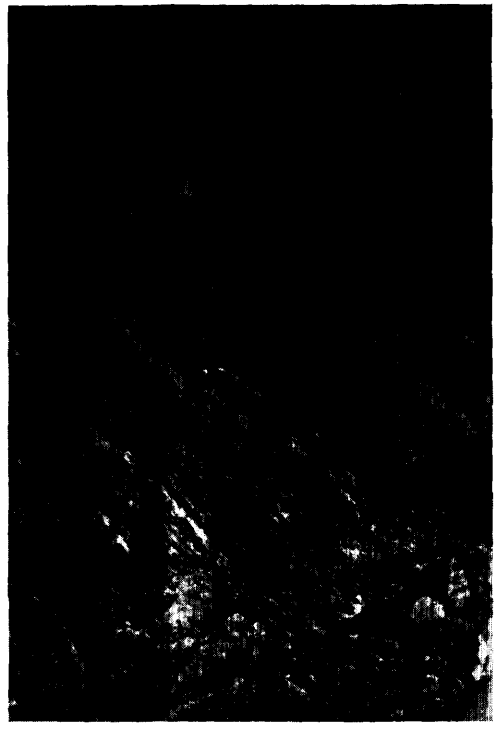
The dynamic changes induced in the rocks have developed new minerals: quartz from chert, magnetite and hematite from siderite, actinolite from ankerite, and biotite from the iron minerals. Garnets are profusely developed in the sediments, granodiorite, and diorite at Colpitts lake and are shown in the photograph above. The garnets are common in many other places as

[1]E. S. Moore, Ont. Bur. Mines, Vol. XVIII, pt. 1, 1909, pp. 210, 211.
[2]P. E. Hopkins, op. cit., p. 202.

a metamorphic mineral in the Marshall Lake series. Moore[1] describes garnets and tourmaline from the Onaman iron ranges, and the uncommon occurrence of actinolite, developed by contact metamorphism in a vitrified slate, which is apparently intruded by a rhyolite porphyry near by. There, also, biotite is abundant in the phyllites, where the slates contained much iron.

Ferruginous Carbonates

The carbonate rocks are less abundant than in the Porcupine and other areas where the geology is comparable. They are fairly common at O'Sullivan



Green-banded carbonate rock 20 feet north of the shear zone on the Cameron claim, K.K. 998, north shore of Tashota lake. The feet of the drill tripod show at the top of the illustration.

lake in the greenstone close to porphyry dikes. A siliceous rusty carbonate of this general type may be seen at the north end of the Tashota gravel pit. Also on the north shore of Tashota lake a white carbonate rock is banded green with pyroxene, epidote, and zoisite; and traces of zinc blende are present. The outcrop is shown in the photograph above. The rock is a replacement at the contact of greenstone and a band of acid volcanics and iron formation on the north side. In the porphyry, 20 feet southwest of the carbonate, which is about 85 per cent. calcite, a pit is sunk on the auriferous quartz vein of claim K.K. 998.

Bruce and Hawley[2] write as follows:—

[1]E. S. Moore, op. cit., p. 235.
[2]E. L. Bruce and J. E. Hawley, Ont. Dept. Mines, Vol. XXXVI, pt. 3, 1927, p. 14.

Carbonate rocks are commonly found as marginal zones where quartz porphyry and granitic intrusions cut greenstone. In this relationship, the rock in contact with porphyry may be completely carbonatized, and only at some distance from the intrusive will typical greenstone be found. Where carbonate rocks occur with no porphyry actually in contact with them, it can be explained by carbonatization in greenstone immediately above unexposed porphyry masses. . . . Evidently then, if the porphyry causes the alteration of greenstone to carbonates, that process must be a deep-seated and not a surface one.

In discussing the dolomite zones of Larder lake, where similar relations to igneous intrusions occur and where gold has been found, Cooke[1] concludes that after primary dolomitization of the schistose country rock by deposition of ankerite in the cleavage planes fissuring took place, probably in relief of pressure



Marshall Lake series outcropping on an island near the south shore of Marshall lake.

set up by increase in volume consequent on the addition of so much carbonate. Bruce and Hawley,[2] however, have expressed the following opinion:—

It is probable that the volume remained fairly constant. . . . To the greenstone would be added carbon dioxide and water from the igneous mass, producing carbonates and kaolin. Meantime, there would be the absorption by the porphyry of alumina and iron. This hypothesis is borne out by the fact that plagioclase phenocrysts are more abundant near contacts.

Stratigraphy

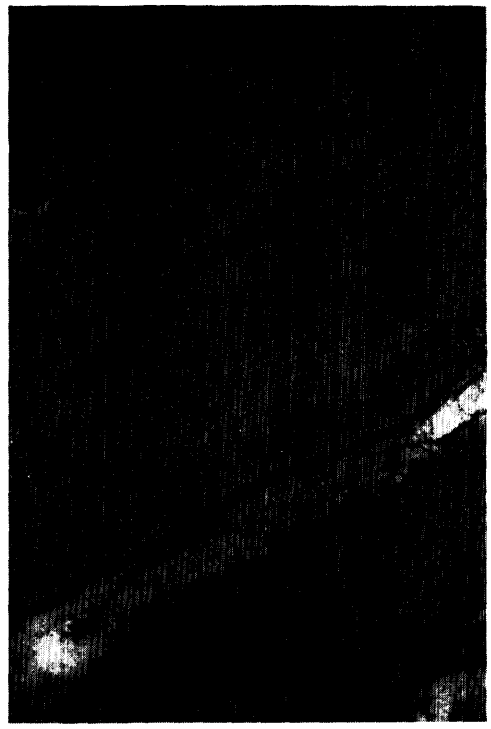
MARSHALL LAKE SERIES

The name "Marshall Lake" series was applied by Hopkins[3] to "a group of metamorphic, quartzose rocks occurring in large volume in the vicinity of

[1]H. C. Cooke, Geol. Surv. Can., Mem. 131, 1922, p. 53.
[2]E. L. Bruce and J. E. Hawley, op. cit., p. 15.
[3]P. E. Hopkins, op. cit., p. 206.

Marshall lake." The series had been classified as Keewatin by Wilson.[1] Wilson and Clark, however, in 1911 mapped this series as Laurentian. Their field relations and lithologic characteristics would place them stratigraphically in a position equivalent to the "Coutchiching delta" as now understood by Bruce (see page 62).

The Marshall Lake series underlies or is interbedded with the Keewatin volcanics north of Deeds lake and Saga lake. In distribution it is chiefly confined to the northern part of the area. Hopkins[2] describes the rocks as follows:—



Cross-bedding in the Marshall Lake series at the north end of the first portage north from Nass lake.

The series is made up of fine-grained metamorphic rocks, consisting dominantly of whitish quartzose mica schists, alternating with subordinate amounts of hornblende-garnet and staurolite-quartz schists and, rarely, with iron formation. The light-coloured quartzose mica schist contains large, angular, broken fragments of white and bluish quartz set in a finer groundmass of quartz with considerable mica and other secondary minerals. A sample from the 83-mile post on the Nipigon Forest Reserve boundary was examined microscopically and found to consist largely of quartz and biotite in the ratio of four to one, the biotite being partly altered to chlorite. Some calcite and magnetite and a few garnet masses are present. Such rocks are probably clastics, associated with which are small amounts of similar-looking rocks, which when examined microscopically proved to be igneous in character. . . . Seven samples of the whitish quartzose mica schist taken from various places in the vicinity of Lily [Gripp] lake were analysed as one composite sample by W. K. McNeill. The results were as follows: silica, 59.10; ferric oxide, 1.45; ferrous oxide, 2.16; alumina, 23.03; lime, 4.40; magnesia, 1.30; soda, 3.82; potash, 2.30; carbon dioxide, 0.57; and water, 1.97 per cent. This analysis represents closely the analysis given by A. C. Lawson for the Coutchiching of Rainy lake. . . . On the northwest shore of Albert lake can be seen a dark-coloured, medium-grained rock containing beautiful large staurolite crystals.

[1]A. W. G. Wilson, Geol. Surv. Can., Mem. 1, 1910, p. 37.
[2]P. E. Hopkins, op. cit., p. 206.

Under the microscope the staurolites are often twinned, and around these crystals bend numerous biotite flakes which are partly altered to chlorite and epidote. Much quartz and small garnet masses also occur in the groundmass. . . .

On the south central shore of Marshall lake, and immediately north of the east end of Willet lake, are narrow bands of iron formation consisting of "sugary" quartz, chert, slate, and rather thin layers of magnetite, associated with which are considerable amounts of pyrrhotite and pyrite. These bands appear to be a part of the Marshall Lake series.

Three types of this series of rocks outcrop in a succession on the south shore of Tennant lake at Pete Carlson's cabin on the peninsula. The general



Keewatin (?) old diabase enclosing a diamond-shaped fragment of rhyolite on the island in Kupfer lake.

strike is 90 degrees, and the dip 75° S. The succession from the north is as follows:—

	Feet
Garnet schist	100
Slates	60
Quartzite	30
Hornblende schist	30
Quartzite	5

A quartz-biotite schist of fine grain, which weathers a rusty brown, is a common member of the Marshall Lake series north and east of Briarcliffe lake, for example, on the west shore of the north arm of Colpitts lake.

The Keewatin amphibolite or altered diorite intrudes the series in many places. Parts of the rock which contain phenocrysts of feldspars may be confused with rhyolite or diorite. Pegmatites, which carry tourmaline, garnets, and more rarely beryl, intrude them in great number in the general vicinity of the Kapikotongwa river. The Keweenawan diabases are also common intrusive dikes.

KEEWATIN

Basic Greenstone

The basic extrusives, which are commonly recognized as "greenstones," are typically chloritic schists marked by torsion cracks and in many places by ellipsoidal and amygdaloidal structure. These rocks were originally basaltic flows; they are now in places penetrated by coarser, non-pillow, altered quartz diabase. The fresher lava exhibits a basaltic texture of rods of plagioclase set in a groundmass of pyroxene or hornblende with much chlorite, calcite, and other secondary minerals. Saussuritized feldspars are an ordinary component of the more massive greenstones, and in general much secondary calcite is present.

A small mass of altered andesite or porphyritic lava was found in contact with light grey-green basalt on the property of the Northern Airways Mining and Exploration Company, claim K.K. 1,749, on the east shore of O'Sullivan lake. The andesite occurs between the shore and the pits; it is porphyritic and is close to a narrow porphyry dike. Epidote is present as a mineral resulting from alteration. A somewhat similar porphyritic basalt from a point 7,000 feet northwest of Gzowski lake also shows epidote in thin section along with zoisite(?), pyroxene, calcite, ilmenite, and leucoxene, with some iron-staining.

Bands of quartz-mica schist, sometimes 20 feet or more in width, interbed the volcanic flows at Tashota and at Muriel lake and are described on page 76.

Serpentine

Serpentine occurs in greenstone in two places near the contact of the Marshall Lake series. The larger occurrence is partly drift-covered but is known to be about a square mile in area and outcrops along the Kawashkagama river immediately above O'Sullivan lake. The serpentine appears to be an altered peridotite which was intrusive into the altered Keewatin mica-hornblende-chlorite schists. Hopkins[1] describes the serpentine as developed from the alteration of crystals having the form of olivine. A thin section showed large areas of calcite and numerous grains of magnetite. The rock resembles slate at the last portage on the route to O'Sullivan lake, but it is composed almost entirely of actinolite. Hopkins[2] give the following analysis of the serpentine:—

	Per cent.
Silica	37.54
Alumina	6.36
Ferric oxide	5.00
Ferrous oxide	6.91
Lime	2.55
Magnesia	28.66
Soda	.70
Potash	trace
Chromium	trace
Carbon dioxide	3.06
Water (combined)	9.44
Total	100.22

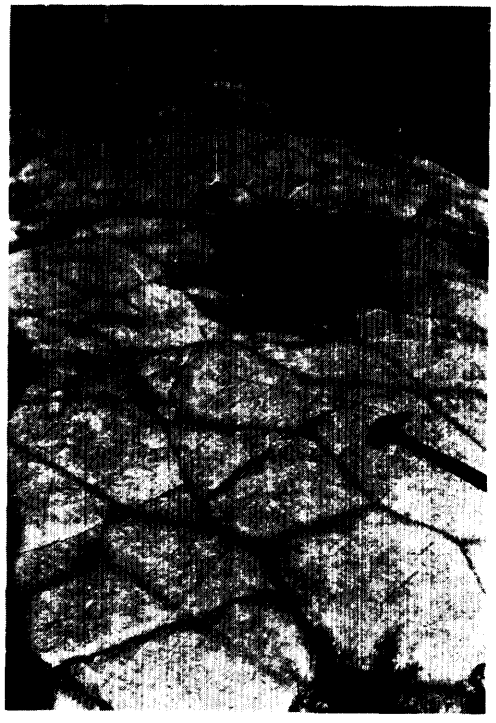
Serpentine of similar origin at the southwest corner of Toronto lake is crossed by veinlets of asbestos and magnetite, the crystals of which bear distinct olivine outlines. Chromium is absent from the metallic veinlets. The talc schist a quarter of a mile farther west may also represent an alteration phase of a peridotite.

[1] P. E. Hopkins, op. cit., p. 206.
[2] Ibid.

The serpentines described above are assigned to Keewatin time during which that system was extensively invaded by basic dikes and bosses.

Diabase, Gabbro, Granodiorite, Quartz Diorite

Basic igneous rocks of an indeterminate age penetrate the Keewatin system. The intrusives are chiefly dikes of diabase and diorite, which also attain more equidimensional boss forms where they are of greater width. Most commonly the dikes follow the strike of the volcanics. There is no evidence of more concentration of this igneous invasion in one part of the area than in another. Alteration of the rocks has left them still with many of their original character-



Jointing in a feldspathic igneous sheet on the east shore of Iron lake. This is possibly the basement below the Coutchiching sediments.

istics. A great similarity exists between these intrusives where altered to chloritic and hornblendic schists and the older Keewatin volcanics.

Sharp contacts of the diabase with flow types of the Keewatin show in the diamond-drill cores of the Tashota Gold Mines. A specimen of quartz diorite from a place east of Ledingham lake is typically coarse-textured and in the hand specimen plainly shows quartz, which, however, may be partly secondary. The hornblendes have been much altered to chlorite. Quartz is interstitial in the groundmass. Secondary calcite and epidote are abundant, and magnetite is present.

The diabase has been observed in some instances to enclose angular xenoliths of rhyolite, but it never definitely cuts masses of rhyolite in such a way that two ages of diabase may possibly be distinguished. Rhyolite fragments up to

3 feet in length occur in diabase 8,220 feet northwest of the north end of the portage into the lake west of Kupfer lake. An island in the middle of Kupfer lake is formed of a diabase fresher than the more common Keewatin diabases, and this encloses rhyolite fragments as long as 6 inches (see photograph on page 70).

The large dike of gabbro 1,500 feet northwest of the King-Dodds mine is much altered. Pyroxene is rare, the plagioclase is mostly replaced by calcite, and pyrite and ilmenite are accessory, the latter replaced by leucoxene.

Quartz Diorite Transition to Granodiorite, Muriel Lake.—This transition is clearly seen on the western island in Muriel lake. The more basic rock forms the centre ridge of the island and is gradational into the light granodiorite at the north end, 150 feet distant. The quartz diorite consists largely of hornblende with only a few feldspars. Interstitial quartz and calcite make up the balance



Thin section of a feldspathic igneous sheet on the east shore of Colpitts lake. The groundmass of this rock is largely quartz embedding orthoclase phenocrysts, biotite and magnetite, and secondary calcite. (× 17.)

of the rock. The granodiorite in thin section is seen to be formed of abundant large feldspar phenocrysts interlocked with quartz, which is abundant. Hornblende and muscovite are rare; there is some secondary calcite, chlorite, ilmenite and leucoxene, and kaolin.

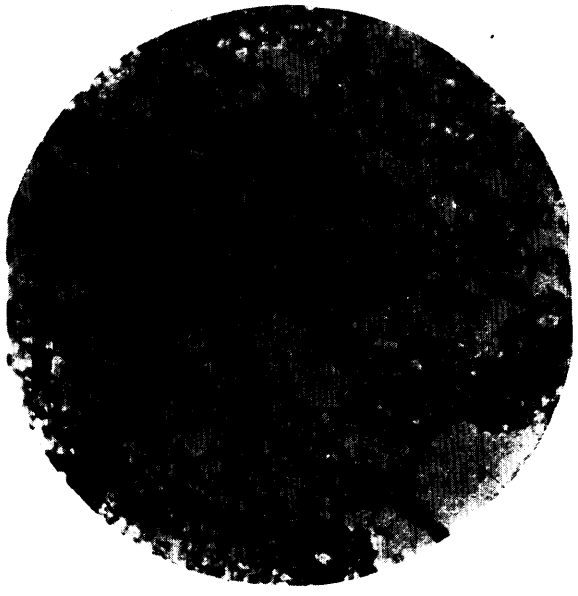
Pseudocolumnar Structure in Granodiorite, Colpitts Lake.—A feldspathic igneous rock, best described as granodiorite, lies a few hundred feet north of the pyrrhotite veins at Colpitts lake. Columnar structure is partially begun, to judge by the six-sided polygonal cracks in the rock on top of the cliff on the east shore (see photograph on page 72). A thin section (see photomicrograph above) shows the groundmass to be largely quartz holding orthoclase phenocrysts, accessory biotite, and magnetite and secondary calcite; great strain effects are apparent. This section resembles the description of a mass of rhyolite, believed to be intrusive, on the north shore of Castor lake.

The structure just described appears to have been converted into a kneaded garnet breccia a third of a mile westward across the lake close to a profuse development of garnets in the quartzose sediments (see photograph on page 66). At this place the largest garnets occur in an altered quartz diorite and form about 40 per cent. of the rock. A thin section shows abundant hornblendes, intergrown with quartz, and some feldspar.

Large and perfectly formed secondary garnets occur with a little calcite and zoisite(?).

Rhyolite

The rhyolites weather light and, on close examination, show a pink colour. They are interbedded with basic flows and appear to be flows themselves.



Thin section of rhyolite or sedimentary schist from claim K.K. 1,895. This shows muscovite and biotite in a groundmass composed largely of quartz, in which the feldspars have altered to sericite. The veinlet is epidote. The dark grain is pyrite. (× 17.)

Rarely, dikes of rhyolite cut the greenstone. Generally the rhyolite grades into the overlying agglomerate, tuff, slate, and iron formation.

There are two kinds of rhyolite. The coarser one is composed of white quartz phenocrysts, commonly three-sixteenths of an inch long, and feldspar crystals in a glassy light-grey groundmass. This variety grades to a dark-grey porphyry, which resembles chert. The former may be seen a quarter of a mile north of Paska station. The cherty rhyolite occurs at mileage 31½ on the railway.

Rhyolite dikes occur in the greenstone on the shore of O'Sullivan lake and eastward to Muriel lake and beyond. Here, in the sheared chalcopyrite zone, they are typically rusty with pyrite. Larger masses of rhyolite in the shape of lenses up to 60 feet wide are difficult to distinguish from sedimentary rocks, which as a general rule are somewhat darker, although here and there, as for instance along the creek at the outlet of Muriel lake, they are as light as the

rhyolite. The photomicrograph on page 74 shows a specimen of rhyolite on the northeast shoulder of the hill, on claim K.K. 1,895, Muriel lake. The structure is porphyritic, although the feldspar has altered to sericite. Chlorite is developed, and epidote fills a veinlet; pyrite is much disseminated.

The rhyolites between Oboshkegan and Metcalfe lakes have been altered to sericite schist, soapy to the touch. The surface is rusty, owing to the pyrite content. Bismuthinite was found by Hopkins in the quartz veinlets that traverse this rhyolite.

Rhyolites of the Onaman iron ranges are described by Moore[1] as follows:—

> These rocks all have a porphyritic texture and a holocrystalline groundmass, the latter developed by recrystallization under metamorphic agencies. . . . In some of the rhyolites the crystals have been pulled apart and the spaces between the fragments filled with the regular groundmass in such a way as to indicate that this process took place during the extrusion and movement of the molten rock. . . . In some slides no quartz crystals occur, in some plagioclase and orthoclase are nearly equal, and in others all three may be well represented. The quartz phenocrysts sometimes contain mineral inclusions. The phenocrysts of both quartz and feldspar are very often rounded or gouged by the groundmass.

Tuff and Vesicular Rhyolites.—A band of water-lain volcanic tuff appears on the 34-chain portage on the South branch of the Onaman river, a little more than a mile west of the Nipigon Provincial Forest line. The tuff shows a finely banded sedimentary structure with more than 20 *laminae* in a specimen an inch thick. The *laminae* consist of alternating bands of muscovite and chlorite, and more rarely silica. Quartz veins, which show evidence of rock movement, cross the bedding planes of the tuff. A trail to Sollas lake crosses a high ridge of tuff 8,000 feet north of the first portage up Deeds creek.

Graphitic, vesicular rhyolites are recorded by Gledhill[2] on the northeast shore of Gledhill (Whitefish) lake. Associated with banded pyrite and silica, a rock of this kind outcrops on the west bank of the South branch of the Onaman river a few hundred yards above the pontoon bridge on claims K.K. 718 and K.K. 720. The banded pyrite reappears on the south shore of Coughlan lake. The vesicles in the rhyolite have so much the form of bubble cavities as to suggest that their origin is primary rather than due to the removal of the pyrite content by solution.

Rhyolite Tuff, Agglomerate, Slate, Conglomerate

In the vicinity of Paska the rhyolites were found by Hopkins[3] to pass upward into the pyroclastic and sedimentary rocks, which consist of rhyolitic tuff, agglomerate, slate, and conglomerate(?), with no sharp line of demarcation. These are to be seen along the railway from mileage 36 to 35; here, the greywackés overlie the ash rocks.

The most prominent band of the volcanic fragmental rocks extends from a point a mile south of Kowkash northwestward for a distance of 14 miles to Gzowski lake, where it is intruded by granite. Pebbles of rhyolite, some rounded and water-worn, others angular, reach a length of 3 feet. The fine ash rocks appear to have been water-lain. Tourmaline occurs both in these rocks and in the quartz veins cutting them, and also in the Keewatin auriferous quartz veins at Tashota.

A specimen from the outcrop west of Gledhill lake, in line with the sediments at the north end, is seen under the microscope to be composed of finely banded subangular to rounded quartz grains and altered plagioclase with a very thin

[1]E. S. Moore, Ont. Bur. Mines, Vol. XVIII, pt. 1, 1909, p. 224.
[2]T. L. Gledhill, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, p. 75.
[3]P. E. Hopkins, op. cit., p. 204.

band of calcite and numerous tiny biotite flakes. The dark-banded greywacké is mostly covered by muskeg between Oboshkegan and Gledhill lakes.

Garnet Schist Interbedded with Greenstone.—Garnet schist interbedded with greenstone is fairly common east of Muriel lake. The width of the horizon reaches a hundred feet in some places. The rock is fine-grained and grey in colour instead of the green of the volcanic rock. A specimen from about two miles east of Muriel lake shows about 70 per cent. of finely banded quartz grains, abundant garnets of fair size, muscovite, a few biotite laths, about 10 per cent. hornblende, some pyrite grains, and a very small amount of apatite. Where this type of rock has been more sheared and mineralized, it has the appearance of contorted black slate, as at pit No. 1, claim K.K. 1,895.

Lenses of rock of a more doubtful sedimentary type occur in the greenstone, such as a band that resembles rhyolite crossing the creek a few hundred feet below the outlet of Muriel lake. Under the microscope, the only feldspars to be seen in the rock are small, components of the fine to medium quartz groundmass in which are large biotite flakes and a little chlorite.

Carbonate Rock South of Muriel Lake.—A crystalline and a conglomerate type of carbonate have about equal distribution. The latter, which seems to be of sedimentary origin, is to be seen in the vicinity of Walkup creek, as shown on the insert map facing page 100. No chalcopyrite mineralization has been found near this rock. This is a brown-weathering rock with an irregular surface due to the abundant rhyolite pebbles, which are oriented lengthwise with the strike. The matrix effervesces freely with hydrochloric acid. The horizon is about 25 feet wide and there is no abrupt margin to the greenstone above or below.

The crystalline limestone, however, is associated with pyrrhotite-chalcopyrite mineralization and forms a sharp contact wall with greenstone or rhyolite, the country rock. It varies in width from 1 to 15 feet and dips steeply. On claim K.K. 1,977, one of several narrow bands has a known depth of at least 3 feet and is capped by greenstone in which are garnets and magnetite. A wedge of rhyolite and older diabase occur adjacent to the greenstone on the north.

Iron Formation

The Onaman iron ranges were discovered in 1906, and soon afterward many claims were staked by the Flaherty syndicate, C. Bain, and other prospectors. Diamond-drilling has been done, but the claims were allowed to lapse. The ranges, which have been studied by Moore,[1] consist of red jasper, some "sugary" quartz, often well banded, and magnetite, with a little specular hematite. The banded iron lies conformably upon the pyroclastics and sediments previously described. The iron ranges form two major synclines extending east and west. The northern range runs eastward from Wilgar lake for 10 miles. The southern range, called the Bain deposit, parallels the northern at a distance of two miles and is 700 feet wide in places.

Widely separated bands of iron formation occur near Tashota, a third of a mile northeast of the water tank, also on claims K.K. 337, K.K. 61, and near mileage 61 of the Nipigon Provincial Forest line at 150 feet north of an exposure of quartz on claim K.K. 463. This last band is 12 feet wide, strikes east-west, and dips 85° N.

[1]E. S. Moore, op. cit.

At the property of the Tashota Gold Mines, banded iron parallels the ore zone to the north as close as 300 feet. At Lake Ste. Marie, magnetite of the banded iron has been replaced by pyrite, which carries low gold values. This also appears to be the case in the extension of the banded silica-pyrite on claim K.K. 442, the first claim west of the Tashota.

Iron formation on the east shore of Cecil lake dips 61° S. and strikes 112 degrees, in line with the pillow lava across the lake.

The banded iron and chert on the south shore of Briarcliffe lake is probably one of the numerous iron horizons of the Marshall Lake series.

LAURENTIAN

Granite Gneiss and Granite

Considerable areas of granite gneiss cut by granite occur at O'Sullivan lake, also on the portage south from Briarcliffe, west of Kawashkagama lake, and west of Elbow lake. Biotite granite gneiss is the prevailing rock of the Ogoki lake basin. These gneisses resemble the "Laurentian type," which is widespread in the pre-Cambrian shield. The fresh granites are of greater extent than the gneisses, which are clearly intruded by the former. Pink intrusive granite only a few chains in width may be seen cutting the gneiss at the base of a cliff near the Kapikotongwa river at the west edge of the map-area, also on the south shore of Jungfrau lake, and just west of Felsen lake. South of Cavell, the granite gneiss is a coarsely banded hornblende-biotite gneiss with a nearly pure interstitial white quartz.

Massive white granite is uncommon, but it occurs associated with white pegmatite on Little Dog lake at the narrows and on Queenston lake and Muriel river. The foliation of the white mica granite west of Elbow lake is incomplete locally, so that in thin section a specimen looks fresh without any trace of crushing of the component quartz, plagioclase, and large biotite crystals.

Altered granite a few miles distant, at 4,000 feet west of Ledingham lake, in thin section shows biotite and hornblende, with titanite and magnetite as accessory minerals. Intense metamorphism and the effects of weathering have caused pseudostratification in the granite gneiss outcropping on the easternmost island of Ogoki lake.

The Laurentian granite is believed to be one era earlier than the Algoman, partly on the evidence of pebbles of white granite, porphyry, and felsite that were found in the Timiskaming conglomerates at Conglomerate lake. This series of rocks was formed of material eroded from rocks of the Keewatin system and the Marshall Lake series and, as postulated, from the Laurentian granite.

While there may be granites and gneisses earlier in age than the Timiskaming sediments, it is difficult to make any separation on the map between the possibly older granites and the Algoman granites.

TIMISKAMIAN

Sediments of Timiskaming age that resemble the conglomerate and greywacké of Kirkland lake underlie an area of several square miles south and west of Conglomerate lake.

On the map accompanying Hopkins' 1917 report, a narrow strip of conglomerate, greywacké, and slate is shown on Toronto (Cross) lake and is described by him as follows:[1]—

> The strike is southeasterly, and the dip almost vertical. The conglomerate is a typical beach conglomerate containing numerous coarse pebbles about four inches in length with little matrix.

[1]P. E. Hopkins, op. cit., pp. 210, 211.

The pebbles consist chiefly of grey feldspar porphyry and a gray quartzose mica rock resembling the Marshall Lake series, with an occasional greenstone and white vein quartz pebble. A thin section of one of the grey porphyry pebbles showed microcline, albite, and a few quartz phenocrysts in a microcrystalline groundmass of quartz, biotite partly decomposed to chlorite, and iron oxide.

The belt of Timiskaming sediments south of Conglomerate lake was found to extend west to the first falls on the Onaman river and to occur in isolated outcrops between that place and Ledingham lake.

The slates, greywackés, and conglomerates of Conglomerate lake are described by Gledhill[1] as forming structurally a tilted, closed syncline between Keewatin greenstones, a predominant feature of which is the vertical and northern dip of the strata. The slates are strongly cleaved so that perfect slabs an inch thick and one or more feet square can be pried from the outcrops on the shore at the southeast corner of the lake.

Feldspar and quartz porphyry dikes penetrate the greywackés south of Conglomerate lake, which is a factor in determining the age of the sediments as pre-Algoman.

Further, the conglomerates of this lake are placed between the Laurentian and Algoman periods by the discovery of white granite pebbles in a sheared conglomerate uncovered by the uplifted roots of a fallen tree, 5 chains southeast of the portage at the east end of the lake. The pebbles were elongaged by shearing of the strata.

Pebbles of the same degree of attenuation or foliation were found in the conglomerate located 4,500 feet in a direction of 310 degrees from the 30-foot falls of the North branch of the Onaman river. The strike of the beds is 80 degrees, and the dip is 80° N. The pebbles are white granite, porphyry, and felsite.

At the west end of Conglomerate lake, pebbles are rare and confined to basic types. A thin section of an altered diorite (Keewatin?) pebble is seen to be composed of altered plagioclases, interstitial quartz, and hornblendes altered to chlorite. A veinlet of calcite crosses the section. Garnets and pyrite are accessory minerals.

ALGOMAN

Granite

Granite referred to Algoman age makes up about one-third of the field. It is seen to cut the gneiss on the west shore at the narrows of Jackson lake. It is also found at the base of a cliff 1,500 feet north of the Kapikotongwa river at the west edge of the map-area, at the south end of Jungfrau lake, and in other places. The larger exposures of the batholith occur at Onaman lake, around Tashota, and in the northern part of the area. The granites are predominantly a coarse-grained, flesh-coloured potash feldspar type. Local variations to a grey type are biotite and hornblende granite.

Gneisses are enclosed in the granite and exposed on the west shore of Goode lake[2] and on the water route between Abamasagi lake and Durer lake; foliated xenoliths are common at the south end of Little Dog lake in pink biotite and hornblende granite of medium grain. The granite on the portage leading east from Little Dog lake holds fine-grained portions and small crystals of magnetite. Specular hematite occurs across about 5 feet in the granite close to a quartz vein on the 60-chain portage on the Little Current river, several miles below O'Sullivan lake. The deposit is of little extent.

[1]T. L. Gledhill, op. cit., p. 69.
[2]P. E. Hopkins, op. cit., p. 209.

The red granite at Redmond is a homogeneous boss mass of a type described by Hopkins as containing microcline, albite, quartz, and biotite altered to chlorite. At Tashota the small granite stock near the water tank is coarse-grained and sheared locally; tongues from the mass intrude the adjacent Keewatin rocks. Microscopically, it is seen to be predominantly microcline and quartz and shows strain effects. Zones of sericite have been developed, and accessory zircons and apatite are present.

The pink granite on the Kapikotongwa river is partly graphic granite but normally has a grain of 5 mm. Forming the base of a cliff of gneiss 100 feet high the granite looks like a sill, as the sharp upper contact is a plane dipping only 10 degrees from the horizontal.

A hybrid granite with large boulders was noticed by Gledhill at the greenstone contact about two miles east of the Nipigon Provincial Forest line, North branch of the Onaman river. A dark facies of the granite is common in the Tashota–Onaman River area owing to the assimilation of the adjacent schist complex.

Syenite

Four widely separated bosses of hornblende syenite intrude the older rocks. The syenite component of the Redmond granite extends far to the north and cuts the rhyolites at mileage 37.3 on the railway. On the west shore of Deeds lake, it is a coarse, homogeneous hornblende syenite. The microscope reveals abundant microcline and accessory apatite.

The syenite penetrates the old granite gneiss for about two miles along the southeast shore of Ogoki lake, where numerous fracture or jointing planes of the gneiss are filled with veinlets of syenite as much as a quarter of an inch wide. The syenite is normally granitic, but portions are coarser grained and approximate a hornblendite. Between these two a gradational phase may generally be found, for example, west of the outlet of Ogoki lake, where a coarse porphyry with large feldspar phenocrysts is developed. Microscopical examination of the syenite from the southwest point of the large island in Kayedon lake shows hornblende, 35 per cent.; plagioclase, 60 per cent.; microcline, 3 per cent.; accessory zircon, pyrite, and magnetite; secondary calcite and sericite.

A boss of equal size and one much smaller intrude between the Marshall Lake series and the greenstone, at one mile east of the outlet of O'Sullivan lake and one and a half miles northeast of Jungfrau lake, respectively. Irregular dikes of a few feet in width from the former mass cut the greenstone, which is locally turned from the direction of prevailing strike.

Lamprophyre

Narrow dikes of lamprophyre at mileage 31.6 of the railway cut banded Keewatin ash rocks. Dikes of a similar nature cut the rhyolites on the northwest shore of Lake Ste. Marie. A dike 2 feet wide cuts the rhyolites at the cabin half way along the west shore of Oboshkegan lake. More basic and wider dikes are involved in the shearing on the northeast shore of Tashota lake, and narrow lamprophyre dikes occur on the King-Dodds and Kipper-Tashota prospects.

The lamprophyre is here referred tentatively to the Algoman period and is believed to correspond to dikes at Kirkland lake.

On weathering the Oboshkegan lake dike displays a rough surface with sharp ridges, all of a dark olive-green, with ferromagnesian phenocrysts recognizable. Under the microscope, the rock is seen to consist of plagioclase, hornblende, biotite, a little quartz, pyrite, and secondary calcite.

The lamprophyre dike, 400 feet southwest of the south shaft of the Kipper-Tashota prospect is 4 feet wide and under the microscope is seen to be composed of long pyroxene crystals, much biotite, tiny feldspar crystals, much chalcopyrite, and cubes of pyrite. Secondary calcite and a little chlorite make up a large part of the lamprophyre, evidently a much altered rock.

Feldspar Porphyry

Feldspar porphyry dikes are more abundant than quartz porphyry. Both types were found only in the Keewatin and Timiskaming series The greater number of dikes are near Tashota and in the south Onaman country; fewer occur northwest of Muriel lake.

The porphyry dikes on claims K.K. 514 and K.K. 524 are essentially acid plagioclase and biotite. They have been sheared and bear mineralized vein quartz. An average sample analysed by the Provincial Assayer is reported by Gledhill[1] as follows:—

	Per cent.
SiO_2	67.18
Al_2O_3	16.40
TiO_2	.61
FeO	1.85
Fe_2O_3	1.25
MgO	1.17
CaO	2.93
K_2O	.88
Na_2O	6.01
CO_2	1.32
H_2O	.67
Total	100.27

The hand specimen shows light-coloured feldspars surrounded by fine flakes of biotite . . . and in a number of cases . . . is replaced by pyrite, galena, and sphalerite. Chemically, it is richer in soda than potash, a point it has in common with gold-bearing porphyries of the Sturgeon Lake gold field, Porcupine, Kirkland Lake, and Lightning River gold areas.

Under the microscope the following essential minerals were seen: orthoclase, acid plagioclase, biotite, and quartz, besides accessory apatite, sericite, pyrrhotite, and calcite.

This type occurs also a few hundred feet east of the shaft on the Cline claim, K.K. 61, at Tashota.

Coarse-grained porphyries intrude the Timiskaming greywacké south of Conglomerate lake. This porphyry from a place three-quarters of a mile south of the junction of the North and South branches of the Onaman river contains small quartz veins with pyrite and chalcopyrite and under the microscope is seen to be composed of plagioclase feldspars highly mashed in an exceedingly fine-grained groundmass partly of quartz; pyrite accessory.

A 3-inch pink dike was followed 20 feet in greywacké and lost in overburden a mile south of the junction of the two branches of the Onaman. The dike appears to be an aplite or sheared porphyrite composed, as determined microscopically, of crushed and elongated plagioclase and quartz phenocrysts in a fine-grained groundmass of angular quartz crystals, which are compressed and lie in one direction. Hornblendes have been altered to chlorite. Zircon is accessory.

Many of the dikes average 10 feet in width and are chiefly massive. They are crossed by small distortion zones.

Quartz Porphyry

Quartz porphyry dikes have been found chiefly within a broad arcuate area that originates in the south Onaman country and passes northeast through

[1]T. L. Gledhill, op. cit., pp. 77, 78.

Tashota, Deeds lake, Howard falls, and ends with O'Sullivan lake. The dikes are fairly narrow and weather to a light-grey colour, resembling those of Porcupine. The porphyries are generally found near gold-bearing quartz veins and are thought to be connected at depth with the granite masses. They reach a maximum width of about 30 feet and are commonly schisted along with the country rock of Keewatin greenstones and carry quartz veins.

The quartz porphyry at No. 1 pit, claim K.K. 524, Tashota Gold Mines, is highly sheared, although the shearing tends to pass around the porphyry dikes owing to their narrowness and their position parallel to the plane of shearing. The quartz phenocrysts stand up well in the crushed groundmass and give a blue "bird's eye" effect. The marginal contact of the greenstone is sharp, as seen in the core from diamond-drill hole No. 9 at 197 feet. The porphyry lacks noticeable border chilling, which indicates great depth of origin. The feldspar phenocrysts appear stony white in a grey groundmass.

A specimen from the King-Dodds prospect at Howard falls, examined under the microscope, is described by Hopkins[1] as showing "large, rounded, angular, and broken quartz grains, and albite phenocrysts, partly altered to sericite. The crystalline groundmass consists of quartz, feldspar, sericite, calcite, and a little chlorite. This description will also answer for the porphyry from the Wells claim."

Quartz porphyry on the Cryderman patented claim, K.K. 1,844, O'Sullivan lake, is strongly sheared, the shear planes of which strike 60 degrees and dip 75° S. The porphyry carries quartz veinlets and pyrite. Gold values are reported. Ankerite bounds the porphyry on the west.

Quartz porphyry dikes apparently intrude the Timiskaming greywacké close to the greenstone contact a mile southeast of the junction of the North and South branches of the Onaman river. The quartz and feldspar phenocrysts of this porphyry measure nearly a quarter of a inch in width in a dark-grey groundmass, but the quartz "eyes" are few.

The porphyry dikes are believed to have filled fissures in the earth's crust, and in the dikes were formed channels by contraction on cooling, which were filled from below by gold-bearing solutions emanating from the granite magma.

The invasion of the Timiskaming sediments by the dikes points strongly to an Algoman age for the granite and porphyry bodies.

Pegmatite Dikes

Pegmatite dikes are found cutting the white and pink granites, also rarely the greenstone, and they invade the Marshall Lake series in great number along the Kapikotongwa river and the lakes on its course. The dikes are chiefly muscovite pegmatites.

In the granite, pegmatite with orthoclase crystals up to one inch in length occurs on the portage below Goode lake, also on the south shore of Meta lake and on the portage north to Briarcliffe lake, and commonly near the greenstone contact in the south Onaman country. A coarse red pegmatite on the west shore of Fleming lake shows a "vein" of sugary quartz bearing tiny garnets in the contact zone of the vein.

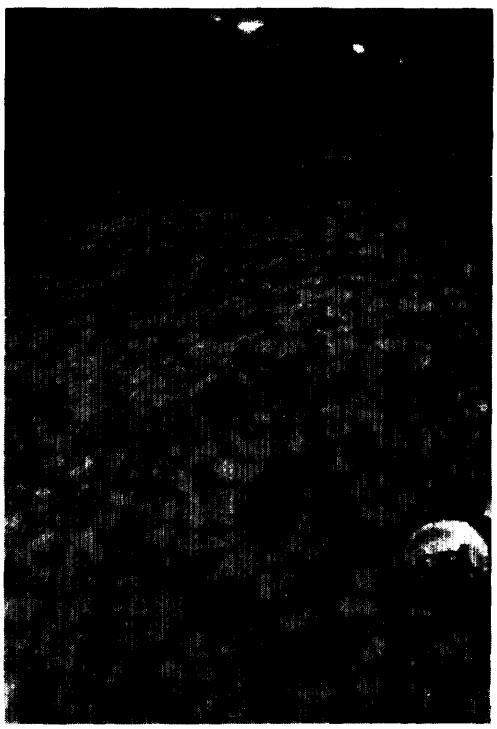
A specimen of pegmatite in greenstone a mile and a half southwest of Queenston lake contains minute crystals of apatite and tourmaline.

A large proportion of the pegmatites between Percy lake and Melchett lake carry considerable tourmaline in crystals varying from a quarter of an inch to an inch in diameter. A notable example is the dike crossing the highly

[1]P. E. Hopkins, op. cit., p. 210.

garnetiferous quartz-mica schist at the outlet of Briarcliffe lake. A tourmaline dike, which averages a foot in width and shows perfect comb structure in which the crystals are grown from the walls of the dike toward the centre, cuts the schist on the west shore of Colpitts lake for 200 feet, forks, and dips 45° N. so that it appears to join the pyrrhotite deposit at depth, both of which strike about 85 degrees. This dike was assayed for tin at the Provincial Assay Office, Toronto, but with negative results.

Garnets are very common in the pegmatites near or cutting the Marshall Lake series, but the pegmatites in the granite are non-garnetiferous. Beryl crystals were found up to an inch in width in two muscovite dikes a few feet



Matachewan porphyritic diabase dike, showing large feldspar phenocrysts, a mile and a half northwest of the 30-foot falls on the North branch of the Onaman river.

wide 900 feet northeast of Saga lake and in a dike 300 feet long about a mile east-northeast of these. The beryl in the last dike is associated with hornblende and perthite, but it is not an abundant constituent mineral.

MATACHEWAN DIABASE

The four coarsely porphyritic diabase dikes encountered in the area are referred to the Matachewan diabases of Matachewan, Cobalt, and Porcupine, where these dikes are known to be post-Algoman and pre-Cobalt. The diabase looks like a replica of the published illustration[1] by A. G. Burrows of Matachewan diabase near the Montreal river (see photograph above).

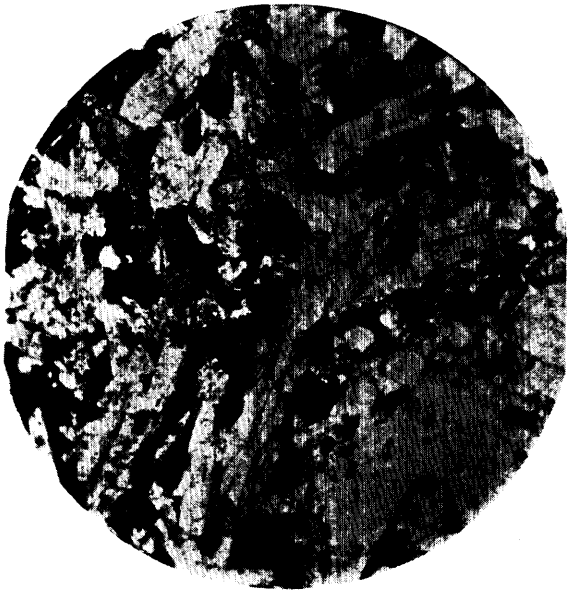
[1]Ont. Bur. Mines, Vol. XXVII, pt. 1, 1918, p. 230.

The dike that outcrops a mile and a half northwest of the 30-foot falls, North branch of the Onaman river, lies within 600 feet of the granite. The surface is blotched by white plagioclase phenocrysts, an inch or so in length, set in a dark-green, fine-grained groundmass, which is composed of feldspar, pyroxene, labradorite, and a little interstitial quartz (see photomicrograph below). The dike at Penequani station cuts the granite, but is itself schistose at the margin. The dike on Colpitts creek distinctly crosses the pegmatite.

These Matachewan dikes occur far apart, near the general margins of the larger areas of granite gneiss.

KEWEENAWAN DIABASES

The quartz and olivine diabases of the area are ascribed to the Keweenawan period of igneous activity. Olivine diabase has been found, rarely, in the south



Thin section of Matachewan diabase from a point a mile and a half northwest of the 30-foot falls, North branch of the Onaman river. This shows labradorite and pyroxene and some interstitial quartz. Magnetite is common, and a little pyrite is present. (× 17.)

Onaman country. Neither quartz nor olivine can be seen in many of the diabases, which are, however, probably closer allied to quartz diabase. These dikes, which weather brown, penetrate the other consolidated rocks in great number, are commonly vertical, and range in width from a few inches to 200 feet. One was traced for more than a mile on the surface. The remnant of a nearly horizontal sill occurs near mileage 37 on the railway, and the dike at Deeds lake dips 45° W. in granite.

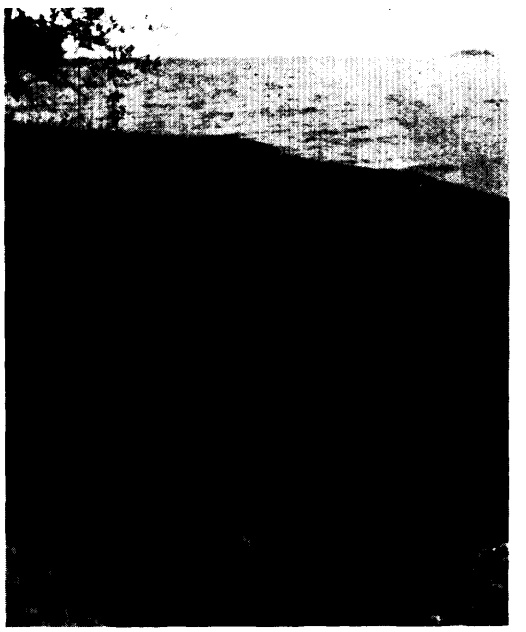
Olivine diabase was recognized by Gledhill[1] in the south Onaman country; the dikes "accompany the mineralized breaks on the Kenty and McKechnie discoveries," and are characterized by a green-weathering surface. Olivine was not found in any specimens of diabase collected by the writer.

[1]T. L. Gledhill, op. cit., p. 78.

A specimen from a narrow dike on claim K.K. 1,895, Muriel lake, has an ophitic texture and is composed of pyroxene, labradorite, and accessory magnetite; there is no interstitial quartz and the minerals are fresh.

A typical quartz diabase from the South branch of the Onaman river has an ophitic texture and is composed of plagioclase and pyroxene with secondary hornblende and accessory magnetite or ilmenite, all enclosed in a micropegmatite of interstitial quartz and orthoclase.

Diabase cut by large chilled dikes of microcrystalline diabase was found in the southwest part of Ogoki lake on the northeast side of the island with the long sand spit (see photograph below) and also on the south channel of the Ogoki river on the big island east of Kayedon lake. At Ogoki lake the younger dike carries 10 per cent. pyrrhotite and under the microscope looks fresher than



Contact of two diabase dikes of Keweenawan age on an island in Ogoki lake.

the coarser-textured dike which carries a little serpentine, ilmenite, and leucoxene. Biotite is abundantly disseminated throughout the younger dike of the two on the Ogoki river.

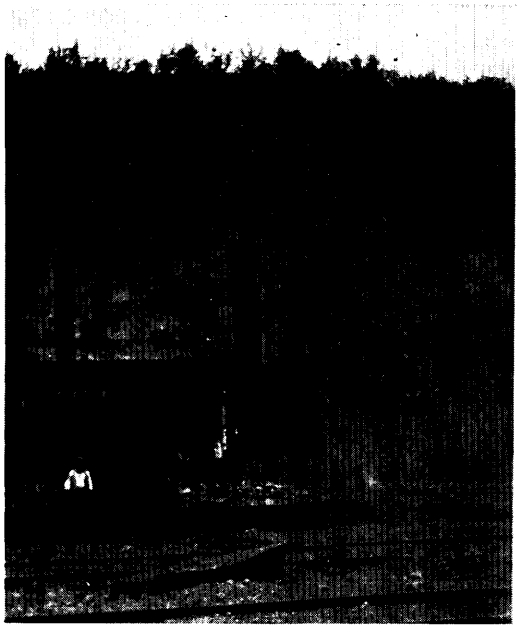
PLEISTOCENE

The Kowkash area lies west of the clay belt of Northern Ontario, the clays of which were formed as deposits in a now extinct glacial lake. The scattered clays of the Kowkash area have a similar origin and thus occupy the lower levels. They are found beneath the peat on parts of Toronto lake, in the bed of Deeds creek and Tashota creek, and along Johnson creek, where they are mixed with glacial sand for at least a mile north of the mouth of the creek.

The glacial deposits consist of stratified clay, boulder clay, sand, gravel, and boulders. The boulders are arranged in low narrow ridges as part of the ground moraine that covers much of northern Canada.

Glacial scratches and grooves are exposed on the hard rock surfaces where the overburden has been removed. The jaspers have retained a beautiful polish. North of the railway the direction of ice movement is seen to have varied from S. 30° W. to S. 50° W. The grooves on Oboshkegan lake strike southeast, but they follow an east-west direction at mileage 61 of the Nipigon Provincial Forest line.

A terminal moraine occupies the central part of the area and reaches a thickness exceeding 100 feet at the Tashota gravel pit. Kowkash is built on the outwash part of the terminal moraine. One photograph in the report by Hopkins[1] shows five kettle lakes, former sites of five blocks of ice stranded at the edge of the retreating glacier. The bottoms lie as much as 80 feet below the rims of the higher surrounding hills, in which the glacial boulders are granite,



Gravel pit at Cavell showing coarse cross-bedding, truncated above by a horizontal bed of glacial conglomerate.

greenstone, chert, fossiliferous limestone, and other rocks. The majority of the boulders have not travelled far. The nearest limestone in place is the Silurian, distant 55 miles northeast from Cavell station.

The morainal hills are widely distributed across the area, but are more numerous and higher within a circle centred in Esnagami lake, the circumference of which lies on Muriel lake, Cone hill, and points a few miles west of Kawashkagama lake. Cone hill is capped by a kettle lake, the water level of which was only slightly affected during the dry summer of 1929.

In the ballast pit at Cavell, shown in the photograph above, the lower beds of alternate sand and gravel dip 25° W. and are overlain by a horizontal stratum of coarse gravel, which grades upward into a 2-foot layer of sand. Apparently turbulent waters flowing west laid the coarse gravels; after the

[1]P. E. Hopkins, op. cit., p. 213.

retreat of the ice-front, gravels were brought in swift currents and spread horizontally, where subsiding waters covered them with the reworked and sorted glacial debris and sand.

In the Onaman valley, Gledhill[1] found that the clays and gravels increase in thickness as Lake Nipigon is approached. On the claims of the Canada Mines Syndicate, he noted alternately dark and light clays, the dark *laminae* of which contain vegetal material. He postulates the overflowing of Lake Nipigon when the glacial ice was melting.

RECENT

In general the products of Recent deposition are superimposed over extensive areas of all the earlier rocks in the form of peat bogs, swamps, river silts, beaches, and transported boulders.

The streams of little gradient follow a meandering course, sorting out the unconsolidated glacial drift. Since glacial time very little erosion has been effected in the hard rock. The steep slopes of hills of glacial moraine are characteristic. The kettle lakes have been filled to only a fraction of their depth.

Miles of swamps have been grown over and have begun to fill the low places of the country. This has culminated in the building of peat bogs. Toronto lake is fast filling up, and Sollas lake is similarly shallowed by vegetal debris. The deeper channel in many shallow lakes borders one shore rather than following a course down the middle.

The strong 'longshore currents and ice flows of the larger lakes have built boulder spits exceeding 100 yards in length in Hanover, Lucy, and Melchett lakes. Sand beaches are notable features on one or two islands of O'Sullivan lake, on Durer lake, and on Marshall lake at the sand cliff.

Travertine has been described as follows by Moore:[2]—

> The deposit of calcium carbonate, or travertine, in Red Paint lake is at least 20 feet deep at the southeastern end, as a pole can be thrust down in it to that depth. Around other portions of the lake the deposit varies greatly in thickness, and may even be lacking. The creek leaving the lake is so saturated with calcium carbonate that it deposits travertine on the roots and stems of plants along its course, and on the bottoms of the upper lakes of the Red Paint river. . . . the source of this mineral is probably the calcium carbonate found on the pebbles of the drift in the surrounding region. . . . Were this deposit favourably situated, it might be used in the manufacture of cement.

Somewhat similar material is found in Wawong and nearby lakes which are characterized by a clear blue-green colour. White marl is abundant on the bottom of Chara lake. It is associated with a prolific *Chara* (algae) reef in the west half of the lake. White shell marl was noted by Hopkins[3] in a small pond half a mile southwest of the Tashota gravel pit.

ECONOMIC GEOLOGY

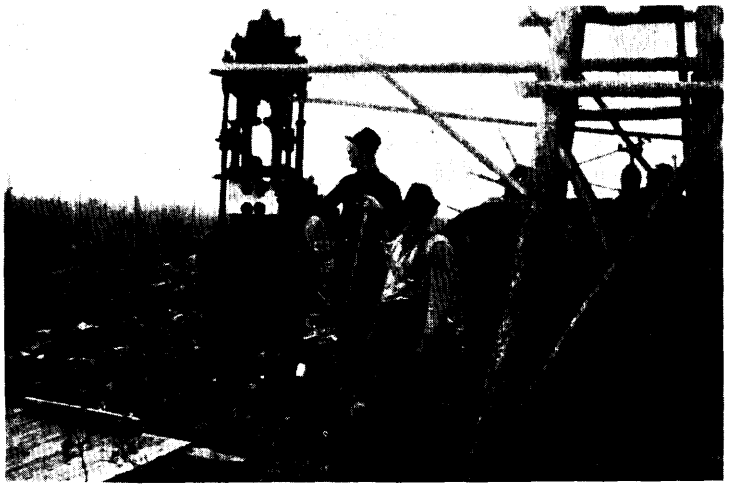
The discovery of mineral deposits of economic interest are to date confined to the Keewatin rocks. Gold is the chief ore, although silver occurs in minor quantities along with the gold mineralization centred around Tashota. At Muriel lake chalcopyrite has been discovered in partially silicified shear zones in Keewatin greenstone and rhyolite. These lenses, however, are too discontinuous to make a substantial prospect at present. The insert map facing page 100 shows the geology of the Muriel Lake area.

[1]T. L. Gledhill, op. cit., p. 79.
[2]E. S. Moore, op. cit., p. 252.
[3]P. E. Hopkins, op. cit., p. 215.

Pyrite deposits are widespread and reach widths of several feet, but these have not been fully prospected. The pyrrhotite bodies are also fairly common, but no values have been found in platinum or nickel with this sulphide. The Onaman ranges remain in this area the greatest potential source of iron.

Two non-metallic rocks of potential value should also be mentioned, the red and grey biotite and hornblende granite along the railway at mileage 37 and 51, which appears to be of a quality suitable for building stone, and also the travertine, which is a deposit of calcium carbonate at least 20 feet deep in Red Paint lake. This might be useful in treatment of the farming soil of the clay belt. The travertine has been described on page 86.

Much progress has been made in exploration of the ore at the property of the Tashota Gold Mines. The reason for the closing of the earlier prospects near Tashota is not clear in each case, but it is probable that the greatest factor



Stamp mill on the claims of P. B. Cameron and J. A. Picotté, who are seen in the photograph (October, 1930).

was the difficulty encountered in finding ore at depth. At the outset, chances were favourable; and it is probable that diamond-drilling may yet be advisable for certain of the older workings, should the finds now being developed prove successful. Messrs. Cameron and Picotté plan to sink on a high-grade vein at Tashota lake and expect to use a 14-ton stamp mill in the spring of 1931. Geo. H. Adair intends to follow down on the silver-gold vein of his find 2 miles south of Tashota and to sort and ship the high-grade to the Noranda smelter.

Types of Mineral Deposits

GOLD

Gold is found in sheared veins of quartz in fissures passing through basic Keewatin greenstone, in which rhyolite and iron formation are commonly interbedded. Quartz or feldspar porphyry, or both, may commonly be found as intrusives close by. Gold values are also obtained from mineralized quartz veins which impregnate the quartz and feldspar porphyry dikes.

The ore deposits are generally a combination of these two types. The minerals associated with the gold in the veins are pyrite, pyrrhotite, chalcopyrite,

sphalerite, galena, silver, bournonite, molybdenite, bismuthinite, graphite, telluride (a small quantity reported), and tourmaline. Fluorspar was found in a barren vein near Tashota creek at the railway by Hopkins.[1] Where the relative ages of the minerals can be inferred, pyrite and pyrrhotite are seen to be the earliest. They appear to be replaced in most veins by chalcopyrite, sphalerite, galena, and silver, in that order. The high-temperature minerals, molybdenite, bismuthinite, and tourmaline, each indicate great depth of origin for this part of the original ore zone. It is evident that the upper part of the gold vein systems have long since been removed by erosion.

Evidently, at the time of origin of mineralization, an early stage in the process was the injection of feldspar and quartz porphyry dikes into the fissures formed by shearing and torsion in the Keewatin rocks during the time of Algoman mountain-building. The next stage was the injection of volumes of mineralized siliceous solutions both into and outside the walls of the cooling porphyry dikes. The channels in which the solutions moved were perhaps formed by the shrinkage of the porphyries. These fissure openings both in dike and country rock were further widened in places by crystallization of the residual juices in circulation from the underlying granite magma.

SILVER

Keweenawan dikes are abundant in this area, and a small showing of cobalt bloom was found in the diabase on claim T.B. 4,480 and a few chains southeast of the log cabin on claim K.K. 524. Silver is, however, a minor constituent in the gold ores of the properties at Tashota and at the Tashota Gold Mines, and must be considered as accessory to the gold mineralization genetically related to the Algoman granite. Silver would likely be found in greater quantity in the area of Keweenawan diabase dikes and sills in the shales, sandstone, and dolomite of that age as developed on the shores of Lake Nipigon touching on the southwest corner of the map-area.

COPPER

The copper deposits occur in the following associations:—

1. Chalcopyrite replaces pyrite and pyrrhotite in gold-quartz veins in Keewatin greenstone. In this case the copper owes its origin to the differentiation of the Algoman granitic magma or to basic dikes.

2. Pyrite-pyrrhotite-chalcopyrite replacements in sheared zones extend through five miles of Keewatin basic lavas, rhyolites, diabases, and diorites at Muriel lake. The mineralization is best developed in the rhyolite-greenstone contact zones south of Muriel lake. The igneous rock that is presumably the source of this extensive deposit is to be found either in the Keweenawan diabase dikes or the hornblende syenite. A siliceous dike of the former cuts the southeast shore of the first lake south of Muriel lake west of claim K.K. 1,895.

3. Long, discontinuous replacement zones of pyrrhotite-chalcopyrite after original pyritiferous iron formation bands occur in the garnetiferous quartz-biotite schist of the Marshall Lake series close to altered rhyolite flows and early granodiorite intrusions. The source here is presumably Keweenawan diabase dikes. The chalcopyrite occurs in very rare and tiny veinlets in pyrrhotite of no economic value (see photograph on page 103).

PYRRHOTITE

The larger deposits are described on page 103. Hopkins[2] has reported no gold or nickel values obtained from an 8-foot pit three-quarters of a mile

[1] P. E. Hopkins, op. cit., p. 215.
[2] Ibid, p. 225.

east of mileage 84 on the Nipigon Provincial Forest line. The pit is sunk on an altered iron formation of pyrite, pyrrhotite, and magnetite.

Similarly the pyrrhotite mass on the south shore of the pond at mileage 55.7 on the railway is also lacking in gold, platinum, and nickel. The pyrrhotite at Rupert falls, Kawashkagama river, is reported to carry no nickel or gold. It is improbable, then, that the pyrrhotite bodies are promising for nickel, gold, or platinum.

IRON

The banded iron deposits of Keewatin age are for the most part of medium grade. The following analysis of a sample across 15 feet from the southern Onaman range is taken from Moore's report:[1]—

	Per cent.
Total metallic iron	55.79
Iron in ferrous condition	10.94
Silica	37.10

Moore estimates that a portion of the same band would run 30 to 40 per cent. metallic iron across 50 feet on the southern range, which has not been drilled. Numerous bands a few inches in width assay 67 per cent. of iron.

PYRITE

Pyrite occurs in the greenstone, rhyolites, slates, and in the Marshall Lake series. In origin it has in some cases probably been formed on the sea bottom as a precipitate, and elsewhere it has replaced the minerals with which it occurs, chiefly in the iron formations and in the sheared rhyolites.

The more notable deposits are the following:—

1. On claim K.K. 1,943, east of Muriel lake, pyrite developed by contact metamorphism is found in greenstone that is nearly surrounded by granite. This is small and of low grade.

2. A few hundred yards above the pontoon bridge across the Onaman river pyrite is found disseminated in quartz veins and sugary quartz permeating a shattered greenstone, which is partly vesicular. Trenching has been done across the zone, which has an average width of 30 feet and a length of several hundred feet. The same zone evidently reappears on the south shore of Coughlan lake.

3. A massive pyrite deposit occurs in the black slates at the northeast end of Gledhill lake, 300 yards south of a syenite hill. It is 4 feet wide and grades into the pyritiferous nodular slates of an iron formation type.

4. Trenching has exposed a pyrite band 3 feet wide within 100 yards of the northeast shore of Lake Ste. Marie. Across 3 feet the pyrite assays 31.3 per cent. sulphur and $2.40 gold per ton.

5. Hopkins found pyrite on the small pond 4 chains east of Willett lake. The pyrite runs 25 per cent. sulphur, but no gold values were obtained.

6. On claims 2 miles northwest of Paska, a number of long trenches have been sunk in the Keewatin rhyolites. At No. 1 post of claim K.K. 1,792, a pit 8 by 6 by 4 feet has been sunk in highly pyritiferous rhyolite, which strikes 125 degrees and dips 65° N. Pyrite in a cluster of crystals is in one place crossed by a quartz veinlet.

A pit 320 feet east of No. 4 post of claim K.K. 1,790 shows a zone of pyrite 15 feet wide in a dark siliceous rock, which is partly brecciated at the north end of the pit where the strike is 80 degrees and the dip 80° N. Forty feet to the east

[1]E. S. Moore, op. cit., p. 243.

a trench crosses the same zone of breccia, of which a number of fragments are calcareous. More trenching has been done farther east.

Ground for Prospecting

The most favourable areas for the probable discovery of gold veins are covered by glacial overburden. Even without the aid of geophysical methods, prospecting may yet be rewarded by valuable gold discoveries in the Keewatin greenstones of the south Onaman country. The Timiskaming sediments of that vicinity should also be searched for mineralized veins or shear zones.

A smaller but newer field in Keewatin greenstone lies between O'Sullivan lake and Muriel lake. This rock is intruded by a boss of hornblende syenite,

Photo by W. A. Coughlan.



Shaft at the Tashota mine, 14 miles southeast of Tashota.

as is the greenstone at Tashota that bears the gold-quartz mineralization.

Attention should be given to the mass of greenstone two miles northeast of Jungfrau lake, which is also intruded by a small boss of hornblende syenite.

Principal Mining Prospects

GOLD

Tashota Gold Mines, Limited

The claims (K.K. 522-26, 536, 537, 562) of the Tashota Gold Mines, Limited, are situated about 14 miles southeast of Tashota. The mine may be reached by a winter road from Tashota or by a water route and roadway from Paska. On the latter route, a 4-mile road leading to the mine starts from the broad part of the North branch of the Onaman river below Barnum lake and crosses the south branch by pontoon bridge.

History.—Gold was found in the south Onaman country in 1917 by Ross Barnum and Jack McKechnie, and on the McKechnie claim in 1923. Work under option was begun here in 1927, when results were so favourable that a company was formed with H. H. Vaughan, Montreal, as president. Approximately a quarter of a million dollars has been expended to date, and an active programme for further work has been projected. C. E. Denny is consulting engineer.

Geology.—The mine is located in a belt of greenstone about two and a half miles wide and only a few hundred yards from the contact with the pink Algoman granite of Onaman lake. The Keewatin volcanics in the vicinity of the mine strike approximately east-west and, with a band of iron formation a few chains north of the veins, dip steeply to the north. Trenching and pits on the claims east and west of the property show that the structural breaks and mineralization extend in both directions. The horizon of the iron formation at the west boundary of the Johnson claim is a siliceous rock high in pyrite content. Pillow lava is the general country rock of the vein system. Keewatin intrusives also form part of the country rock, notably a quartz diorite cut by the granite a few yards southwest of No. 1 pit on the south vein.

Narrow quartz porphyry dikes intrude the greenstone. These Algoman dikes are distorted by shearing, especially along the edges. The blue quartz phenocrysts are conspicuous in a grey feldspathic groundmass both in specimens from the weathered rock and in the diamond-drill cores. In the latter, the phenocrysts are common close to the greenstone contact. W. A. Coughlan, resident engineer, has noted mineralized blebs of quartz in the porphyry, which he finds raking westward underground. Surface exploration to date has been carried out by digging and sinking about twenty trenches and pits.

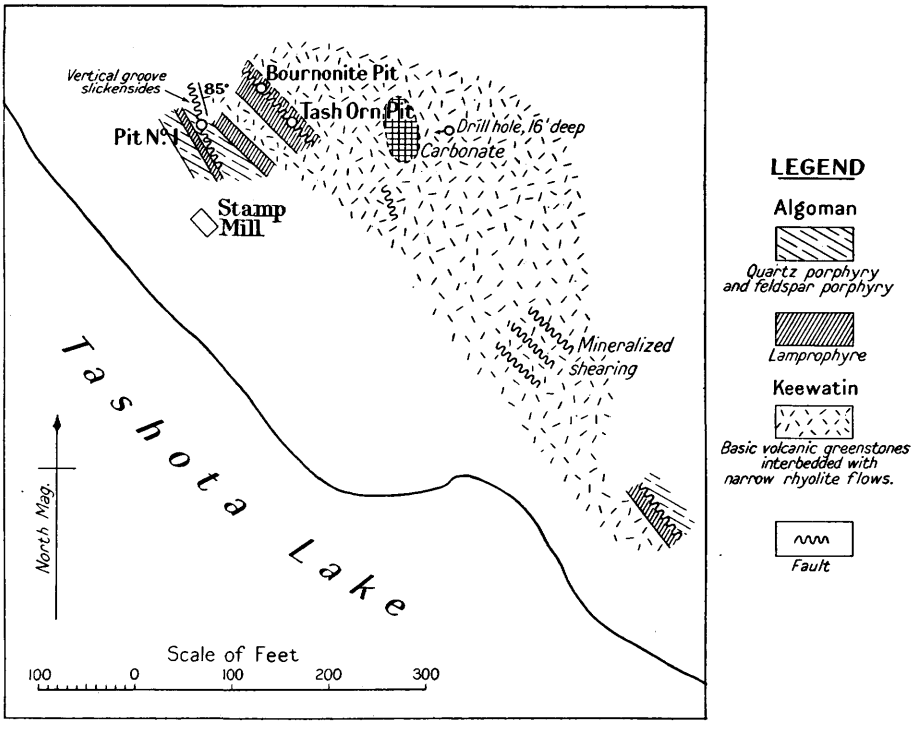
Structure.—The average dip of the veins is about 80° N. Faulting in a north-south direction since the time of mineralization has moved the south vein some yards off the line of strike in few places, as, for example, the south vein at trench No. 22. Further work may show that the north vein was formerly the eastern part of the south vein. This probability, however, is lessened by the occurrence of parallel shear zones both east and west of the mine. Mr. Coughlan found that the drag folds in the fault that crosses the south vein rake 35 feet to the west at a depth of 160 feet.

A two-compartment shaft has been put down to the 200-foot level, where several hundred feet of drifting and crosscutting has shown that the two main veins are considerably north of their position on surface. The north vein is known to be 400 feet long, and the other, which is 200 feet to the south, is uncovered at intervals for 1,000 feet. The veins have also been located underground in some of the 10 diamond-drill holes bored up to June, 1929. A third vein, which has not been found on the surface, appears in the crosscut 40 feet south of the shaft on the 200-foot level.

Ore.—Drill-holes shorter than those mentioned above were successful in picking up the veins between the 200- and 300-foot levels. Mr. Coughlan in a letter to the writer, dated November 15, 1929, says: "One especially, drilled from underground, brought up a very nice section."

The ore occurs in quartz veins and in the enclosing greenstone schist, which is well mineralized. The quartz veins are discontinuous lenses in the schist and range from tiny veinlets to veins several feet wide and 15 or 20 feet in length. Mineralization in the quartz and schist is chiefly confined to pyrrhotite and

chalcopyrite. The presence of the latter mineral seems to be necessary for the occurrence of gold. Tellurides are present in very small amounts. Native gold occurs in both the north and south veins. Mr. Coughlan states that there is a lowering of the gold values close to the porphyry dikes. In polished sections of the ore, it is apparent that the pyrite and pyrrhotite were formed first, followed by chalcopyrite in which blebs of the pyrrhotite remain after replacement. The average of assays made from 19 samples across 48 inches taken by J. G. Ross, consulting engineer, was $15.20. Assays made by Mr. Coughlan in 1929 of 26 samples across 48 inches taken from the western part of the drift on the 200-foot level gave an average value of $16 gold per ton.



Sketch map showing the geology of veins on the Cameron-Picotté property.

The Ore Dressing and Metallurgical Laboratories, Department of Mines, Ottawa, have returned a report by A. K. Anderson on 765 pounds of ore sent by the Tashota Gold Mines. Parallel tests were made on the ore to find what value of recovery could be secured. Screen analysis showed a large percentage of native gold and hence a lower recovery from coarse grinding. In conclusion Mr. Anderson writes:—

Recoveries of from 90 to 95 per cent. of the copper can be easily obtained. Due to the presence of free gold, flotation alone does not yield maximum recoveries of this metal.

Flotation followed by table concentration, as in test No. 5, yields a recovery of 92 per cent. of the gold in concentrates and middlings. Tests Nos. 6 and 7 show that 75.80 per cent. of the gold is free and can be recovered by amalgamation. Flotation followed by amalgamation gives 93.7 per cent. recovery of the gold and when augmented by cyanidation, 97.4 per cent.

In test No. 5, assays showed a flotation concentrate of copper, 28.68 ounces; gold, 25.4 ounces; silver, 24 ounces to the ton.

Cameron and Picotté

The claims (K.K. 998, 1,038, 1,041) of P. B. Cameron and J. A. Picotté border on the north shore of Tashota lake about a mile north of Tashota. A tractor road is used for transportation. Mr. Cameron has bored one diamond-drill hole 16 feet deep to test a carbonate rock that outcrops close to his Tash-Orn pit. Otherwise exploration has been confined to pits sunk on quartz veins and rusty zones in the greenstone.

Mining on a narrow high-grade vein at pit No. 1 is planned for the winter months of 1930-31. A 30- to 40-mesh steam stamp mill with a capacity of 14 tons in 24 hours has been installed to treat this ore (see photograph on page 87).



Polished surface of ore from the Cameron-Picotté claim, K.K. 998, Tashota lake, showing chalcopyrite (Ch), sphalerite (Sp), and bournonite (B) in vein quartz (Q). The light area (Q) near the bottom of the illustration is galena. (× 100.)

The country rock in the Tashota lake basin is Keewatin greenstone, which trends northwest-southeast. A number of outcrops of iron formation appear east of the lake. More than a dozen veins have been uncovered in the lake basin. The veins, which are wide and well mineralized, fill strongly sheared and schisted zones in the greenstone.

A number of porphyry dikes intrude the greenstone at pit No. 1; they have all been severely altered in the process of shearing. The rock succession across the strike at pit No. 1, starting at the shore, is as follows: quartz porphyry, 40 feet; greenstone, 3 feet; biotite lamprophyre, 2 feet; quartz porphyry, 5 feet; lamprophyre, 8 feet; greenstone and rusty pyrrhotite, 2 feet; lamprophyre, 1 foot; brown-weathering, highly sheared quartz porphyry, 30 feet. The

"bournonite pit" is sunk in the last-named porphyry on a quartz vein 15 inches wide.

The strike of the vein at No. 1 pit is 160 degrees, and the local dip is 85° N. Vertical faulting is plainly evident. Vertical slickensiding indicates steep faulting along the vein in quartz porphyry. Polished sections of the ore from this pit show that the minerals fill irregular fractures in quartz. Remnant grains of pyrite have been replaced by sphalerite and chalcopyrite. Pyrrhotite was seen in siliceous gangue. The mineral bournonite was identified by M. Haycock in contact with chalcopyrite, sphalerite, and galena, but no age relationships could be determined (see photomicrograph on page 93).

Assays of a selected sample from the bournonite pit gave: gold, none; silver, 4 ounces; zinc, 6 per cent.

The carbonate rock 12 feet northeast of the Tash-Orn pit is about 18 feet wide and lies against a volcanic breccia and rhyolite. The carbonate appears to owe its origin to replacement. The rock is white, being fully 80 per cent. calcite, and is marked with numerous closely spaced pale-green bands, consisting of pyroxene, epidote, and zoisite. Traces of zinc blende occur throughout the mass, shown in the photograph on page 67.

Molybdenite occurs in a quartz vein close to calcite veins exposed in the pit on claim K.K. 1,062 about 300 feet south of the cabin. Small amounts of arsenopyrite occur in the vein on the island in line with the vein at No. 1 pit of the Cameron-Picotté property.

Geo. H. Adair

This property (claims K.K. 986, 989, 990, 996) lies 2 miles south of the station at Tashota. The shaft is on claim K.K. 990.

The country rock is Keewatin greenstone. The eastern margin of the granite batholith reaches to within a few hundred yards of the vein showings and shaft. The rocks in the vicinity of the shaft are a succession of 200 feet of highly schisted and curly chlorite greenstone schist and rhyolite striking from due north to 25 degrees and dipping generally 70° E. Quartz veins of a few inches in width permeate the rhyolite porphyry, some bands of which are 10 to 25 feet wide. The greenstone schist members are derivations from lava and early quartz diorite intrusive bodies. The latter shows on its surface numerous light-coloured spots of kaolinized feldspar. One quartz porphyry dike cuts the volcanics at 125 degrees and in proximity to this, two Keweenawan diabase dikes.

The shaft, which is vertical and about 70 feet deep, was sunk about five years ago several feet west of the high-grade discovery vein, which strikes 25 degrees and dips 75° S.E. According to Ross Barnum, who helped to sink the shaft, there are no signs of the vein in its lower levels.

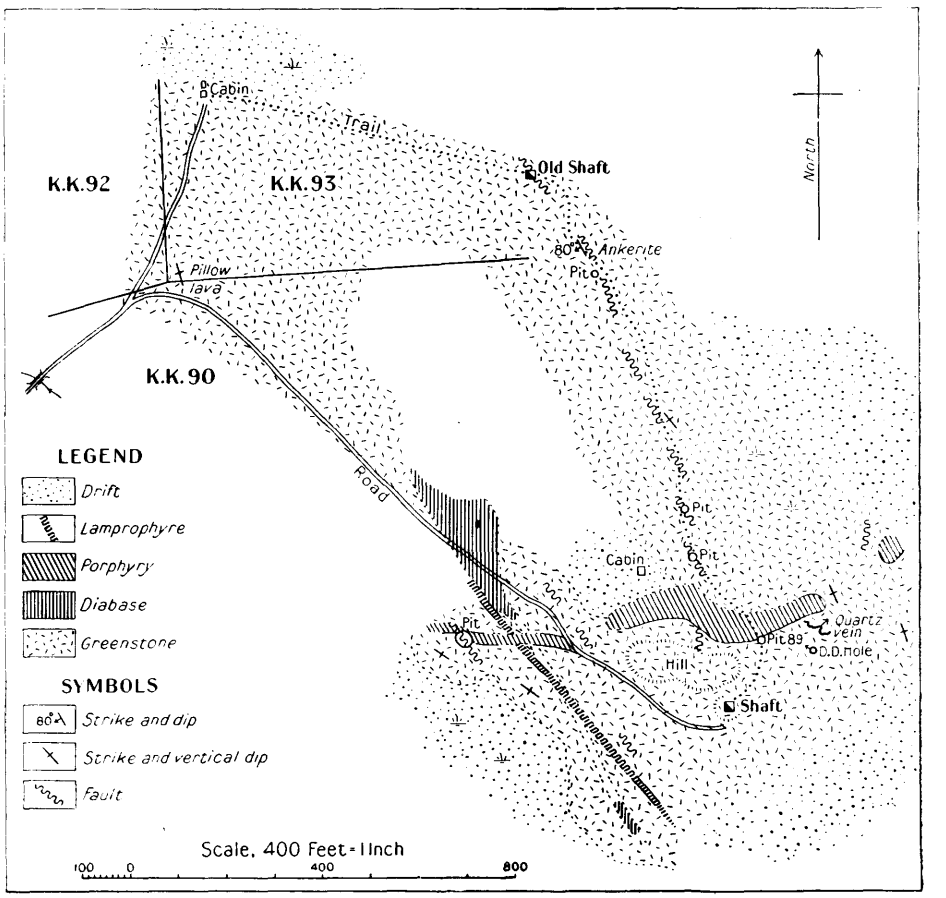
Channel sampling, done under an option held by the Timmins interests, showed $225 in gold over a length of 4 feet 3 inches, but the samplings were of a low-grade average from the shear zone north of the vein. The high-grade vein was again sampled in October, 1930, by W. H. Hansen for the McVittie Graham Mines, Limited, from which Geo. Adair reports an assay value of $185 across 4 feet. Mr. Adair states that the discovery vein mentioned above also carries several ounces of silver to the ton, and it is his intention to follow this vein downwards, to sort the high-grade ore, and to ship a carload to the Noranda smelter.

Kipper-Tashota

The Kipper-Tashota group of patented claims (K.K. 89-93, 142) is situated two miles east of Tashota. A series of parallel quartz veins traverses

the greenstone, which for several square miles shows signs of strong shearing. One large dike of the old Keewatin diabase is crossed by the road northwest of the south shaft. The Algoman intrusives, lamprophyre and feldspar porphyry, have undergone deformation at or close to the contact with a quartz and schist vein several feet wide south of the diabase, as shown on the map below. Talc and ankerite in small quantities occur in the sheared contact of porphyry and quartz-veined schist, in which, however, sulphides are scarce.

Here and elsewhere on the vein system, pits have been sunk. Two shafts were placed about 1,000 feet apart on the most prominent vein, which strikes



Sketch map showing geology in the vicinity of the shaft on the Kipper-Tashota property.

about 340 degrees and thus closely parallels the strike of the country rock. This vein is broken across in at least five places along its length by local faults of a few feet displacement. The quartz veins in a number of places make a width of at least 5 feet.

Native gold was reported from the surface at the south shaft by Hopkins, under whose direction a programme of channel sampling was carried out a few years ago. Gold values were found to range from $5 to $7 per ton. The ore at the south shaft is seen in polished section to be chiefly chalcopyrite in a gangue of pyrite and quartz.

King-Dodds

The gold discovery in 1915 made on the King-Dodds claim (K.K. 480), which is about three-quarters of a mile east of Howard falls, caused the first rush to the Kowkash gold area. In 1916, a shaft was sunk on claim K.K. 480 to a depth of 60 feet on the vein, which dips 75° N. Operations were renewed in August, 1930, under the direction of E. W. King-Dodds and E. E. Foreman, superintendent, and the shaft is being prepared for deepening. The vein was uncovered by means of trenching, from 260 feet west of the shaft to about 50 feet east of it.

The strike of the vein and dip conforms generally to that of the country rock, which is about 100 degrees. The rock is predominantly composed of basic Keewatin flows with minor basic intrusives of that age. A number of rhyolites are interbedded with the greenstone about 500 feet southwest of the shaft. Three rhyolite flows about a third of a mile west of the shaft are parallelled on the north side by a rhyolite conglomerate breccia. The Algoman intrusives, feldspar and quartz porphyry dikes, cut the greenstone several hundred feet south of the shaft. The largest of these, a quartz porphyry, has been considerably sheared, as has a porphyry just southeast of the shaft. A narrow calcite vein was found in the latter porphyry-greenstone contact zone.

The maximum width of the quartz vein is only 4 to 6 inches in lenses which narrow down to knife-blade thickness. The schist is best developed on the north side of the vein, and it carries a minor amount of gold. The vein can be followed down the side of the shaft to the bottom. In 1916, native gold was found at a depth of 40 feet. In 1930, native gold was seen at about 170 feet west of the shaft by the writer. The associated minerals in the quartz are pyrite, pyrrhotite, chalcopyrite, and a little galena.

Fifty feet east of the shaft, the vein changes direction from its general strike of 102 degrees to 82 degrees. The vein has not been followed for more than 30 feet, owing to an overburden of glacial sand and clay, which covers several acres north and east of the vein. Part of this is typical muskeg but is well drained by the river not far distant. A site a little to the north of the vein would be suitable for drilling operations to prospect the covered sector, in which mineralization may have occurred.

Tash-Orn Mines, Limited

Gold was discovered on this, the Wells claim, T.B. 2,892, a mile and a half southeast of Tashota, in 1916. In June, 1917, the shaft was down 120 feet and was expected to be at the 200-foot level by July, but since then the mine has been abandoned. A siding of the Canadian National Railway runs to within a quarter of a mile of the property. Hopkins[1] writes:—

> The rocks on the property are chiefly Keewatin pillow-lava schists, which have a general strike of 30° east of north and dip vertically. These are cut by narrow altered quartz porphyry dikes, probably of Algoman age.
>
> A shaft was commenced on a lens of quartz several feet in extent and carrying visible gold. Running north from this lens on the surface there are numerous parallel quartz stringers through which gold solutions have circulated. To the southwest of the shaft small lenses of quartz can be traced for about 90 feet. The shaft was sunk vertically to a depth of 100 feet and visible gold, sometimes coarse in character, was encountered to this depth in various parts of the vein. A shipment of 700 pounds of ore from the shaft at a depth of 30 to 35 feet was reported to give on assay $20 of gold to the ton. At a depth of 92 feet drifts have been run to the north on the numerous parallel veins, and to the southwest following the irregular strikes of the leases, and in addition some crosscuts have been made. The vein is greatly brecciated, the gold generally occurring along the dark fractures, which are filled with crushed quartz, calcite, talc, chlorite, and pyrite. Some native copper is present in the vein at the surface, while chalcopyrite, pyrrhotite,

[1]P. E. Hopkins, op. cit., p. 218.

tourmaline, and sericite occur in varying quantities. The deposit has been enlarged by the replacement of the country rock. The mineralized schists adjoining the veins and between the lenses sometimes carry gold values, but often they do not contain any gold.

Hopkins[1] reports that the ore body developed on the first level is longer than that on surface and averages $5 to the ton.

Cline

No work has been done on the Cline claim, K.K. 61, since 1925, at which time Gledhill[2] wrote:—

The rocks on K.K. 61 near Tashota [immediately northwest of the water tank] consist of sheared greenstones and a sediment resembling banded iron formation This sedimentary rock is made up of fine bands of silica and magnetite and in places pyrite instead of magnetite. Some bands consist of fibrous amphibole.

The banded rock has been impregnated with gold-bearing solutions. The greenstones show much shearing action and the mineralized quartz veins have well-defined walls.

Visible gold was seen in the oxidized banded rock composed of magnetite and silica.

A 60-foot shaft has been sunk, southeast of post No. 4 of this claim, on a quartz vein which is reported to be four to five feet wide at the bottom of the shaft. The greenstone schists dip northeast at 60 degrees and strike northwest. Good gold pannings were obtained from the oxidized cap overlying the mineralized rock.

Richardson-Loudon-Ogilvie

This claim, T.B. 2,599, on the Kawashkagama river near the first rapids below Johnson creek, has been described by Hopkins.[3] The narrow quartz vein in Keewatin pillow lava is 200 feet long and averages 2 inches in width. It strikes at 85 degrees and dips 70° S. Coarse gold was seen in six or seven places along the vein. Outcrops are scarce, but near the vein a biotite granite dike 6 feet wide outcrops.

Devanney

The Devanney claim, T.B. 2,650, lies on the northwest shore of Tashota lake. Gold values were reported to be low, and no work has been done since 1916. Hopkins[4] gives the following description:—

The main vein has a tortuous course along a general northwest and southeast direction and dips from 50° to 80° to the southwest. The vein is lenticular, varying in width from a few inches to 8 feet and is traceable intermittently for about 1,000 feet. Adjacent to the vein, in places, are other narrow parallel veins. The white quartz has occasional dark bands parallel to the walls and resembles the "Rea" vein at Porcupine described by A. G. Burrows in his report on that area. The dark seams consist of tourmaline, pyrrhotite, pyrite, and crushed quartz. Certain parts of the vein comprise a mixture of schist and quartz, which are heavily impregnated with pyrrhotite, pyrite, and tourmaline with smaller amounts of chalcopyritei mica, and chlorite. A very little visible gold, a telluride, and bismuthinite are also present. The wall rock, a Keewatin greenstone, is entirely altered to chlorite, calcite, and quartz, and is cut by narrow quartz porphyry dikes. . . . Three diamond-drill holes were put down in the vicinity of the 20-foot shaft to test the vein at vertical depths of approximately 100, 150, and 250 feet, respectively. The vein where cut was in each case about 8 feet wide, but the gold contents were reported to be low.

Kipper-Cameron

The Kipper-Cameron claims, K.K. 329 and 330, lie south of Hull lake. Gledhill[5] has described this property as follows:—

This discovery is situated near the south edge of Hull lake on an east and west ridge; the mineralization is along a shear zone at the contact of Keewatin greenstone and quartz porphyry. The quartz veins form a sheeted structure in the schists and strike N. 85° E. and dip north at 75 degrees. A dozen or more test pits have been sunk along the break, and a mineralized zone of variable width has been shown to extend in linear fashion for a length of several chains.

[1]P. E. Hopkins, op. cit., p. 220.
[2]T. L. Gledhill, op. cit., p. 84.
[3]P. E. Hopkins, op. cit., pp. 216, 218.
[4]Ibid., p. 218.
[5]T. L. Gledhill, op. cit., p. 80.

The greenstone schist in the break has been pyritized. The footwall of the sheeted zone consists usually of quartz porphyry. Tourmalinized gold-bearing quartz fills cross-fractures in the earlier formed, sheeted quartz veins. The minerals, besides gold, are chalcopyrite, siderite, galena, and sphalerite.

The gold-bearing deposits in this area follow closely the northern edge of a wide belt of quartz porphyry extending from Metcalfe to Oboshkegan lake.

Canada Mines Syndicate

No work has been done on these claims, K.K. 397 and 401, for the last few years. Gledhill[1] describes the property as follows:—

On claim K.K. 397, a wedge of sheared quartz porphyry was intruded among the Keewatin greenstone schists. Auriferous pyrite in quartz veins occurs near the contact of the porphyry with the greenstone. The quartz veins have been drag-folded and are not continuous. A sample of the more richly mineralized, auriferous, pyrite-bearing quartz, when assayed by the Provincial Assayer, gave $193.60 in gold per ton.

Another vein filled with cabonates, galena, sphalerite, and chalcopyrite extends east of the porphyry and the drag-folded quartz veins. These carbonate veins are not drag-folded, but are linear, having the same strike and dip as the enclosing greenstone schists. The greenstone schist dips north at 85 degrees and strikes about N. 60° E. The carbonate gangue in this vein shows grey and white banding, and its rusty weathering in the outcrop is suggestive of the weathering of siderite, the iron carbonate. The gold and silver values are low in the carbonate veins.

On K.K. 401, a sheared porphyry occurs in greenstone schists along with a vein consisting of quartz, pyrite, galena, and sphalerite. The better mineralized portion of the vein, which is rich in pyrite, galena, and sphalerite, carries $2.20 in gold per ton and 14.9 ounces of silver per ton.

In the present discovery, all the gold is contained in mineralized quartz veins which are not plentiful enough or continuous enough to be mined. Possibly a mineralized shear zone will be found on this property near the junction of the porphyry and greenstone.

Kenty

No recent work has been done on the Kenty claims, K.K. 800 and 831, which have been described by Gledhill[2] as follows:—

A trail a mile long leads south to the discovery from a camp on the south shore of the east end of Conglomerate lake.

The mineralization occurs in the greenstones across a width of 150 feet. . . . They strike N. 80° E. and dip at 85 degrees toward the north, and have been impregnated with finely crystallized pyrite. Parallel-sheeted quartz veins and in places narrow dikes of feldspar split the schist and produce a banded rock resembling a granite gneiss.

The mineralized zone extends east and west with the schistosity strike. The dip is nearly vertical. Recrystallized greenstone bounds the mineral zone on the north; on the south the mineralization can be traced to where the rock is covered by muskeg. The mineralization was no doubt produced from solutions coming from the granite.

Some quartz veins up to 3 feet in width lie on the north side of the mineralized belt. Channel samples taken by J. Kenty across 8 to 10 feet of mineralized schist carried values ranging from $4 to $14 in gold per ton. Gold pannings were made by the writer in several places on the discovery. Portions of the schist are silicified. Pyrite, molybdenite, and gold appear to be the only ore minerals. Claims lying east and west of Kenty's discovery have mineralized schist which gives gold assays. This part of the camp has an overburden of glacial drift which makes prospecting somewhat difficult.

Currie

The Currie claim, K.K. 514, lies about a third of a mile northwest of the property of the Tashota Gold Mines. No development work has been done since the time of Gledhill's description,[3] which is as follows:—

This discovery was made in August, 1923, and was of interest because of the finding of a rich galena, sphalerite, pyrite vein. The break is in Keewatin greenstone and trends in a northeast direction across the claim. At the east end the vein is very narrow and has a little rusty quartz carrying a few specks of galena. T. Currie by careful prospecting followed the break westward and found that it widened in this direction. The break contains a feldspar porphyry dike similar to that on K.K. 514.

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[1]T. L. Gledhill, op. cit., p. 82.
[2]Ibid.
[3]Ibid, p. 83.

There is some evidence that this vein is a replacement of a pyrite lens in the Keewatin rocks. . . . The pyrite appears in the galena as rounded blebs, which lends support to the replacement theory. This ore is of special interest on account of its content of both gold and silver, the silver running as high as 40 ounces per ton and the gold from $5 to $6 per ton.

Johnson

At present the showings on the Johnson claim, K.K. 442, are well exposed, owing to the stripping done during the past two years in the morainal sand, which is commonly 4 to 6 feet deep. A geological map of the claim is shown on the map of the Tashota Gold Mines (see insert facing page 90). Gledhill[1] gives the following description:—

The structural break is occupied by quartz veins and a feldspar porphyry dike. The general schistosity strike is N. 66° E., and the dip is 80 degrees towards the north.

One mineralized vein system 50 feet wide is made up of brecciated vein quartz and greenstone. The ore minerals are pyrite, chalcopyrite, and pyrrhotite. Some of the chalcopyrite bands are half an inch wide. The large quartz pyrite lens carries traces of gold. The chalcopyrite-quartz mineralization carries much higher values in gold than the pyrrhotite-quartz mineralization.

Brett-Trethewey

The Brett-Trethewey claims border the northwest shore of Deeds lake. The contact between a large syenite boss and the Marshall Lake series crosses the peninsula and the low *roches moutonnées* islands in the bay west of it. The mineralized shear zone lies about 400 feet north of the syenite contact. It has been stripped and trenched for about 100 feet in a direction oblique to the strike of the country rock, which is generally about 75 degrees but varies considerably.

The main body of rock stripped is a rusty, banded and contorted siliceous rock 50 feet wide. It strikes 60 degrees and appears to be sedimentary like the banded rocks that outcrop a few hundred yards to the west. This "quartzite" is highly chloritic and rich in pyrrhotite across a width of 20 feet on its south border. On the north side a band of pyritiferous sugary quartz one foot wide, striking 70 degrees, is crossed obliquely by a readily crumbling graphite schist vein, one to two inches wide, from which low gold values were reported.

Fifty-four magnetic dip needle readings were taken. At the pit, 80 and 70 degrees were recorded, and the same figures at 150 feet to the southeast; whereas nine readings of −70 to −80 degrees were read within a distance of about 75 feet, centred at the pit. The average of the remainder was about −30 degrees. The interpretation of the readings is obviously to be applied to a body located close to the surface in view of the abrupt changes noted.

Russell Cryderman

Narrow quartz veins fill the fissures in a sheared quartz porphyry dike that outcrops for 110 feet along the shore of O'Sullivan lake in the bay of the 103-chain portage. The country rock is greenstone, in which ankerite has developed across 30 feet at 10 feet west of the porphyry. The quartz veins in the dike are not more than a few inches wide. They strike 60 degrees and dip 75° S. The porphyry dike reappears on the east side of an island in the bay with a small showing of ankerite. The centre of the island is formed by a wide Keweenawan diabase dike, in which much epidote has formed. On the mainland the northern part of this dike cuts the greenstone 180 feet west of the Cryderman porphyry dike.

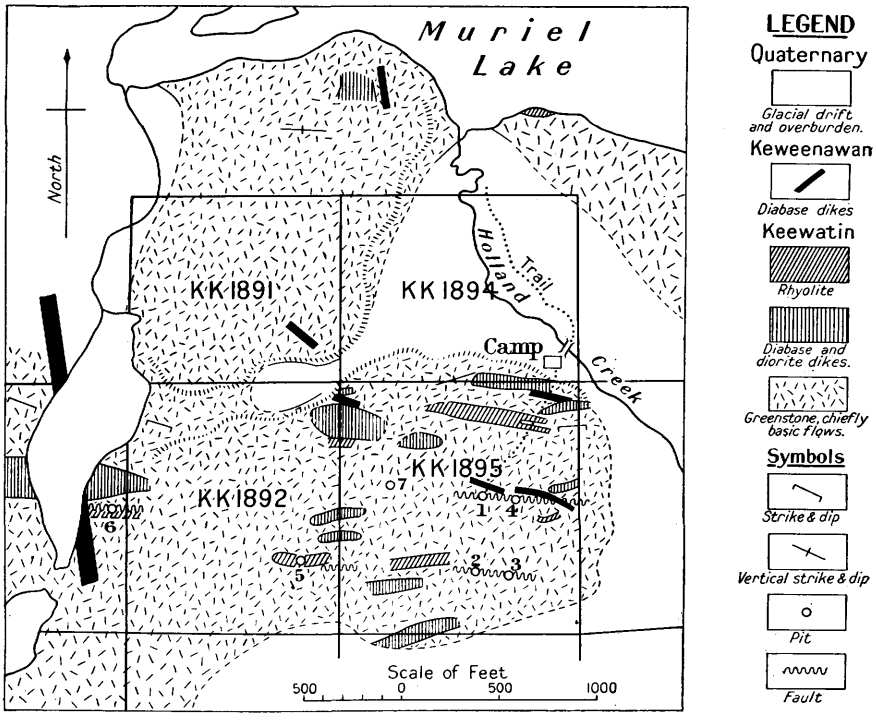
Close to the shore on the claim east of the porphyry dike, a felsite dike was found mineralized with pyrite and traversed by a narrow quartz vein. Gold values reported from a 5-foot and a 4-foot channel sample in the ankerite zone

[1]T. L. Gledhill, op. cit., p. 83.

were $6 and $20, respectively. Horace Strong is said to have panned gold in the porphyry dike.

Robert Wells

These claims lie west of the Nipigon Provincial Forest line on the South branch of the Onaman river. Wide quartz veins in Keewatin volcanics and intrusives have been well exposed by trenching. A few hundred yards west of the camp on claim T.B. 4,510, a vein 200 feet long passes through a green quartz porphyry, which is sheared across 6 feet. It could not be determined whether the porphyry was a flow or dike, although the specimen appears identical with porphyry dikes of this region. A narrow vein at the camp site is crossed



Sketch map showing geology on some of the Holland-Chellew claims.

obliquely by a narrow fault zone, which is nearly parallel to the vein, and is mineralized with chalcopyrite, sphalerite, and galena.

At the south end of the group of claims (T.B. 4,478, 4,510, 4,516, 4,521), a quartz vein 3 feet wide carries pyrite, chalcopyrite, sphalerite, and galena. Ankerite is associated with this vein. A vein 20 feet wide 600 feet to the west was poorly mineralized. A small quartz vein 100 feet distant at 145 degrees widens out in passing from the greenstone into the rhyolite.

Channel sampling and assays done on these veins in June, 1930, by C. Springer showed low values in gold.

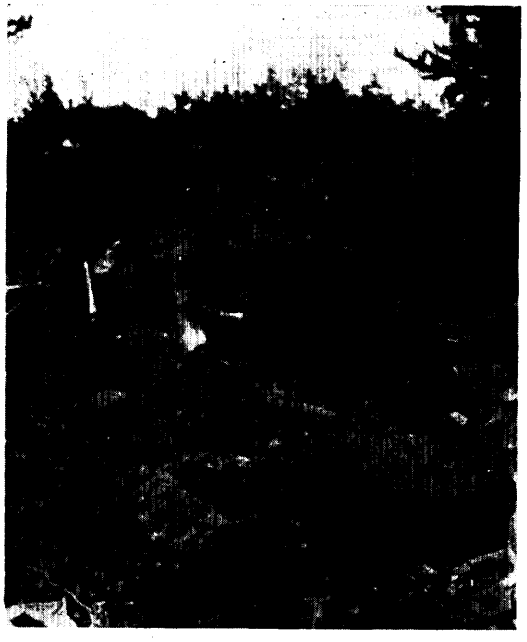
COPPER

Holland-Chellew

The Holland-Chellew claims (K.K. 1,886, 1,887, 1,888, 1,891, 1,892, 1,894, 1,895, 1,898) are situated just south of Muriel lake. Greenstone, which is

the country rock of the Muriel lake basin, forms hills in a topography also made hilly by numerous terminal moraines. Seven rhyolite flows occur with the greenstone on claims K.K. 1,898 and 1,895. Keewatin diorites occur in abundance.

On these two claims, 7 pits have been made in two parallel zones of mineralization, which are about 400 feet apart. They are of about equal length and strike nearly east-west, parallel to the strike of the confining rocks. The mineral deposits are lens-shaped with maximum dimensions of about 100 by 15 feet. These are zones formed by strong shearing accompanied and followed by the mpregnation of lenses of quartz-biotite schist by narrow quartz veins. The atter are contorted and twisted. The resultant schist is black and under the



E. J. Holland and Charles Chellew at No. 1 pit of claim K.K. 1,895, July, 1929.

microscope is seen to be composed of fine quartz and muscovite, in which a few tiny garnets occur.

Examination of the polished surface of a specimen from the southern zone showed that the quartz was fractured by tiny strain fissures orientated at nearly right angles, at the junctions of which occur the larger nodules of pyrrhotite and chalcopyrite. The chalcopyrite veins the pyrrhotite, replacing it irregularly.

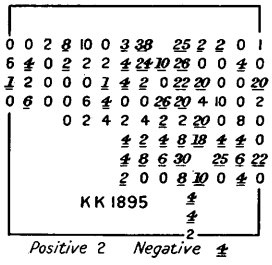
A channel sample across 4 feet from a mineralized vein on claim K.K. 1,886 assayed for E. J. Holland gave the following results: copper, 12 per cent.; silver, 5.4 ounces; and gold, $1.80 per ton. What appears to be the continuation of the zone on the southern part of claim K.K. 1,887 is a mineralized vein and vein rock 33 feet wide, striking 70 degrees and dipping nearly vertically. Pyrite is abundant in a sugary quartz matrix. Galena occurs sparingly in this vein at the north side of the sheared zone. The rock of the south side is evidently a sheared rhyolite in contact with Keewatin diabase. At the contact there is a chloritic gossan zone.

An assay of a selected sample from the shear zone gave the following results: lead, 33.46 per cent.; zinc, 5.70 per cent.; silver, 45 ounces.

A magnetic survey by dip needle was made over claim K.K. 1,895 and a plan of the readings plotted on a scale of 1,000 feet to the inch (see diagram below).

J. Perry

At the Perry claims, K.K. 1,977 and 1,978, on Muriel lake, a mass of crystalline limestone 15 feet wide on claim K.K. 1,978 is separated from the galena vein of claim K.K. 1,887 by a succession of rocks which are, reading from the south, a narrow band of greenstone in contact with the limestone; rhyolite, 15 to 20 feet; basic lava, 30 feet; and the Keewatin diabase. The limestone dips steeply north and strikes 80 degrees. Low ground covers the limestone



Diagrammatic sketch of magnetic dip-needle readings on claim K.K. 1,895, Holland-Chellew group, Muriel lake.

along its strike eastward to its reappearance in a hillside 500 feet distant, where it is only 6 feet wide. Chalcopyrite and pyrrhotite occur in a black schist lens a few inches wide between the limestone and rhyolite on the north side. The same mineralization occurs sparingly at the south contact, also with a narrow rhyolite, itself bounded by a coarse basic greenstone. The limestone is thought to be the product of metamorphism, although it may be sedimentary.

Northern Airways Mining and Exploration Company

Small showing of chalcopyrite and pyrrhotite are exposed in pits on claim K.K. 1,749, on the northeast shore of O'Sullivan lake north of the larger islands. The rock in the vicinity of the pits is a lava flow of fine texture and olive-green colour. The wall of the westernmost pit is formed by a narrow quartz porphyry dike. What appears, in thin section, to be a much altered porphyritic basalt or andesite is found in contact with the lava between that pit and the shore. In the lower part of the pit, numerous spherulitic accretions are composed of chalcopyrite-bearing pyrrhotite, but they are too dispersed to indicate a valuable deposit. Low ground intervenes between pits Nos. 1 and 2, 300 feet distant at 280 degrees. This is in a low hillside of rhyolitic lava. Chalcopyrite is not abundant but is commoner than pyrrhotite. A 2-inch vein strikes 70 degrees, dips 60° N., and carries a small quantity of carbonate. A second quartz vein 65 feet south and 150 feet long strikes 65 degrees. This is closely parallelled by a quartz vein, which dips 75° N.

The location of No. 3 pit is 130 feet at 220 degrees from pit No. 2; here pyrite and chalcopyrite occur disseminated in the rhyolitic lava. Rock shearing is inconspicuous but it may be covered over in the low ground between the pits.

PYRRHOTITE

Colpitts Lake

Eighteen claims were laid out but not recorded by Len. and Chas. Brookbanks and Joe Perry in the summer of 1929 on a deposit of pyrrhotite, which outcrops on the shores of Colpitts lake. Two parallel zones a quarter of a mile part extend for more than two miles in a general east-west direction. Pyrrhotite mineralization has replaced discontinuous lenses of pyrite in metamorphosed garnetiferous quartz-biotite schists. On the cliff south of Iron lake,



Polished surface of a specimen of pyrrhotite (P) from the pit on the west shore of Colpitts lake showing a tiny veinlet of chalcopyrite (Ch) and secondary quartz (Q) veinlets replacing the pyrrhotite. (× 100.)

close to an altered diorite, fully a third of this rock is composed of garnets. (See photgraph on page 66.) In both rocks, the garnets are commonly half an inch wide and under the microscope are seen to enclose fine quartz granules. The diorite a third of a mile west of Colpitts lake is thus largely garnetiferous and otherwise composed of hornblende intergrown with quartz, and a few feldspars and some secondary calcite and zoisite(?).

The metalliferous zones are enclosed in schists dipping steeply to the north and in some places are closely parallelled by intrusions of metagranodiorite or a rhyolite that has been altered to the hornblende-garnet composition. This rock shows pseudocolumnar structure on the east shore of Colpitts lake and is described on page 73. A forked tourmaline pegmatite dike of probable Algoman age joins the pyrrhotite at depth on the west shore of Colpitts lake. The dike is only 15 inches wide for 200 feet; it strikes 85 degrees, and dips 45° N. Four

fresh Keweenawan dikes of diabase rich in pyrite and pyrrhotite intrude the arkosic metasediments locally.

Faulting appears to mark the line of the cliff that crosses the Colpitts lake portage. This is the southern gossan zone which is faulted northward just west of Iron lake.

The pyrite content is very high in the cliff face east of the portage. In the pit on the hillside on the west shore of Colpitts lake, where the zone reaches a width of about 18 feet, the ratio is about 50 per cent. pyrite and 50 per cent. pyrrhotite. Of the few quartz veins, one about 2 inches wide was noticed. A polished surface of "ore" from the pit shows massive pyrrhotite invaded by embayments of quartz (5 per cent.), partly in the form of minute, straggling veinlets, from which a tiny veinlet of chalcopyrite crosses the pyrrhotite, as shown in the photomicrograph on page 103. An assay made at the Provincial Assay Office returned gold 40 cents to the ton but no copper or nickel. A specimen from the pit a quarter of a mile farther west showed abundant much-pitted pyrite, 20 per cent. quartz embayments, and 25 per cent. younger pyrrhotite impregnated with quartz granules. The assay returns here were very similar to the preceding ones.

South Shore of Meta Lake

A pyrrhotite deposit, which has been staked twice in the last 15 years, forms a straggling zone of gossan across the peninsula formed between the two streams that enter the southwest bay of Meta lake. The country rock is chiefly a hornblende schist, which strikes 90 to 100 degrees. Intrusive stocks of amphibolites occur along the strike, toward the west end of which a richly garnetiferous schist is traversed lengthwise by narrow quartz veins. The disseminated zones of pyrrhotite are so leached that sericite and quartz are the only predominant minerals, and metallics are rarely to be seen where the deposit has not been trenched. Sampling done by Hopkins[1] showed the absence of platinum and nickel.

South Shore of Marshall Lake

This deposit of pyrrhotite is a replacement of iron formation in the Marshall Lake series and is crossed by quartz veins 10 feet in aggregate width, which are evidently the source of the pyrrhotite at depth. The quartz veins strike generally 145 degrees and dip 75° N.E. The outcrop is 15 feet wide and is exposed for 100 feet between overburden on the west and the bay on the east. Seven pieces of pyrrhotite from different parts of the open cut, which is 12 feet deep, were assayed for Hopkins[2] in 1916 but gave no values for nickel, platinum, or gold.

[1]P. E. Hopkins, op. cit., p. 88.
[2]Ibid.

A Deposit of Titaniferous Magnetite in Angus Township, District of Nipissing

By M. E. Hurst

Introduction

Titaniferous magnetite has been known to occur in Angus township, district of Nipissing, for a good many years. The deposit has remained undeveloped chiefly because there has been little or no market for iron ores containing titanium. Within recent years the demand for titanium compounds has greatly increased and, if this demand continues to expand, it will be necessary to find new sources of supply. It seems probable that, owing to the scarcity of high-grade titanium ores, the utilization of titaniferous magnetites will then receive more serious consideration.

Location and Means of Access

In 1897, A. E. Barlow[1] reported the occurrence of a body of diabase lying within the extensive area of granite gneiss that forms the southern part of the district of Nipissing. Later surveys place the location of this body in the townships of Flett and Angus. Most of the diabase mass is in Flett township, where it is well exposed in the vicinity of Fanny, McDiarmid, and Breadalbane lakes. A narrow tongue extends in a northeasterly direction into Angus township. Near the tip of this tongue there are several outcrops of titaniferous magnetite. The principal exposures are on location W.D. 403, which is owned by D. O'Connor, of Connaught, Ont.

The deposit lies about five miles northeast of Kenney siding on the Temiskaming and Northern Ontario railway. It is reached by way of an old logging road, a mile and three-quarters long, that connects Kenney with the west side of Fanny lake. From the end of the road a canoe route is followed to the north end of Fanny lake and across a short portage into McDiarmid lake. A trail leads from a point midway along the east shore of McDiarmid lake to the boundary between Flett and Angus townships. This line is followed to the lake just north of the 2-mile post where the trail swings eastward to the showings.

General Geology

The body of diabase in which the deposits of titaniferous magnetite occur is a Y-shaped mass about 4 miles long and from half a mile to one and a half miles wide. It is surrounded by granite gneiss. The contact between these rocks was observed along the south shore of Fanny lake and near the small lake just north of the 2-mile post on the boundary between Flett and Angus townships. In these localities the contact is not sharply defined but consists rather of a zone in which the transition from one rock to the other is represented by hybrid types or their schistose equivalents. The rocks occurring most frequently in this zone are schists composed chiefly of biotite together with subordinate amounts of quartz, hornblende, and brown garnet.

[1]Geol. Surv. Can., Vol. IX, pt. I, 1897, p. 109.

Granite Gneiss

The granite gneiss is usually medium-grained and pale pink in colour. Biotite is the principal ferromagnesian constituent. The gneissic structure is more or less distinct depending on the relative abundance and linear arrangement of the biotite flakes.

Diabase

The diabase is normally massive and coarse-grained, and brown, greenish-purple, or black in colour. Except in the weathered portions of the outcrops, the rock constituents, as seen under the microscope, are remarkably fresh. The rock is composed essentially of plagioclase and augite. Among the minor constituents, titaniferous magnetite, biotite, and apatite are uniformly present; olivine and pyrite occur occasionally; and quartz is lacking. In the hybrid rocks developed along the diabase-granite contact, quartz, biotite, and brown garnet are quite abundant.



Photomicrograph of thin section of diabase from the O'Connor property, showing magnetite (black), augite (A), and plagioclase (P). (Lower nicol only, ×16).

The plagioclase occurs in idiomorphic interlacing laths having the composition of basic andesine or labradorite. The ophitic texture is rarely well developed, as the augite is confined chiefly to the interstices between the laths of plagioclase. The augite exhibits a faint violet pleochroism and is probably titaniferous. In weathered portions of the diabase the grains of augite are invariably surrounded by a reaction rim composed chiefly of chlorite and serpentine. Biotite occurs as flakes, which often adjoin or partially surround the grains of magnetite. Apatite is present in stout prisms and is usually associated with the plagioclase. Olivine occurs sparingly as rounded grains embedded in the augite. Patches of magnetite, occasionally exhibiting an octahedral habit, are uniformly distributed throughout the rock.

A specimen of fresh diabase, obtained from an exposure at the point indicated on the accompanying map, was submitted to the Provincial Assay Office for analysis. The results were as follows:—

	Per cent.
SiO_2	50.14
Al_2O_3	22.19
Fe_2O_3	1.74
FeO	6.49
CaO	8.94
MgO	2.25
Na_2O	3.52
K_2O	1.39
TiO_2	2.13
MnO	.10
P_2O_5	.39
H_2O (−100° C.)	Nil
H_2O (+100° C.)	.32
CO_2	.02
S	.17
	99.79
Specific gravity	2.88

The diabase is readily affected by atmospheric agencies, and in most of the exposures the rock is soft and partially decomposed. This decay usually extends only a short distance below the surface. Pyrite and augite are the first minerals to decompose and their removal leaves the laths of plagioclase standing in relief. In places the rock has disintegrated entirely and the outcrops are marked by a coarse, rusty sand composed of the liberated mineral grains.

Age Relationships

Present information is insufficient to determine conclusively the age relationships of the diabase and the granite gneiss. As no sedimentary formations have been found in the area, it is almost impossible to correlate these rocks with similar intrusives in other areas, except on the basis of lithological characteristics and on their mutual relations to one another. No clear-cut or sharply defined contact was observed between these rocks. They appear to be separated by a zone in which there is a gradual transition, through intermediate rock types, from granite to diabase. The gradational character of the contact zone suggests that the two rock masses were intruded either simultaneously or so closely following one another that the earlier had not completely consolidated before the intrusion of the later body.

Evidence obtained in the field was too conflicting in character to warrant a decision at the present time as to whether the granite is older or younger than the diabase. Several observations were made that may afford a clue to the age relationships of these rocks:—

1. Numerous quartz veinlets cut the granite gneiss. None was seen in the diabase. If the diabase body were older or of the same age as the granite it might be expected also to contain quartz veinlets.

2. The location of the magnetite bodies and the minerals associated with them suggest that the deposits may be due, in part at least, to contact metamorphism. As these deposits are genetically related to the diabase, such an origin would imply that the diabase is younger than the granite.

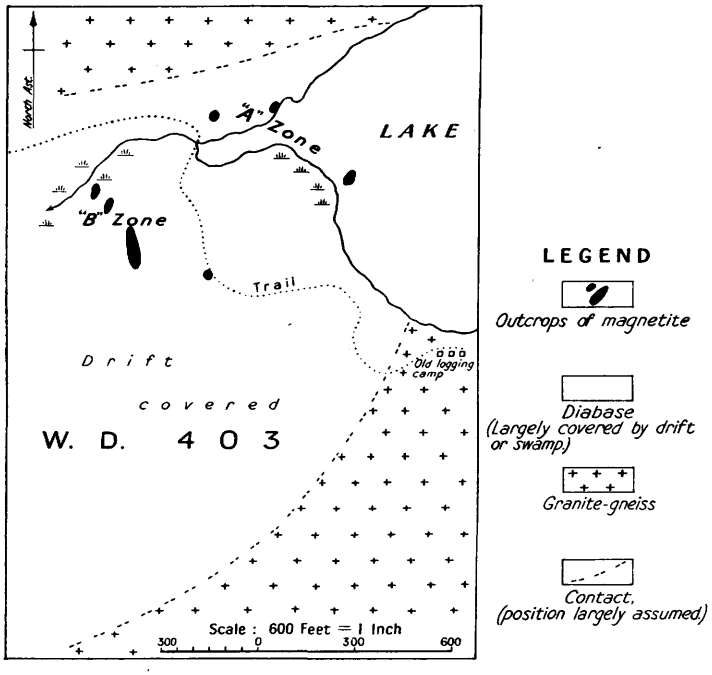
3. The magnetite-bearing zones appear to be truncated by the granite. If such is the case, the granite is younger than the diabase.

Description of the Deposit

The principal showings occur near the outlet of the small lake on location W.D. 403. Exposures of titaniferous magnetite, separated from one another

by drift or swamp, were observed at seven points. While sufficient development work has not been done to establish the continuity of the mineralization between these exposures, the alignment of the outcrops indicates the presence of two magnetite-bearing zones (referred to below and on the accompanying plan as "A" and "B") situated about 400 feet apart and roughly parallel to one another. These zones trend in a northwesterly direction across the tip of the diabase mass near its contact with the granite gneiss. The bodies of magnetite, as well as the diabase in their immediate vicinity, are quite schistose. The schistosity strikes N. 20°-25° E. (astr.) and intersects the northwesterly trend of the mineralized zones.

The "A" zone outcrops on the north shore near the outlet of the lake. It is exposed again about 185 feet west of this point and also on an islet 300 feet



Plan showing the exposures of magnetite on mining location W.D. 403, Angus township.

to the southeast. Owing to the limited size of these exposures very little information concerning the continuity of the mineralization and the dimensions of the zone could be obtained.

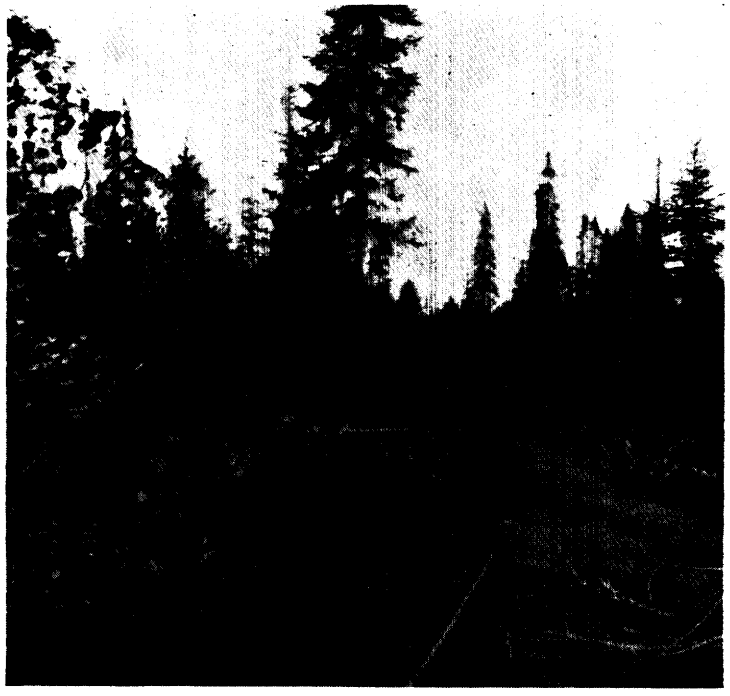
The "B" zone outcrops about 400 feet southwest of the "A" zone. The principal exposures are in the marshy ground just south of the creek flowing from the lake and on a prominent ridge near by. Near the creek there are two hummocks of magnetite, each about 50 feet long and 15 feet wide, which extend a few feet above the surrounding swamp. On the adjacent ridge there is a body of magnetite, in places exposed for a width of 40 feet, which can be traced for 175 feet in a southeasterly direction before it is hidden by overburden. These exposures indicate that the zone has a length of at least 300 feet. A fourth outcrop was found to the southeast of the ridge. If the mineralization

is continuous to this point, then the length of the zone would be increased to 450 feet.

A grab sample of the best-looking material from the "B" zone was submitted to the Provincial Assay Office for partial analysis. It contained:—

	Per cent.
Fe	43.62
TiO_2	21.96
P_2O_5	.05
V_2O_5	.18
S	.03

The mineralized zones consist chiefly of a schistose mixture of titaniferous magnetite and altered diabase. In places there are streaks, patches, and veinlets



Glaciated exposure of titaniferous magnetite, "B" zone, O'Connor property.

of solid magnetite, but as a general rule the magnetite and gangue are intimately intermingled. The gangue is principally pale-green talc, actinolite, and green spinel (ceylonite). Grains of spinel are often finely disseminated through the massive magnetite. In addition, the ore zones contain remnants of greenstone or diabase that have been partially recrystallized into garnet, hornblende, and magnetite.

The magnetite bodies are believed to be genetically related to the diabase body. Such a relationship is indicated by the presence of magnetite as an original and widely disseminated constituent of the diabase and by the presence of titanium in the magnetite bodies and in the diabase. The location of the magnetite bodies at or near the granite-diabase contact and the occurrence of such minerals as garnet, spinel, and hornblende in the ore zones, suggest

that the deposits may be due to contact metamorphism induced by the intrusion of the diabase into the granite. If, however, the diabase is older than the granite, it is hardly likely that the deposits owe their origin to the contact metamorphic effects of the granite intrusion and some other mode of origin must be postulated. There is some evidence to indicate that the mineralization may be due to replacement of greenstone remnants caught up in the diabase or to segregation



Photomicrograph of a thin section of ore from the "B" zone, O'Connor property, showing titaniferous magnetite (black), spinel (S), talc, and actinolite (TA). (The negative has been retouched to show the spinel. Lower nicol only, ×51.)

and injection of magnetite during the consolidation of the diabase body. Since their formation the deposits have been modified to some extent by shearing movements and the ferromagnesian minerals originally associated with the magnetite have been converted to talc, actinolite, and chlorite.

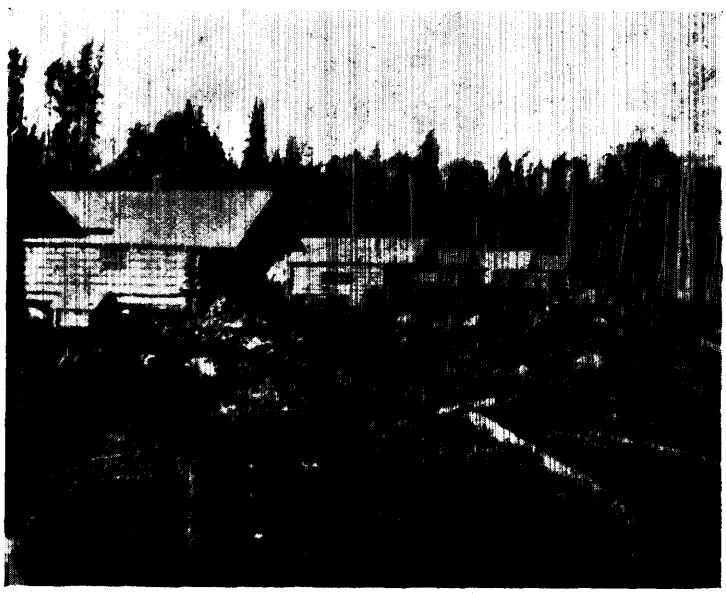
The possibility of similar deposits of magnetite occurring elsewhere along the diabase-granite contact should not be overlooked. As this contact zone is largely obscured by drift and swamp, dip-needle or magnetometer surveys would be of considerable help in locating the most promising sections in which to carry on intensive prospecting.

Chromite Deposits of the Obonga Lake Area, District of Thunder Bay

By M. E. Hurst

Introduction

The occurrence of chromite in the Obonga Lake area and the initial exploration of the deposits have been described by A. R. Graham,[1] who made an examination of the area in the fall of 1929. Since this report was made, additional chromite-bearing zones have been discovered on ground controlled by the Consolidated Chromium Corporation and some underground development has been done on one of the most promising showings.



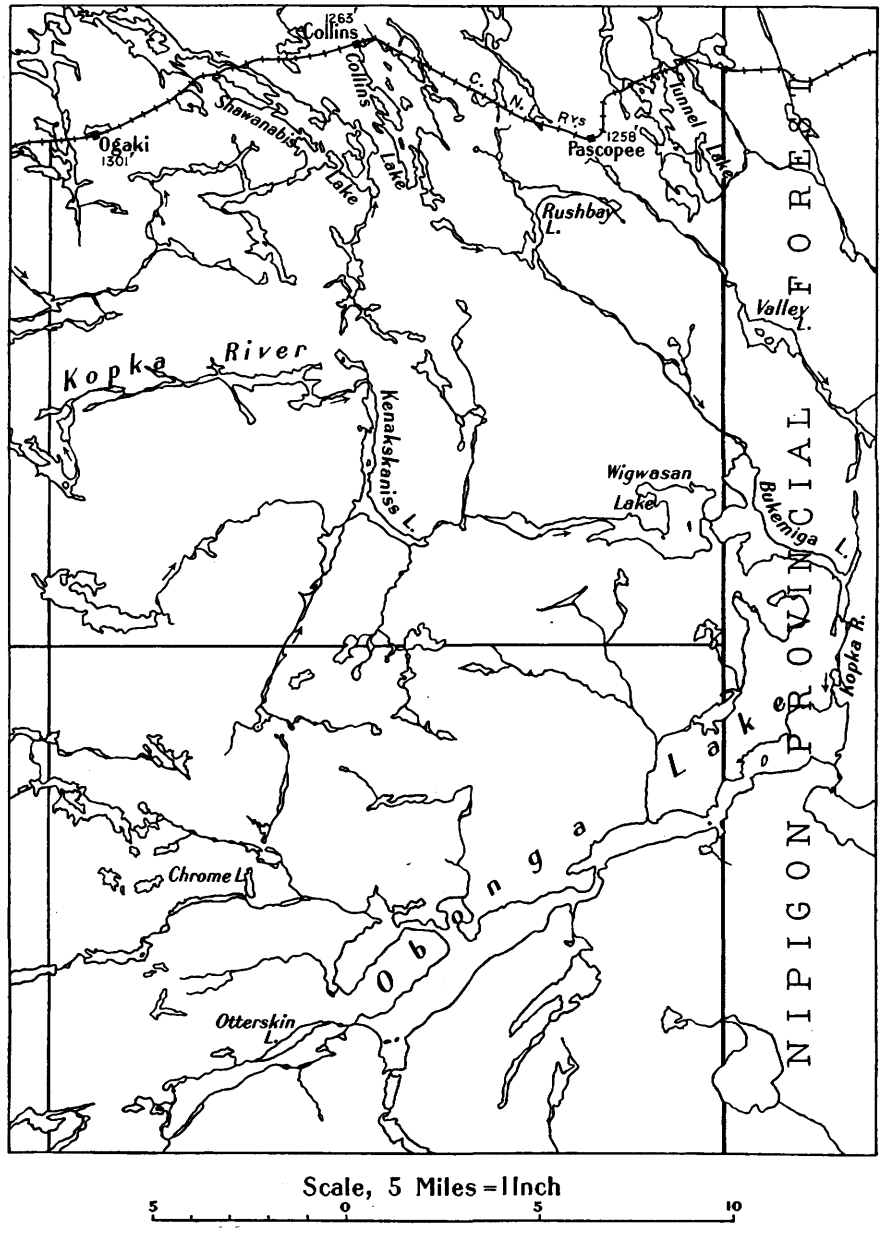
Camp of the Consolidated Chromium Corporation at Chrome lake, October, 1930.

The Obonga Lake area is situated in the district of Thunder Bay about 23 miles south of Collins on the Canadian National railway and an equal distance west of Lake Nipigon. At the present time the area is reached most conveniently by canoe from Collins. The route extends southward through Collins, Shawanabis, and Kenakskaniss lakes to Chrome lake and requires 17 portages.

The occurrence of chromite in the Obonga Lake area was first observed in the fall of 1928 by W. Keefe and R. A. MacDonald, who staked a group of claims in the vicinity of the lake now known as Chrome lake. This group was taken over by Golden Centre Mines, Inc., and a subsidiary known as Consolidated Chromium Corporation was organized to develop the property. Options were taken on additional ground until, in the fall of 1930, the corporation controlled 52 claims covering most of the serpentine body. Early development work consisted of stripping and trenching. During the winter of 1929-30, approximately

[1]A. R. Graham, Ont. Dept. Mines, Vol. XXXIX, pt. 2, 1930, pp. 51-60.

1,000 feet of diamond-drilling was done on the showings at the north end of Chrome lake. In the summer of 1930, underground exploration was begun on the "E" zone, situated about half a mile east of Chrome lake. A permanent



Map showing the canoe route from Collins station to Chrome lake. The route goes through Collins lake, across to Shawanabis lake, south from its southeast bay to Kenakskaniss lake, and from its southwest bay south to Chrome lake.

camp was erected on the west side of Chrome lake and construction of a winter road between Collins and the property had just been started when operations were suspended in the latter part of October, 1930.

The writer wishes to acknowledge his indebtedness to A. R. Globe, resident manager, and to G. D. Frye, analyst, for their cordial co-operation and assistance during the examination of the property in October, 1930.

General Geology

The general geology of the area has been described by A. R. Graham.[2] For convenience a summary of the rock formations is given below:—

QUATERNARY	
PLEISTOCENE:	Boulder clay, glacial erratics.
	Unconformity
PRE-CAMBRIAN	
KEWEENAWAN:	Diabase, dolomite.
	Unconformity
ALGOMAN(?):	Granite, granite gneiss, pegmatites.
	Intrusive contact
PRE-ALGOMAN(?):	Serpentine, talc carbonate schist.
	Intrusive contact
BASEMENT COMPLEX:	Keewatin greenstones, chlorite schist, iron formation. Conglomerate, quartzite, slate.

The oldest rocks in the area are metamorphosed sediments, chiefly quartzite, conglomerate, and mica schists, of Keewatin or possibly Coutchiching age. They strike N. 70° E. and dip 45° S. beneath the synclinal belt of Keewatin greenstones that extends westward from Obonga lake.

Following the eruption of the Keewatin lavas, a lenticular body of peridotite having a maximum width of three-quarters of a mile and a length, from east to west, of about 3½ miles, was intruded into the sedimentary rocks. The chromite deposits are genetically related to this intrusion and were formed at this time.

The next period of igneous activity was marked by batholithic intrusions of granite (Algoman?). A granite mass invaded the sediments lying immediately north of the peridotite body, and the rocks in this locality were recrystallized to form gneisses and mica schist. Emanations that accompanied the granite intrusion are thought to have been responsible for the alteration of the original constituents of the peridotite which, with the exception of chromite, have been almost completely replaced by serpentine and penninite.

After a long period of erosion, Keweenawan dolomite was deposited on the granite-greenstone surface. Sedimentation was soon interrupted by the extrusion of a vast sill-like body of diabase that covered, in the vicinity of Obonga lake, all the preceding rock formations.

Since Keweenawan time the area has been subject to continual erosion and no trace of more recent consolidated rocks remains. The pre-Cambrian surface is now partially hidden beneath the mantle of boulder clay and erratic blocks deposited during the last glacial epoch (Pleistocene).

Economic Geology

The chromite deposits are associated with the lenticular mass of serpentine that extends from the west end of Puddy lake to a point 1½ miles east of Chrome

[2]A. R. Graham, op. cit., pp. 53-56.

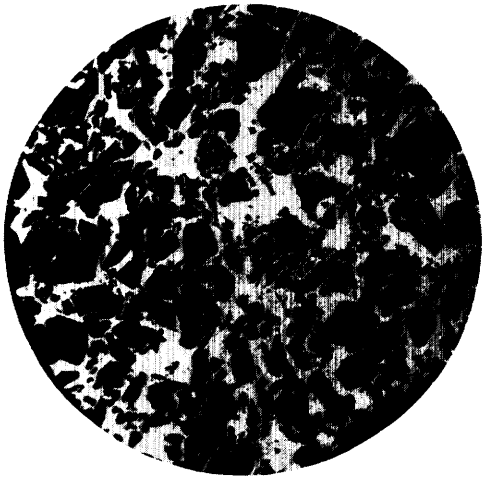
lake, a distance of 3½ miles. Although most of the chromite-bearing zones that have been found so far lie near the north contact, there appears to be no reason why similar mineralization should not occur in other portions of the



Photomicrograph of serpentine rock showing grains of chromite (black) in a groundmass composed of penninite and serpentine (light-grey) and carbonate (dark-grey). (One nicol, × 16.)

serpentine body. The concentrations of chromite are of two types: (1) disseminated; (2) massive.

The disseminated deposits consist of patches or zones of indefinite outline and extent in which grains of chromite, about the size of a pinhead or smaller,



Photomicrograph of chromite rock showing grains of chromite in a matrix of colourless serpentine. (One nicol, × 16.)

are distributed irregularly through the serpentine rock. Owing to the spotty character of the mineralization the chromic oxide content may range from a trace to 20 per cent. within comparatively short distances. It is difficult to

estimate, without bulk sampling tests, the average chromic oxide content of these deposits, but there appears to be a considerable tonnage of material containing about 10 per cent. chromic oxide.

In the massive deposits the grains of chromite are so closely spaced and the proportion of serpentine is relatively so small that the material may be described as chromite rock. Such concentrations occur in the form of patches, schlieren, and vein-like segregations. These bodies may be separated by a sharp contact from the surrounding serpentine or, as is frequently the case, the chromite rock may be bordered by a zone several feet in width in which there is considerable disseminated chromite. The chromite rock contains, on the average, about 35 per cent. of chromic oxide, although selected samples have yielded as high as 41 per cent. The most important concentrations of massive chromite occur in the "B" and "E" zones.

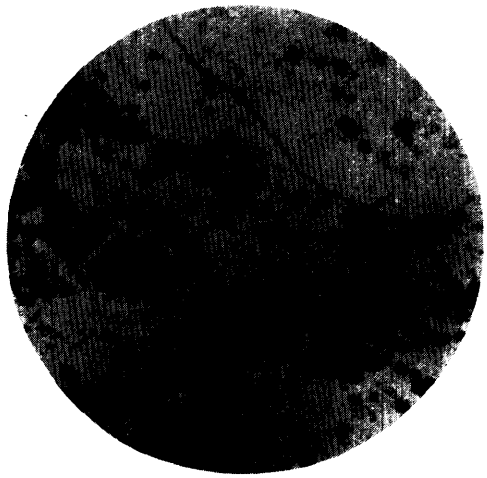
The chromite appears to have been an original constituent of the peridotite, and its concentration into the types of deposits described above is believed to have been due to processes of segregation that went on simultaneously in widely separated parts of the peridotite body during the period of cooling and crystallization. There is little evidence to indicate that gravitative settling of the chromite grains was the controlling factor in the location of the chromite concentrations, for these occur in close proximity to the hanging wall as well as near the footwall of the serpentine body. Of the massive bodies of chromite, those which are surrounded by a zone containing disseminated chromite are thought to owe their origin to segregation *in situ*, whereas those that are in sharp contact with barren serpentine appear to have been squeezed or injected into their present position. The vein-like appearance of some of the chromite bodies has been accentuated by shearing movements that have converted the adjoining serpentine to schist. It is possible that the chromite concentrations may be, in part, of hydrothermal origin, but no conclusive evidence in support of this contention has been obtained.

Representative specimens of serpentine and chromite rock obtained from the underground workings on the "E" zone were submitted to the Provincial Assay Office for analysis. The following analyses are believed to be typical of the chromite occurrences in the area.

	Sample No. 1	Sample No. 2	Sample No. 3
	per cent.	per cent.	per cent.
SiO_2	24.94	9.94	10.34
Al_2O_3	4.36	6.83	6.57
Cr_2O_3	13.74	40.89	40.68
FeO	10.78	17.11	16.47
Fe_2O_3	6.65	3.94	4.53
CaO	4.35	.34	.31
MgO	24.92	16.50	16.81
K_2O	.31	.....	.....
Na_2O	.35	.....	.....
H_2O+100	7.00	4.24	4.19
H_2O-100	.03	.....	.....
CO_2	.66	.....	.....
TiO_2	.12	.....	.....
MnO	.05	.....	.....
P_2O_5	nil	.....	.....
FeS_2	1.65	.....	.....
Total	99.91	99.79	99.90

Sample No. 1—Low-grade serpentine rock, No. 1 shaft (see photomicrograph on page 116).
Sample No. 2—Medium-grained chromite rock, No. 1 shaft.
Sample No. 3—Coarse-grained chromite rock, No. 1 shaft (see photomicrograph on page 116).

The serpentine rock is thought to have been derived from peridotite. The alteration has been so complete that, with the exception of chromite, none of



Photomicrograph of serpentine rock used in analysis No. 1 (page 115). The grains of chromite (black) occur in a groundmass of penninite and serpentine (light-grey) containing patches and veinlets of carbonate (dark-grey). (One nicol, × 16.)

the original constituents of the peridotite remains. Examination of the serpentine rock under the microscope shows it to be composed of serpentine, penninite, carbonate, and scattered grains or aggregates of chromite. It is



Photomicrograph of chromite rock used in analysis No. 3 (page 115). The shattered crystals of chromite (black) are surrounded by colourless serpentine (white). (One nicol, × 16.)

evident from the shattered condition of the chromite grains and the presence of cracks occupied by stringers of carbonate that the rock has been subjected to considerable fracturing and shearing.

Description of the Deposits

When the area was visited in October, 1930, all the known occurrences of chromite, with the exception of one deposit on the MacDonald property, were on claims controlled by the Consolidated Chromium Corporation.

Consolidated Chromium Corporation

Five chromite-bearing zones, referred to below as A, B, C, D, and E, have been discovered on ground controlled by this corporation (see sketch map facing page 116).

"A" Zone.—This zone is located on and near a group of islets at the north end of Chrome lake. Surface trenching and diamond-drilling have indicated an area about 150 feet in diameter in which the serpentine contains grains of chromite disseminated through it. According to the management, one section running north and south across the zone contains an average of 12 per cent. chromic oxide. Six diamond-drill holes were put down on this zone. The following data relating to the drilling was furnished by the management:—

Hole	Angle of inclination	Length	Chromite-bearing rock intersected	
			No. of sections	Total length
		feet		feet
No. 1	45°	123	6	28
No. 2	75°	60	4	16.5
No. 3	45°	63	10	43
No. 6	45°	66	1	20
No. 7	75°	155	not available	
No. 10	55°	110	"	"

Just prior to the suspension of operations, a shaft (No. 2) was begun on the mainland a short distance west of this zone.

"B" Zone.—This zone is located near the northwest corner of claim T.B. 8,424 and about 600 feet east of Chrome lake. It consists of a flat-lying body of chromite having an average thickness of about 2 feet. It is exposed over an area 150 feet in diameter and is estimated by the management to contain about 5,000 tons of material running 34 per cent. chromic oxide. The underlying serpentine contains some disseminated chromite. A diamond-drill hole directed north at an angle of 45 degrees for 196 feet intersected no chromite-bearing rock.

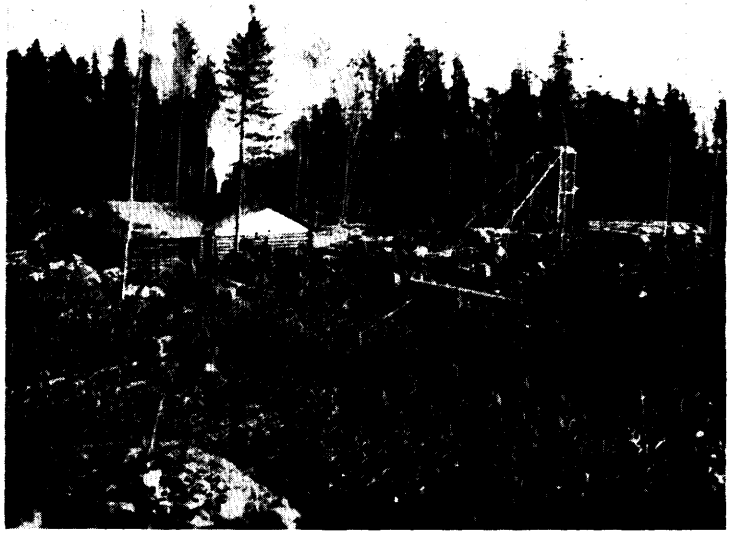
"C" Zone.—Several small patches of chromite-bearing serpentine have been exposed by trenching near the east shore of Chrome lake on claim T.B. 8,426. The serpentine in this section contains considerable magnetite. No analyses are available from this zone, but the chromic oxide content appears to be low.

"D" Zone.—This zone lies about 500 feet west of the "A" zone. It consists of several exposures of chromite-bearing serpentine and occasional streaks of chromite rock. The better-grade material contains 15 to 20 per cent. chromic oxide. Two diamond-drill holes (Nos. 8 and 9) were put down on this zone at an angle of 45 degrees for 70 feet and 106 feet, respectively. Each of these holes intersected a 3-foot section of chromite-bearing serpentine. Further explora-

tion will be necessary to determine whether these showings are related to one another and whether they mark the westward continuation of the "A" zone.

"E" Zone.—This zone is located on claim No. 8,814 near the east end of the serpentine body. It consists of several branching, vein-like bodies (schlieren) of chromite lying about 30 feet apart and roughly parallel to one another. The veins strike N. 60°-70° E. and dip at a low angle to the south. They range in width from 1 to 7 feet and appear to merge toward the northeast. The most persistent vein has been traced by trenching for about 500 feet. Sampling of the surface showings gave, according to the management, an average of 36 per cent. chromic oxide.

A shaft, located at the widest point on the most southerly vein, has been sunk to a depth of 350 feet. Owing to their southward dip, the chromite bodies



Surface plant at No. 1 shaft, "E" zone, Consolidated Chromium Corporation, October, 1930.

exposed near the collar of the shaft were penetrated within a depth of 60 feet. At the 100-foot level, crosscuts were run north for 200 feet and south for 320 feet. These intersected a 200-foot width of serpentine and associated talc-chlorite schists lying between walls of micaceous quartzite. With the exception of several narrow, comparatively high grade concentrations of chromite, most of this width consists of low-grade material containing sporadically disseminated chromite. About 100 feet of drifting has been done on this level. At the time the property was visited about 25 feet of crosscutting had been done at the 225-foot level and none at the 350-foot level.

In view of the limited quantity of chromite rock of a grade running 35 per cent. or more Cr_2O_3 that has been found so far, the writer believes that the future of the deposits depends on the development of a large tonnage of material suitable for milling. The management hopes, by adding the small but higher grade portions of the deposits to the much larger quantity of low-grade material, to obtain an ample tonnage of mill feed rich enough in chromic

oxide to yield satisfactory concentrates.[1] Development work has not progressed far enough as yet to determine whether or not this can be done. In deposits of this type the boundaries of the ore bodies can only be determined by extensive exploration and constant sampling and analysis.

MacDonald Property

An exposure of chromite-bearing serpentine occurs on the MacDonald claims, which adjoin the holdings of the Consolidated Chromium Corporation on the northwest. The deposit lies near the granite contact and about 1,300 feet west of the "D" zone on claim T.B. 8,422. The mineralization is similar in character and appearance to that occurring in the "A" and "D" zones to the east.

[1]Preliminary milling tests, conducted by the Mines Branch, Ottawa, on material from this property, running 4.44 per cent. Cr_2O_3, failed to produce concentrates containing more than 38.7 per cent. Cr_2O_3. (Interim report by A. K. Anderson, Mines Branch, Ottawa, Sept. 3, 1931.)

INDEX, Part IV

A

PAGE

Abamasagi l. 60, 78
A. C. 407, 408, 412 g. locs.
  See Goudreau g. m.
A. C. 516 g. loc. 6
A. C. 570 g. loc. *See* Barnes g. claim..
A. C. 2,301 g. loc. 41
Access to :
  Angus tp., O'Connor claim 105
  Goudreau-Michipicoten area 1
    Smith l. 36
    Parkhill g. claim 39
  Kowkash-Ogoki area 55
    Tashota m. 90
  Obonga L. area 111
    Chrome l., map showing 112
Acid volcanics 4, 5
Acknowledgments.
  Goudreau-Michipicoten area, 2, 30, 39, 47, 54
  Kowkash-Ogoki area 55
  Obonga L. area 113
Actinolite.
  Angus tp., photomicrograph 110
  Goudreau area 29
Adair, Geo. H. 87, 94
Adair, Geo. H. g. claim 64, 87, 94
Aerial photo, Muriel l. ..... *frontis.*
Agawa r. 16
Agglomerate 62, 75
Agricultural land, Kowkash-Ogoki area 59
Alaskite 4, 8, 18, 32
Albert falls 59
Albert l. 69
Alden station 16, 36
Algae, Chara l. 86
Algoma dist.
  See Goudreau g. area; Michipicoten g. area.
Algoma Central & Hudson Bay Ry.
  Acknowledgments to 2
  Altitudes and grading 3
  Sketch map showing route 1
Algoma District Power Co. 52
  Plant, photo 54
Algoma Exploration Co. *See* Kremzar g. claim.
Algoma Steel Corporation.
  Acknowledgments to 2, 47
  Waterpower plant 52
Algoman revolution 63
Algoman rocks.
  Goudreau-Michipicoten area 4, 8-12
  Kowkash-Ogoki area 62, 78-82
  Obonga L. area 113
Algonquin l. (glacial). *See* Lake Algonquin.
Alkali syenite 9, 10
Altitudes.
  Goudreau-Michipicoten area 3, 14
  Lake Superior 54
  Kowkash-Ogoki area 57
Amphibolites 9

Analyses.

PAGE

  Carbonate 24, 43
  Chromite 115
  Diabase 107
  Feldspar porphyry 89
  Iron ore 89
  Magnetite, titaniferous 100
  Mica schist 69
  Serpentine 71
  Siderite 50
Anderson, A. K. 119
  Report by, on Tashota mine ore 92
Andesite 4
Angus tp.
  Geological sketch map ..... *facing* 106
  Titaniferous magnetite, rpt. by M. E. Hurst 105-110
Ankerite 23, 38, 81, 100
Aplite dikes.
  Goudreau-Michipicoten area 4, 8, 12, 18
  Kowkash-Ogoki area 80
Argentite 25
Arkose 4, 43
Arsenopyrite.
  Goudreau-Michipicoten 18, 19, 40, 50
  Long Lake iron range 47
  Kowkash-Ogoki area 94
Asbestos 71
Ash 59

B

Bain, C. 76
Balm of Gilead 58
Balsam 58
Barlow, Alfred E. 105
Barnes, T. T. 25
Barnes g. claim 25
Barnum, Ross 91, 94
Barnum l. 57
Basalt.
  Goudreau-Michipicoten area 4, 6
  Kowkash-Ogoki area 71
Basement complex, Obonga L. area 113
Basic volcanics 4, 6, 7
Batholiths 8, 17, 52
Bell, J. M. 8
Bell, Robert 55, 56
Bennett-Pacaud Synd. 20
Beryl 70, 82
Bethlehem Steel Corpn. 48, 49
Bibliography.
  Goudreau-Michipicoten area 2, 3
  Kowkash-Ogoki area 56
Biotite granite, Kowkash-Ogoki area .. 78
Biotite schist, Angus tp. 105
Birch, white 58
Bismuthinite 88, 97
Bonus on beneficiated iron ore 47
Bore-hole record.
  Ruth iron claim 49
Bornite 23

PAGE
Boulder clay ... 113
Boulder deposits ... 14
Bournonite.
Associated with gold ... 88, 94
Photomicrograph ... 93
Bowen, N. L. ... 9
Boyer l., altitude ... 3
Braidwood, A. ... 55
Brandt, Fred ... 35
Breadalbane l. ... 105
Breccia, volcanic, Kowkash-Ogoki area. 62
Brett-Trethewey g. claims ... 99
Briarcliffe l. ... 60
Rocks ... 70, 77, 81, 82
Trading post ... 57
Brookbanks, Charles ... 103
Brookbanks, Len ... 103
Bruce, E. L. ... 62, 67, 68
Bryden, Robert ... 30
Buddington, A. F. ... 55
Burrows, A. G. ... 2, 20, 55, 82, 97

C

Calcium carbonate. *See* Travertine.
Cameron, P. B. ... 87, 93
See also next ref.
Cameron-Picotté claims ... 87, 93, 94
Geology, sketch map ... 92
Quartz-porphyry dike, photo ... 64
Stamp mill, photo ... 87
Canada Mines Synd. ... 86, 98
Canadian Pyrites Co ... 50
Cancrinite syenite ... 4, 8, 9
Carbonate.
Goudreau-Michipicoten area, 5, 9, 12, 23-25, 40, 42
analyses ... 24, 43
associated with gold ... 18
Long L. iron range ... 47
origin ... 43
Kowkash-Ogoki area ... 67, 68, 76
Photo ... 67
Carlson, Pete ... 70
Castor l. ... 72
Cavell ... 55, 58, 77
Gravel pit, photo ... 85
Cecil l. ... 77
Cedar ... 58
Chalcopyrite.
Goudreau-Michipicoten area, 23-25, 29, 32, 34, 39, 40-42
Kowkash-Ogoki area, 64, 74, 80, 86, 96, 98, 100
associated with gold ... 87, 97
photomicograph ... 93
Chara ... 86
Chara l. ... 86
Charlewood, G. H. ... 24, 43, 55
Chaucer l. ... 64
Chellew, Charles ... 101
See also Holland-Chellew copper claims.
Chitty g. claims ... 30
Chlorite schists.
Goudreau-Michipicoten area ... 6, 23, 33
Kowkash-Ogoki area ... 71
Obonga L. area ... 113
Christie, W. ... 55
Chrome l.
See also Consol. Chromium Corp.
Sketch map from, to Collins ... 112

PAGE
Chromite.
Obonga L. area, rpt. by M. E. Hurst, 111-119
Claims, mining. *See* Mining properties.
Clark, Mr. ... 69
Clay. *See* Pleistocene.
Clay belt of Northern Ontario ... 84
Clay loam for farming, Kowkash-Ogoki area ... 59
Cline claim, Tashota (K. K. 61).
Iron formation ... 76
Notes ... 97
Porphyry, analysis ... 80
Cline Canadian g. property ... 1, 18
Notes and photo ... 35
Cobalt bloom ... 18, 23, 25
Cobalt s. area, rocks ... 13, 82
Coleman, A. P. ... 2, 4, 6
Collins, W. H.
Reference to surveys by, in:
Goudreau-Michipicoten area, 2-4, 20, 43, 47, 48, 50
Kowkash-Ogoki area ... 56
Collins, Ont.
Sketch map from, to Chrome l. ... 112
Collins l. ... 111
Colpitts ck. ... 83
Colpitts l. ... 65, 66
Pyrrhotite, notes and photo ... 103, 104
Rocks ... 70, 73, 74, 82
photomicrograph ... 71
Cone hill.
Drawing by L. F. Kindle ... 59
Kettle l. ... 85
Conglomerate.
Goudreau-Michipicoten area. *See* Doré series.
Kowkash-Ogoki area ... 62, 75-77
photo ... 85
Obonga L. area ... 113
Conglomerate l. ... 77, 78
Gold claims ... 98
Rocks on and near ... 63, 78, 80
Consolidated Chromium Co.
Camp of, photo ... 111
Description; photo ... 117-119
Plan; section ... *facing* 118
Sketch map showing geology ... *facing* 116
Consolidated Mg. and Smelting Co. ... 32
Continental divide ... 58
Cooke, H. C. ... 68
Cooper g. m. ... 17, 36
Description ... 39
Cooper Gold Mines, Ltd. ... 36
Copper.
See also Bornite; Chalcopyrite.
Goudreau-Michipicoten area ... 18, 42
Kowkash-Ogoki area ... 88, 96
Coughlan, W. A. ... 55, 91, 92
Coughlan l. ... 75, 89
Couillard, D. ... 30
Coutchiching series.
Kowkash-Ogoki area ... 62
Obonga L. area ... 113
Cowie, G. S. ... 2, 3, 47
Cross l. *See* Toronto l.
Cryderman, Russell, g. claim ... 81, 99, 100
Currie, T. ... 98
Currie g. claim, near Tashota.
Feldspar porphyry, analysis ... 80
Notes by Gledhill ... 98
Cuthbertson l. ... 47

D

PAGE

Dam sites. *See* Hydro-electric power.
Day, Arthur L. ... 45
Deeds, Col. Edward A. ... 55
Deeds ck. ... 57, 59, 75, 84
Deeds l.
  Gold claims ... 99
  Rocks on and near ... 79, 81, 83
  Structure between, and Marshall l., section. *See* Map 40*f* ... *in pocket*
Deer ... 60
Devanney g. claim ... 97
Diabase.
  Angus tp. ... 106, 107
    analysis ... 107
    photomicrograph ... 106
  Goudreau-Michipicoten area ... 4, 6, 12, 13
  Kowkash-Ogoki area ... 61, 62, 72, 82-84
    photos ... 82, 84
    photomicrograph ... 83
  Obonga L. area ... 113
Diamond-drilling.
  Morrison iron claim ... 46
  Ruth iron claim ... 49
Dickenson, John G. ... 30
Diorite.
  Goudreau-Michipicoten area ... 7, 10
  Kowkash-Ogoki area.
    Muriel l., aerial view ... *frontis.*
Dog l. ... 13, 17, 52
Dolomite.
  Goudreau-Michipicoten area ... 4
    iron ranges ... 42
  Larder l. ... 68
  Obonga L. area ... 113
Doré r. ... 8
Doré series, Goudreau-Michipicoten area ... 4, 7, 8
Drift, Goudreau-Michipicoten area ... 13, 14
Dubois, Frank ... 42
Duck ... 60
Durer l. ... 78, 86
Dynamic metamorphism ... 19

E

Economic geology. *See* Geology, economic.
Elbow l. ... 57, 77
Erythrite. *See* Cobalt bloom.
Esnagami l. ... 85
Esnagami r. ... 60
Evans, J. ... 30

F

Fanny l. ... 105
Farming, Kowkash-Ogoki area ... 59
Faults and folds.
  See Geology, structural.
Feldspar porphyry.
  Goudreau-Michipicoten area, 4, 5, 8, 10, 11, 18
  Kowkash-Ogoki area ... 62, 68
Felsen l. ... 77
Ferrier, Miss D. J. ... 55
Ferruginous carbonate, notes and photos, 67, 68
Fires. *See* Forest fires.
Fish, Kowkash-Ogoki area ... 59, 60
Flaherty Syndicate ... 76
Fleming l. ... 81
Flett tp.
  Diabase in granite gneiss ... 105
  Geological sketch map ... *facing* 106
Float gold. *See* Gold, float.
Flora, affected by glaciation ... 14
Fluorspar ... 88
Forest fires, Kowkash-Ogoki area ... 59
Forests. *See* Trees.
Formational tables. *See* Tables of formation.
Foster, Clement ... 20
Fraleck, E. L. ... 2
Freeman pyrite process ... 50
Frye, G. D. ... 113

G

Gabbro, Kowkash-Ogoki area ... 62, 72
Gagnon, Frank ... 57, 59
  Garden of, photo ... 60
Galena.
  Goudreau-Michipicoten area ... 25, 36, 42
  Kowkash-Ogoki area ... 88, 98, 100
Game, Kowkash-Ogoki area ... 60
Ganley gold vein ... 39
Garden produce ... 59
Garnets and garnet schist ... 66, 67, 70, 76
  Photo ... 66
Geese ... 60
Geology, economic.
  Angus tp. ... 105-107
  Goudreau-Michipicoten area ... 15-54
  Kowkash-Ogoki area ... 86-104
  Obonga L. area ... 113-116
Geology, general.
  Angus tp. ... 105-107
  Goudreau-Michipicoten area ... 4-14
  Kowkash-Ogoki area ... 61-63, 66-86
  Obonga L. area ... 113
Geology, structural.
  Goudreau-Michipicoten area ... 15-17, 31
  Kowkash-Ogoki area ... 63-66
Gibson claims ... 42
Glacial striae ... 13
Glaciation. *See* Hydro-electric power; Pleistocene.
Glaucophane ... 40
Gledhill, T. L.
  Notes by, on mg. claims, Tashota area ... 97-99
  References to surveys by, in:
    Goudreau-Michipicoten area, 2-4, 9, 10, 20, 37, 38
    Kowkash-Ogoki area, 55, 56, 63, 75-80, 83
Gledhill (Whitefish) l. ... 75, 76, 89, 113
Globe, A. R. ... 113
Gneiss.
  See also Granite gneiss.
  Goudreau-Michipicoten area ... 4, 7
  Kowkash-Ogoki area ... 62, 78
Goetz, Alois ... 48, 49
Gold.
  See also Gold, float.
  Goudreau-Michipicoten area ... 4, 8, 17, 18
    hints to prospectors ... 52
    properties described:
      Goudreau area ... 20-36
      Michipicoten area ... 36-41
    types of deposits ... 15, 16, 18, 19
  Kowkash-Ogoki area ... 86-100
Gold, float.
  Miller l., S. of ... 14, 26
  sources of ... 29

PAGE
Golden Centre Mines, Inc. 111
Goode l. 7, 8, 81
Goudreau 1, 5, 6, 14, 16, 17
Goudreau g. area.
Gold properties described 20-36
Report on (with map), by E. S. Moore 1-54
Goudreau g. m. 1, 10, 17
Description, map, photo 20-25
Power for 52
Goudreau l. 14
Goudreau station, altitude 3
Goudreau-Lochaish g. area 2
Grace g. m. 17
Graham, A. R. 111, 113
Granite.
Angus tp. 113
Goudreau-Michipicoten area 4, 7, 9, 18
Kowkash-Ogoki area 61, 62, 77-79
Granite gneiss.
Angus tp. 106, 107
Kowkash-Ogoki area 62, 77
Obonga L. area 113
Granite porphyry, Goudreau-Michipicoten area 7
Granodiorite.
Goudreau-Michipicoten area, 4, 8-12, 17, 18
Kowkash-Ogoki area 62, 66, 72, 73
Muriel l., aerial view *frontis.*
Granophyre, Cobalt area 13
Graphite, associated with gold 88
Graphite schist, Deeds l. 99
Grasselli Chemical Co. 50, 51
Gravel and sand.
Goudreau-Michipicoten area 3, 14
Kowkash-Ogoki area 58, 62
see also Tashota gravel pit.
Green, C. E. 2
Greenstone, Keewatin.
Goudreau-Michipicoten area 6, 9, 10, 18
gold value in 24, 32
hints to prospectors 52
Kowkash-Ogoki area 61, 62, 71
Muriel l. 76
Obonga L. area 113
Greywacké.
Goudreau-Michipicoten area 4, 8, 43
Kowkash-Ogoki area 62, 77
Gripp l. *See* Lily l.
Grooves, glacial. *See* Striae, glacial.
Grout, Frank F. 45
Gutcher l. 16
Gzowski l. 71, 75

H

Hamilton iron claims 51
Hansen, W. H. 94
Hanover l. 59, 86
Hawk Junction 3, 13, 14, 16
Hawley, J. E. 67, 68
Haycock, M. 94
Helen hematite m. 3, 14
Brecciated silica near, photo 3
Exhausted 17
Kaolin 13
Power for 52
Helen hill 3, 13
Helen siderite deposit 17
Hematite.
Goudreau-Michipicoten area 42
See also Helen hematite m.
Kowkash-Ogoki area 78
PAGE
Herman l. 9, 10, 16
Hicks, Charles M. 50
High Falls, Michipicoten r. 14, 52, 53
Hints to prospectors.
Goudreau-Michipicoten area 51
Kowkash-Ogoki area 90
Holdsworth iron claim 47, 50
Holland, E. J. 101
See also next ref.
Holland-Chellew copper claims 100-102
Aerial view *frontis.*
Copper 88
Geology, sketch map showing 100
Magnetic dip-needle readings on 102
Photo 101
Rhyolite, photomicrograph 74, 75
Slate 76
Hopkins, P. E.
Analysis of serpentine given by 71
Description by, of forests, Kowkash area 58, 59
Notes by, on Wells and Devanney claims 96, 97
Pyrite found by, E. of Willet l. 89
Ref. to surveys by, Kowkash-Ogoki area 56, 57, 66-71, 75, 77, 78, 81, 85, 86, 88, 104
Rocks of Toronto l., described by 77, 78
Hornblende granite, Kowkash-Ogoki area 78
Hornblende schist, Tennant l. 70
Hot spring theory of iron formation 44, 45
Howard falls, Kawashkagama r. 59, 81
See also King-Dodds g. claim.
Gold, discovery 55
Water power 61
Hudson bay 62
Hudson's Bay Co. 57
Hull l., gold claims 97
Hurst, M. E.
Reports by, on:
chromite, Obonga L. area 111-119
titaniferous magnetite, Angus tp. 105-110
Hydro-electric power.
Goudreau-Michipicoten area 14, 52
Kowkash-Ogoki area 61

I

Ice. *See* Pleistocene.
Iddingsite 13
Igneous intrusions 17
Index maps. *See* maps, key or index.
Irby, William 50
Irene l. 25
Iron formation.
Goudreau-Michipicoten area 4, 5, 31, 54
description 7
photos 7, 13, 43
pyrite in 17
Kowkash-Ogoki area 62, 76, 77
Obonga L. area 113
Iron l. 103, 104
Drawing of, by L. F. Kindle 65
Igneous sheet, photo 72
Iron ore.
See also Magnetite; Magnetite, titaniferous.
Goudreau-Michipicoten area.
description of the deposits 47-50
economic notes 17, 18, 42-47
Onaman range, analysis 89

PAGE

Iron pyrites. *See* Pyrite.
Iron ranges, Goudreau-Michipicoten area 42-47

J

Jackfish l. 35, 36
Jackpine 58
Jackson, P. A. 55
Jackson l. 78
Jasper 42
Jenkins, L. C. H. 55
Johnson ck., Kawashkagama r. 56, 84
Josephine iron m. 17
Jubilee g. m. 17, 36, 40
Description and photo 38, 39
Jubilee l. *See* Jubilee g. m.
Jungfrau l. 77-79, 90

K

Kaolin, Helen iron m. 13
Kapikotongwa r.
Falls, photo 60
Hydro-electric power 61
Rocks on and in valley 63, 77-79, 81
Kawashkagama l. 58, 77, 85
See also Rupert falls.
Kawashkagama r. 71
See also Howard falls.
Gold claim 97
Kayedon l. 79, 84
Keefe, W. 111
Keewatin formation.
Goudreau-Michipicoten area 2, 4-7
Kowkash-Ogoki area 62, 71-77
Obonga L. area 113
Kenakskaniss l. 112
Kenney siding 105
Kenny, C. R. 2
Kenty, J. 98
See also next ref.
Kenty g. claim 83, 98
Kettle lakes 14, 57
Keweenawan formation.
Goudreau-Michipicoten area, 4, 12, 13, 16, 17
Obonga L. area 113
Key maps. *See* Maps, key or index.
Kindle, L. F.
Report by (with map), on Kowkash-Ogoki area 55-104
King-Dodds, E. W. 55
See also next ref.
King-Dodds g. claim.
Description 96
Geology 73, 79, 96
see also sketch map ..... *facing* 96
Gold-bearing shear zone 64
Kipper-Cameron g. claims 97, 98
Kipper-Tashota g. claims.
Lamprophyre dikes 79, 80
Notes and sketch map 94, 95
Veins, strike of 64
Kirkland l. 77, 79
Kirkland Lake g. field 16, 18, 80
K.K. 61. *See* Cline claim.
K.K. 89-93, 142 g. locs. *See* Kipper-Tashota g. claims.
K.K. 329, 330 g. locs. *See* Kipper-Cameron g. claims.
K.K. 337 g. loc., iron formation 76

PAGE

K.K. 397, 401 g. locs. *See* Canada Mines Synd.
K.K. 413 g. loc., quartz porphyry 65
K.K. 442 g. loc., Tashota area.
Notes by Gledhill 99
Silica-pyrite 77
K.K. 463 g. loc., iron formation 76
K.K. 514 g. loc. *See* Currie g. claim.
K.K. 522-26, 536, 537, 562 g. locs. *See* Tashota g. m.
K.K. 718, 720 g. locs., rhyolites 81
K.K. 800, 831 g. locs. *See* Kenty g. claims.
K.K. 998, 1,038, 1,041 g. locs. *See* Cameron-Picotté claims.
K.K. 1,749 g. loc. *See* Northern Airways Mg. and Exloration Co.
K.K. 1,790, 1,792 pyrite claims. 89
K.K. 1,844 loc. *See* Cryderman, Russell, g. claim.
K.K. 1,886-88, 1,891, 1,892, 1,894, 1,895, 1,898 copper claims. *See* Holland-Chellew claims.
K.K. 1,943 pyrite loc. 89
K.K. 1,977, 1,978 g. locs. *See* Perry, J.
Knox, John, Jr. 36-39
Kowkash 58, 75, 85
Kowkash r. *See* Kawashkagama r.
Kowkash-Ogoki g. area.
Report (with map), by L. F. Kindle, 55-104
Kozak, Nick 25
See also next ref.
Kozak g. claims 25, 26
Kozak l. 25
Kremzar, Patice 26
See also next ref.
Kremzar g. claim.
Description; photo; sketch map 26-30
Kupfer l.
Diabase 72
Rhyolite, photo 70

L

Lake deposits. *See* Pleistocene.
Lake trout 59
Lake Algonquin (glacial) 14, 52
Lake Huron 13
Lake Superior 3, 14
Lamprophyre dikes.
Kowkash-Ogoki area 62, 79
Michipicoten area 4, 12, 18
Larder l. 68
Laurentian revolution 62
Laurentian rocks.
Goudreau-Michipicoten area 4, 7, 8
Kowkash-Ogoki area 62, 77
Lavas, Goudreau-Michipicoten area ... 4-7
Lawson, A. C. 69
Lead, Michipicoten area 18
Properties 41, 42
Ledingham l. 72, 77, 78
Leg l. 47, 48
Legard, J. P. 42
Lightning River g. area 80
Lily (Gripp) l. 69
Limestone, Goudreau-Michipicoten area 4, 42
Limestone, crystalline, Muriel l., S. of 76
Lit par lit structure 25
Little Current r. 61, 78
Little Dog l. 77, 78

Loam. *See* Clay loam. PAGE
Long l., tp. 28. *See* Cuthbertson l.
Long Lake iron range....47, 48
Longbottom g. claims. *See* Parkhill g. claims.
Loon.... 60
Loudon g. claim.... 97
Lovell l.... 35
Lucy l.... 86

M

McCarthy-Webb g. m.
Description; photo; map....32-35
Lode structure, notes and photo.... 19
Rocks.... 23
McCarthy-Webb Goudreau Mines, Ltd. 32
McDiarmid l.... 105
McDonald, J. W.... 20
McDonald, R. A.... 111
MacDonald chromite claim....117, 119
McFadden g. claims.... 30
McKechnie, Jack.... 91
See also next ref.
McKechnie g. claim....83, 91
Mackey pt.... 17
McLeod, G. W.... 2, 3
McVeigh ck....3, 5, 16, 26
McVittie Graham Mines, Ltd.... 94
Magnetic declination, Kowkash-Ogoki area.... 58
Magnetite.
Goudreau-Michipicoten area....29, 42
Kowkash-Ogoki area....71, 78, 97
See also next ref.
Magnetite, titaniferous.
Angus tp., rept. by M. E. Hurst...105-110
photomicrographs....106, 110
Magpie iron mine.
Power for.... 52
Production.... 17
Magpie r., hydro-electric power sites... 52
Mammoth Hot Springs, Wyoming.... 45
Mammoth Metals, Ltd.... 41
Manganese.... 50
Manitowik l.... 8, 52
Manxman g. m.... 17
Maps, geological, coloured.
Goudreau gold area (40*e*)....*in pocket*
Kowkash-Ogoki gold area (40*f*)..*in pocket*
Maps, geological, sketch.
Angus tp.
claim W. D. 403.... 108
O'Connor claims....*facing* 106
Goudreau-Michipicoten area, mg. claims.
Goudreau Gold Mines.... 22
Kremzar claims.... 28
McCarthy-Webb claims.... 34
Parkhill Gold Mines....*facing* 40
Ruth property.... 49
Tp. 48....*facing* 30
Kowkash-Ogoki g. area.
Cameron-Picotté claims.... 92
Holland-Chellew claims.... 100
King-Dodds claim....*facing* 96
Kipper-Tashota claims.... 95
Muriel l. area....*facing* 100
Tashota g. m....*facing* 90
Tashota l., N. of....*facing* 94
Obonga L. area.
Chromite deposits, Chrome l. *facing* 116
Consolidated Chromium Corp. *facing* 118
Maps, key or index. PAGE
Goudreau g. area.... 1
Kowkash-Ogoki g. area.... 57
Maps, sketch.
See also Maps, geological, sketch.
Canoe route, Collins to Chrome l... 112
Dam site at High Falls.... 53
Marl, Chara l.... 86
Marshall l....59, 70, 86, 104
Marshall L. series, photo.... 68
Sand cliff, photo.... 58
Structure between, and Deeds l. *See* section on map 40*f*....*in pocket*
Marshall Lake series.
Composition; age.... 62
Crossbedding in, photo.... 69
Distribution.... 68-70
Kapikotongwa r., photo.... 60
Little Current r., photo.... 61
Marshall l., photo.... 68
Maskinonge l....6, 15, 32
Mineral belt.... 30
Matachewan series, Kowkash-Ogoki area....62, 82, 83
Melchett l....81, 86
Meta l....58, 59, 60, 81, 104
Metamorphic derivatives, Kowkash-Ogoki area....66, 67
Metcalfe l....75, 98
Mica schist.
Kowkash-Ogoki area....63, 69
Michipicoten area.... 6
Obonga L. area.... 113
Michael, Gordon L....2, 30, 32
Michael Syndicate.
Description; map.... 30-32
Michipicoten g. area.
Gold properties described.... 36-41
Report on (with map), by E. S. Moore 1-54
Michipicoten r.
See also High falls.
Hydro-electric power sites.... 52
Michipicoten Harbour.... 14
Miller l.
Gold float from near....14, 26
Mineral belt S. W. of.... 30
Porphyry dike S. of, photo.... 11
Mining properties described.
Angus tp....107, 108
Chrome l....117, 118
Goudreau area....20-36
Kowkash-Ogoki area....90-104
Michipicoten area....36-41
Minto g. m.... 17
Lamprophyre dikes.... 19
Operations; photo; vein....36, 37
Minto Gold Mines, Ltd.... 36
Mispickel. *See* Arsenopyrite.
Mississippi valley, glaciation.... 14
M. J. O'Brien, Ltd....26, 27, 29, 30
Molybdenite....88, 94, 98
Montreal r.... 82
Monzonitic rocks....4, 8, 32
Photo.... 19
Moore, E. S.
Notes by, on rhyolites of Onaman iron ranges.... 75
Refs. to surveys by, Kowkash-Ogoki area....55, 56, 66, 67, 76, 89
Rpt. by, on Goudreau and Michipicoten g. area.... 1-54
Travertine, Red Paint l., described by 86

PAGE
Moose 60
Moraines 14
Morrison pyrite claim, sections 46
Muriel l. 60, 85
See also Goudreau g. m.; Holland-Chellew claims; Perry, J.
Access to 57
Aerial photo of area ..... *frontis.*
Chalcopyrite 86, 88
Rocks on and near 71, 73, 76, 90
rhyolite, notes and photomicrograph 74, 75
Muriel r. 80
Murphy, Thomas. *See* Goudreau g. m.
Muscovite-biotite granite 9

N

Nakina 55, 59
Nass l. 69
Neelands, E. V. 56
Nepheline-syenite 4, 8, 9
New Zealand. *See* Tarawera mt.
Nicho l. 43, 51
Nichols Chemical Co. 47
"C" pit, cross-section 44
Iron formation, photo 43
Pyrite mg., Goudreau area 50, 51
see also Morrison pyrite claim.
Nipigon l. 86, 88
Gold N.E. of, rpt. by L. F. Kindle .. 55-104
Rocks 63
Nipigon Forest Reserve 69
Nipissing diabase 12
Nipissing dist.
Titaniferous magnetite, rpt. by M. E. Hurst 105-110
Nipissing Mining Co. 25
Nolan, J. P. 55
Norris basin, Wyoming 45
North arm, O'Sullivan l., aerial view. *frontis.*
North branch, Onaman r. 57, 61, 79, 80
Diabase dike near, photo and photomicrograph 82, 83
Northern Airways Mg. and Exploration Co. 71, 102

O

Obonga l.
Chromite deposits of area, rpt. by M. E. Hurst 111-119
Oboshkegan l. 85
Rocks on and near 75, 76, 79, 98
O'Brien, M. J., Ltd. *See* M. J. O'Brien, Ltd.
O'Connor, D. 105
See also next ref.
O'Connor magnetite claim, W. D. 403.
Description, photo, map 107-110
geological sketch map ..... *facing* 106
Rpt. on, by M. E. Hurst 105-110
Ogilvie g. claim 97
Ogoki l. 55, 60, 77, 79, 84
Ogoki r. 84
Old Faithful basin, Wyoming 45
Olivine diabase.
Goudreau-Michipicoten area .. 4, 12, 13, 23
Kowkash-Ogoki area 62, 83
Ombabika 55
Ombabika r. 58

PAGE
Onaman iron ranges.
Discovery and notes 76, 77
Ore, analysis 89
Rhyolites, described 75
Onaman l. 78
Onaman r. 63, 86
See also North branch; South branch.
Hydro-Electric power 61
Pyrite 89
Rocks 78, 80, 81, 83, 90
O'Sullivan l. 55, 60
See also Northern Airways Mg. & Expn. Co.
Aerial view ..... *frontis.*
Cone hill near, photo 57, 59
Gold claim. *See* Cryderman, Russell, claim.
Gravel and sand 58, 86
Rocks on and near 74, 77, 79, 81, 90
serpentine, analysis 70
Ottrelite 5

P

Parkhill g. claims.
Description and map 39-41
Development; mill 18
Rocks 10
Partridge 60
Parsons, A. L. 2, 10
Paska 58, 74, 75, 89
Pawitik r. 58
Peat bogs, Kowkash-Ogoki area ... 62, 63, 86
Pegmatite.
Cobalt area 13
Goudreau-Michipicoten area 9
Kowkash-Ogoki area 62, 70, 81, 82
Obonga L. area 113
Peneplain, Goudreau-Michipicoten area 3
Penequani station 83
Penninite 113, 114, 116
Percy l. 81
Peridotite.
Goudreau-Michipicoten area 4, 13, 17
Obongo L. area 113, 114
Toronto l. 71
Perry, J.
Gold claim, Muriel l. 102
Pyrrhotite claims 103
Petrography.
See also Photmicrographs.
Angus tp., diabase 106
Goudreau-Michipicoten area.
acid volcanics 5
basic volcanics 6
diabase 13
grandiorite 10
quartzite 26
Photomicrographs.
Chromite rock 114, 116
Diabase 83, 106
Feldspathic igneous sheet 73
Magnetite ore 110
Rhyolite 74
Serpentine rock 114, 116
Physiography. *See* Topography.
Pickerel 59
Pickering, A. E. 54
Picotté, J. A. 87, 93
See also Cameron-Picotté claims.
Picrite lamprophyre 12

PAGE
Pike..... 59
Pillow lava. *See* Lavas.
Pine l.....14, 15
Pioneer Mining Co..... 39
Pleistocene.
Goudreau-Michipicoten area.....4, 13, 14
Kowkash-Ogoki area.....62, 84-86
Obonga L. area..... 113
Poitevin, E..... 5
Poplar..... 58
Porcupine g. area.....16, 18, 24
Auriferous porphyries.....80, 81
Matachewan diabase..... 82
Porphyrite.....4, 8, 10
Porphyry.
See also Feldspar porphyry; Quartz porphyry.
Goudreau-Michipicoten area..... 25
associated with gold..... 18
hints to prospectors..... 52
photo of dike..... 11
Power. *See* Hydro-electric power.
Pre-Algoman, Obonga L. area..... 113
Pre-Cambrian.
Goudreau-Michipicoten area..... 4-13
Kowkash-Ogoki area.....61-84
Obonga L. area..... 113
Prospectors. *See* Hints to prospectors.
Provincial Assay office.....80, 106
Pulpwood..... 59
Pyrite.
Goudreau-Michipicoten area.
accessory in veins,
5, 10, 12, 17, 19, 23, 24, 29, 32, 34
deposits described..16, 39, 40-42, 50, 51
hints to prospectors..... 51
nature and origin.....42, 47
Kowkash-Ogoki area...80, 87, 89, 98, 103
Tarawera mt., N.Z..... 45
Pyrrhotite.
Kowkash-Ogoki area.....64, 99
associated with gold..... 87
mg. claims.....90, 103, 104

Q

Quartz biotite schist..... 70
See also Marshall Lake series.
Quartz diabase.
Goudreau-Michipicoten area.....4, 12, 17
Kowkash-Ogoki area..... 83
Lake Huron, with mineral deposits.. 13
Quartz diorite, Kowkash-Ogoki area.62, 72, 73
Quartz porphyry.
Goudreau-Michipicoten area,4,5,8,10,11,18
Kowkash-Ogoki area.....62, 80, 81
photo..... 64
Quartz tourmaline vein, photo..... 33
Quartzite.....26, 70, 113, 118
Quartzite g. claims..... 30
Quaternary.
See also Recent; Pleistocene.
Goudreau-Michipicoten area..... 4
Kowkash-Ogoki area..... 62
Obonga L. area..... 113
Queenston l.....77, 81
Quirke, T. T.....2, 3, 20, 43, 47, 48, 50

R

Radiore Co..... 50
Rainy l..... 69
Rand pyrite claim..... 5
"Rea" vein, Porcupine g. field..... 97
Recent formation.
Goudreau-Michipicoten area..... 4
Kowkash-Ogoki area.....62, 86
Red Paint l. and r., travertine.....86, 87
"Red Rock," Cobalt area..... 13
Redmond.....55, 58, 64, 79
Reid g. claim..... 41
Rhyolite and rhyolite tuff.
Goudreau-Michipicoten area..... 4, 5
Kowkash-Ogoki area.....62, 74, 75
photomicrograph..... 74
Richardson-Loudon-Ogilvie claim..... 97
Roads, Goudreau-Michipicoten area... 1
Robinson, A. H. A..... 56
Ross, J. G..... 92
Rupert falls, Kawashkagama r.....61, 89
Ruth iron claim.
Boring record; notes; sketch map... 47-50
Ruth l..... 15

S

Saga l.....63, 69, 82
Ste. Marie l.....77, 79, 89
Sand plains, Goudreau-Michipicoten area..... 3
Sault Ste. Marie, Ont..... 52
Sericite schist.....5, 23, 25, 33
Serpentine.
Kowkash-Ogoki area.....62, 71, 72
analysis..... 71
Obonga L. area..... 113
photomicrograph..... 114
Shawanabis l..... 112
Shell marl..... 86
Sherman l..... 9
Siderite.
Goudreau-Michipicoten area.....4, 7, 17
iron ranges.....42, 47, 48
Kowkash-Ogoki area..... 98
Silica.....7, 43, 45, 47
Photos..... 7, 43
Silt, Goudreau-Michipicoten area..... 3
Silver.
Goudreau-Michipicoten area....18, 25, 42
Kowkash-Ogoki area.....86, 94
associated with gold..... 88
Silver-lead. *See* Galena.
Sketch maps.
See also Maps, geological, sketch; Maps, key or index.
Canoe route from Collins to Chrome l. 112
Dam site at High falls..... 53
Slate.
Goudreau-Michipicoten area..... 43
Kowkash-Ogoki area....62, 70, 75, 77, 78
Obonga L. area..... 113
Smaltite-chloanthite..... 23
Smith l.....50, 51
See also Towagmac g. claim.
Soil. *See* Agricultural land.
Sollas l.....57, 63, 75, 86
South branch of Onaman r.....75, 80, 84
South Goudreau..... 25
Speight l..... 8
Sphalerite. *See* Zinc blende.
Spinel, photomicrograph of..... 110
Spring l..... 6
Springer, C..... 100
Spruce..... 58

PAGE
Spruce partridge 60
Staurolite schists, Kowkash-Ogoki area. 69
Steep Hill falls, Magpie r. 52
Stewart, A. H. 55
Stratigraphic geology. *See* Geology, general.
Striae, glacial 13
Structural geology. *See* Geology, structural.
Sturgeon L. g. field 80
Suggestions to prospectors. *See* Hints to prospectors.
Sulphur.
"C" pit, Nichols Chemical Co., figures indicating percentage 44
Southern States, U.S. 50
Summit l. 58
Syenites.
Goudreau-Michipicoten area ... 4, 8-10, 18
Kowkash-Ogoki area 62, 64, 79

T

Table of formations.
Goudreau-Michipicoten area 4
Kowkash-Ogoki area 62
Obonga L. area 113
Talc, photomicrograph 110
Talc carbonate schist 113
Talc schist 71
Tamarac 58
Tarawera mt., New Zealand 45
Tash-Orn Mines, Ltd. 96, 97
See also Wells g. claim.
Tashota.
Gold and silver 86, 88
mg. *See* Adair, Geo. H., claim; Cline claim; Kipper-Tashota g. claims.
Gravel and sand 58
Rocks at and near 71, 76, 78-81, 90
Tourmaline 75
Tashota ck. 57, 84, 88
Tashota g. m. 59, 64, 88, 94
Geology, sketch map ..... *facing* 90
Ore vein, faulting 65
Report; photo; sections 90-92
Rocks on and near 72, 80
Tashota gravel pit 67, 86
Tashota l. 64, 79
See also Cameron-Picotté claims; Devanney g. claim.
Carbonate rock, photo 67
Geology, N. of, sketch map. *facing* 94
T. B. 2,599 g. loc. *See* Richardson-Loudon-Ogilvie claim.
T. B. 2,650 g. loc. *See* Devanney g. claim.
T. B. 2,892 g. loc. *See* Tash-Orn Mines, Ltd.
T. B. 4,478, 4,510, 4,516, 4,521 g. locs. *See* Wells, Robert, claims.
T. B. 4,480 s. loc. 88
T. B. 8,814 chromite claim 118
T. B. 8,422 chromite claim 119
T. B. 8,424, 8,426 chromite claims. 117
Tellurides of gold 92
Tennant l. 70
Terminal moraines 14

PAGE
Thunder Bay dist.
Chromite deposits, report by M. E. Hurst 111-119
Gold, report by L. F. Kindle 55-104
Thomson, Ellis.
Refs. to survey by, in Goudreau-Michipicoten area 2-4, 13, 20
Timiskaming series.
Goudreau-Michipicoten area 4, 8
Kowkash-Ogoki area 62, 77, 78
Titaniferous magnetite. *See* Magnetite, titaniferous.
Titanium. *See* Magnetite, titaniferous.
Topography.
Goudreau-Michipicoten area 3
Kowkash-Ogoki area 57, 58
Toronto (Cross) l. 57, 58, 71, 77, 84, 86
Tourmaline.
Goudreau-Michipicoten area .. 6, 36, 38-41
accessory in veins 19, 23
photo 33
Kowkash-Ogoki area 75, 97, 103
associated with gold 88
in pegmatites 70
Towagmac g. claim 36
Township 20, Alg., lead mg. 42
Township 26, Alg. *See* Jackfish l.
Township 27, Alg. *See* Towagmac g. m.
Township 28, Alg. 17
See also Barnes g. claim; Goudreau g. m.; Kozak g. claim; Reid g. claim; Ruth iron claim.
Township 29, Alg. *See* Minto g. m.; Parkhill g. m.
Township 30, Alg. 16
Lead mg. 42
Township 48, Alg.
See also Cline Canadian g. claim.
Mg. claims, sketch map ..... *facing* 36
Township 49, Alg.
Gold mg. *See* Brandt, Fred; McCarthy-Webb g. m.; Kremzar g. claim.
Trading posts 57
Travertine 86, 87
Trees, Kowkash-Ogoki area 58, 59
Trout 59
Trout ck., Tp. 29, Alg. 39, 41
Tuffs.
See also Rhyolite and rhyolite tuff.
Goudreau-Michipicoten area 4-6
Kowkash-Ogoki area 74, 75

V

Vaughan, H. H. 91

W

Walker, T. L. 40
Walkup ck. 76
Water power. *See* Hydro-electric power.
Wawa l. 2, 16, 17
Galena near 42
Gold, discovery 17
Rocks 6, 17
Wawa tuff 6, 48
Wawong l. 86
W. D. 403 iron claim, Angus tp.
See O'Connor magnetite claim.
Webb l. *See* McCarthy-Webb g. m.

PAGE
Weeks, J. 3
Wells, Robert, claims, Onaman r. 100
Wells g. claim, T. B. 2,892 ..... 81, 96
See also Tash-Orn Mines, Ltd.
White, W. E. 2
Whitefish 60
Whitefish l. *See* Gledhill l.
Wilgar l. 76
Willet l. 70, 89
Willmott, A. B. 2, 6
Wilson, A. W. G. 2, 56, 69
Wilson, W. J. 56
Wright, J. D. 2
Wysor, D. C. 47

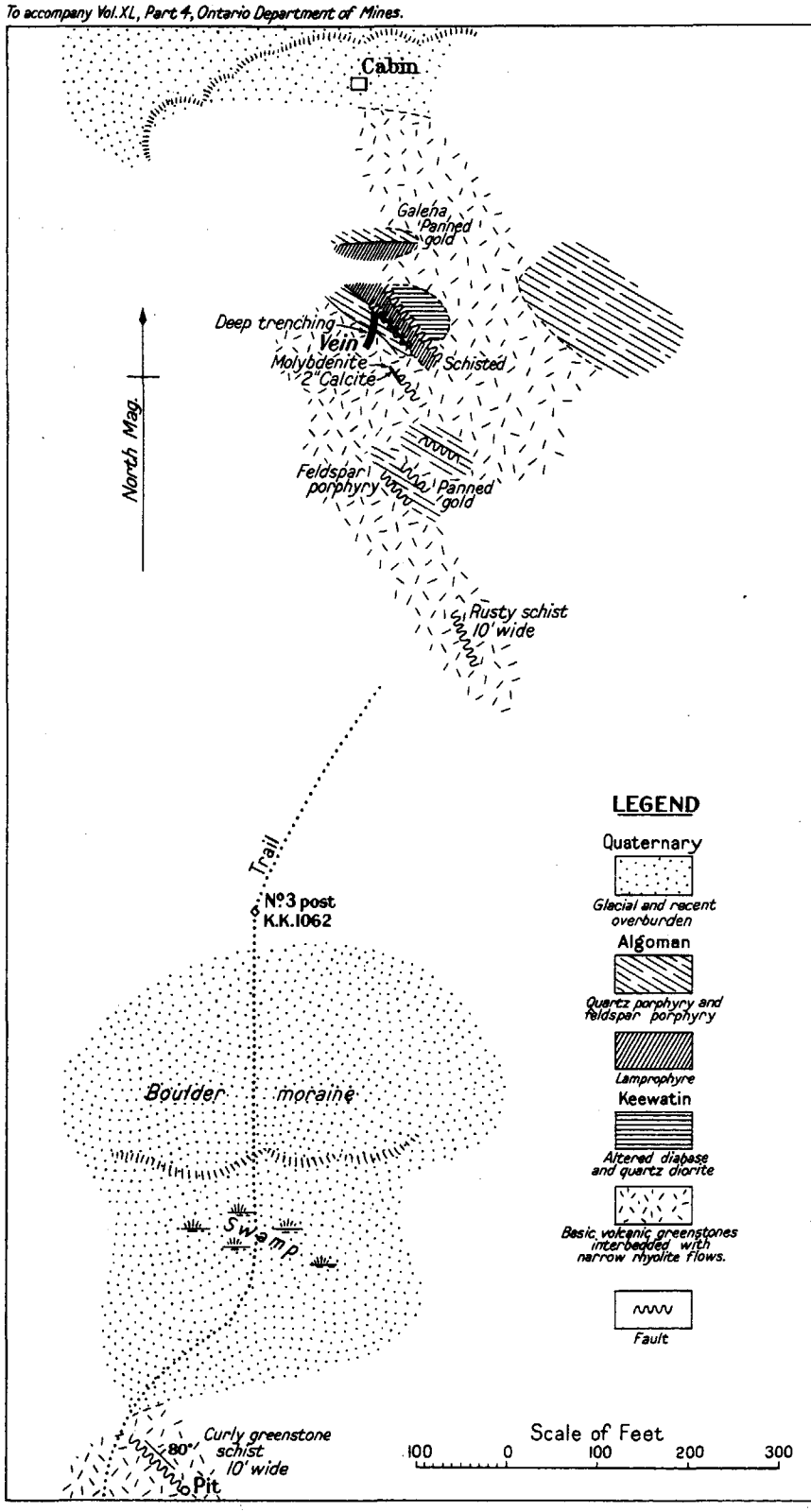
PAGE

Y

Y. 104, 106 claims 17
Yellowstone Park, Wyoming 45

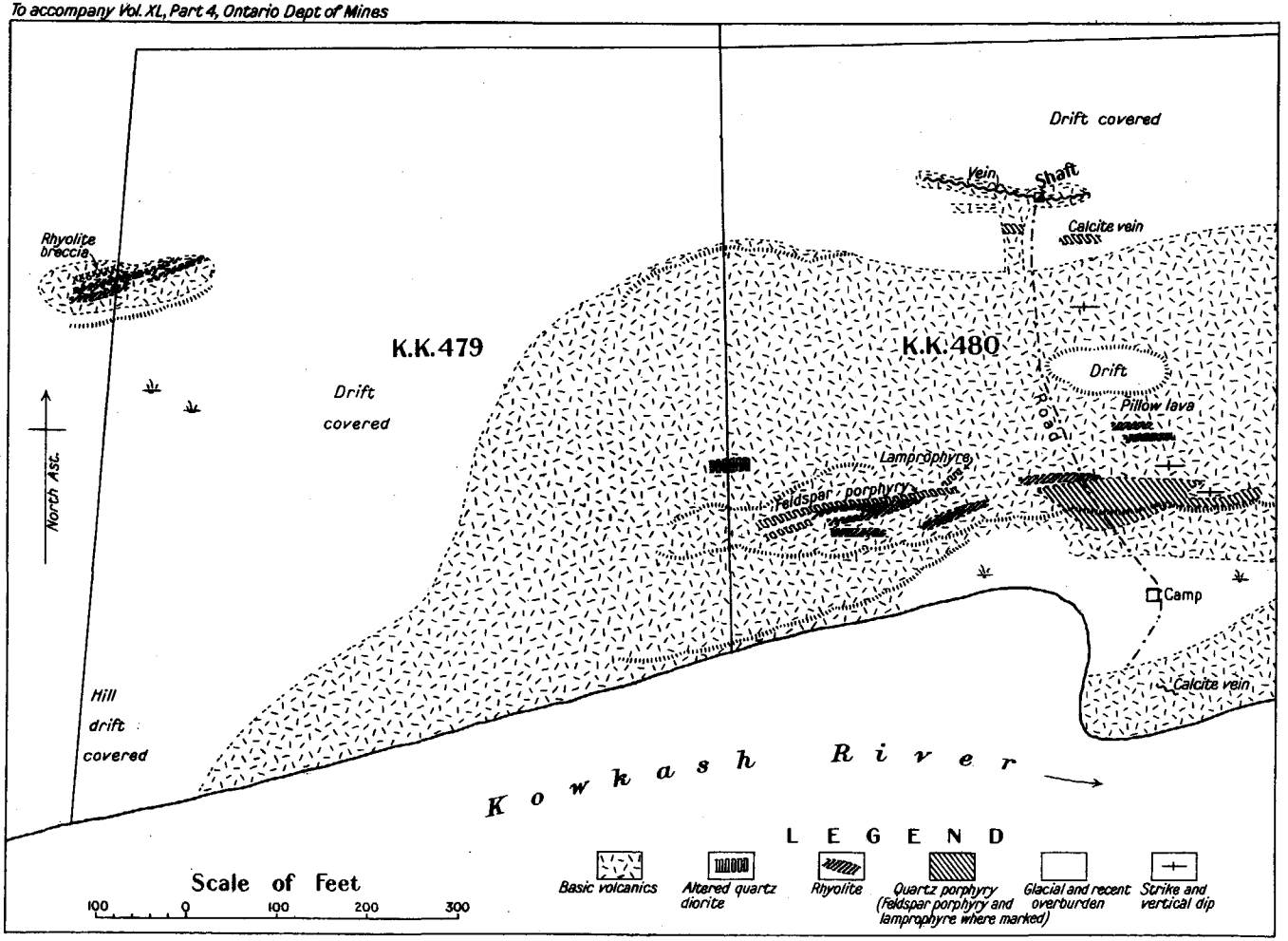
Z

Zinc blende.
Goudreau-Michipicoten area 18, 23, 42
Kowkash-Ogoki area 67, 98, 100
associated with gold 88
Zurbrigg, H. F. 55



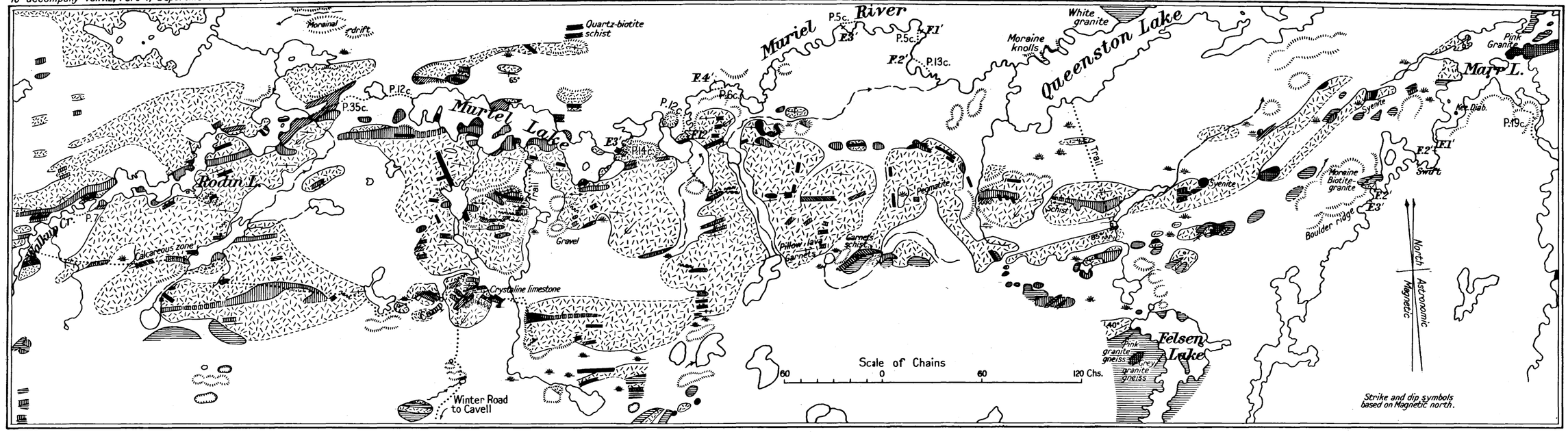
Sketch Map showing Geology three quarters of a mile North of Tashota Lake

To accompany Vol. XL, Part 4, Ontario Dept of Mines



Sketch Map showing Geology on King-Dodds Property

To accompany Vol. XL, Part 4, Department of Mines, Ontario.



Symbols

Geological (assumed) boundary (defined) Fault Glacial striae Shearing Vertical dip & strike Dip & strike Trail or portage Swamp Depression contour Hill

LEGEND

KEEWATIN

Greenstone, chiefly basic flows. Quartz biotite and garnetiferous schists. Diabase and diorite dikes. Rhyolite. Granite gneiss.

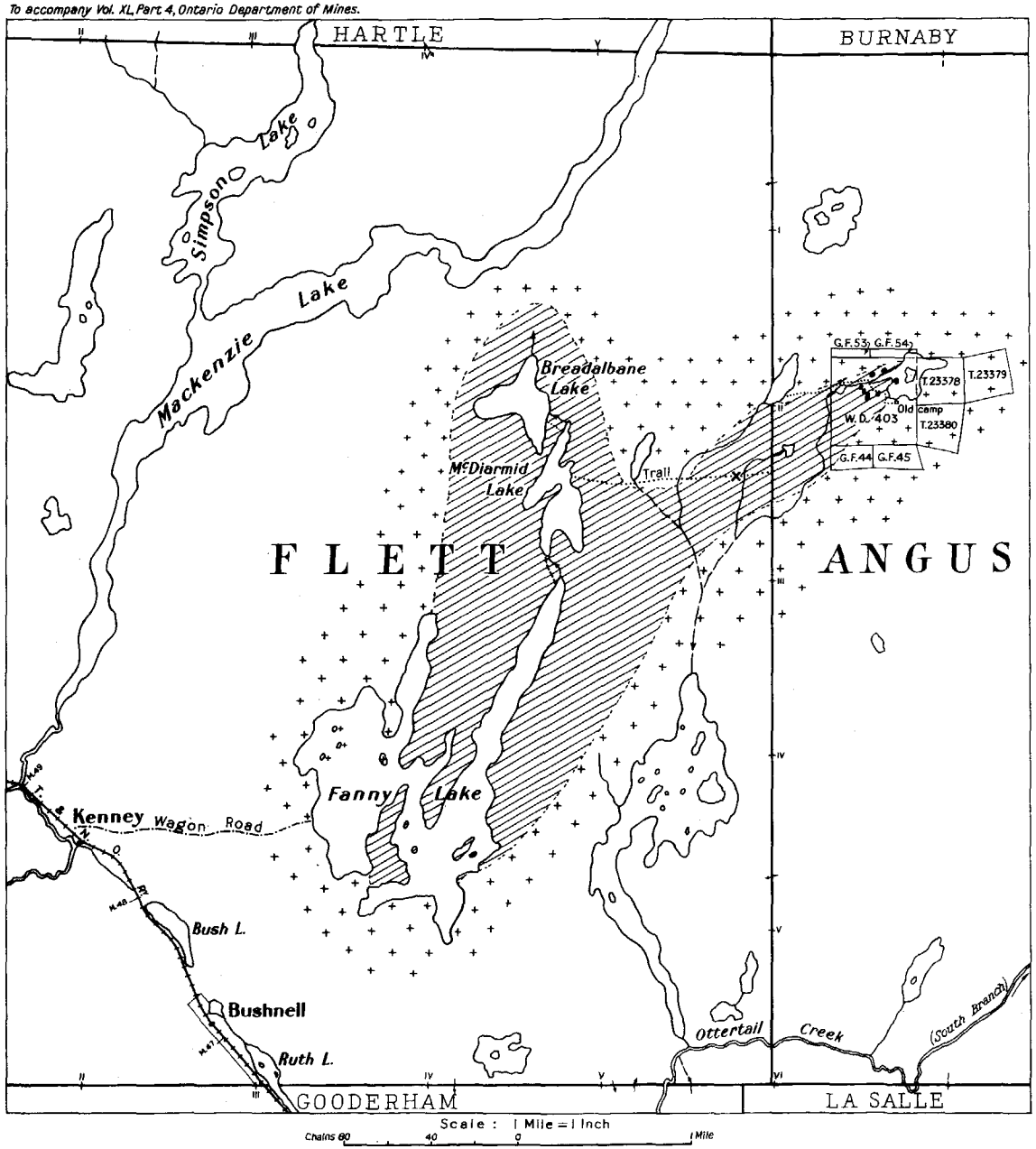
ALGOMAN Syenite. Granite.

KEWEENAWAN Diabase dikes.

QUATERNARY Glacial drift and overburden.

Detail of Muriel Lake area

To accompany Vol. XL, Part 4, Ontario Department of Mines.



LEGEND

Outcrops of magnetite

Diabase

Intrusive Contact

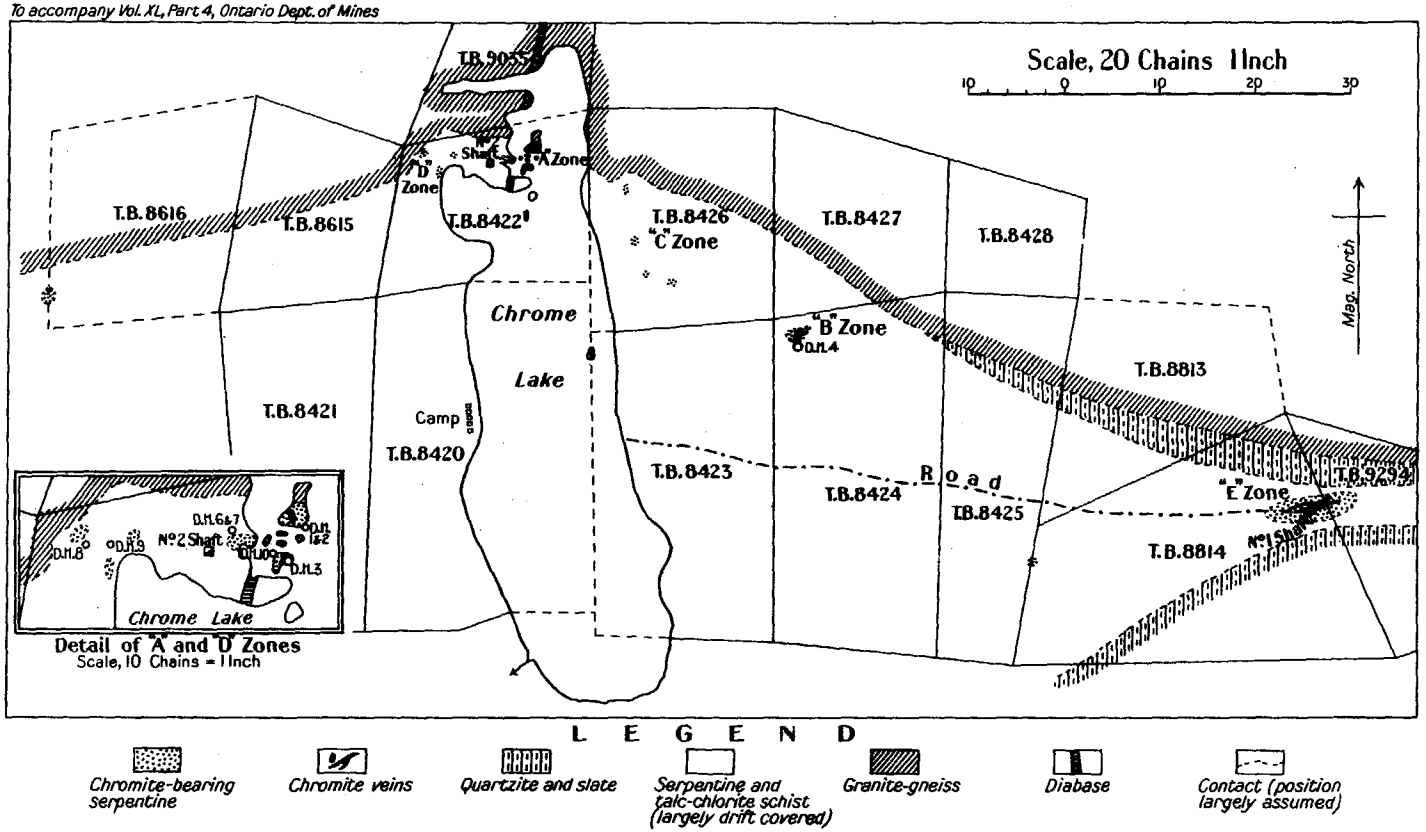
Granite-gneiss

Contact (largely assumed)

Point at which specimen of diabase was obtained for analysis.

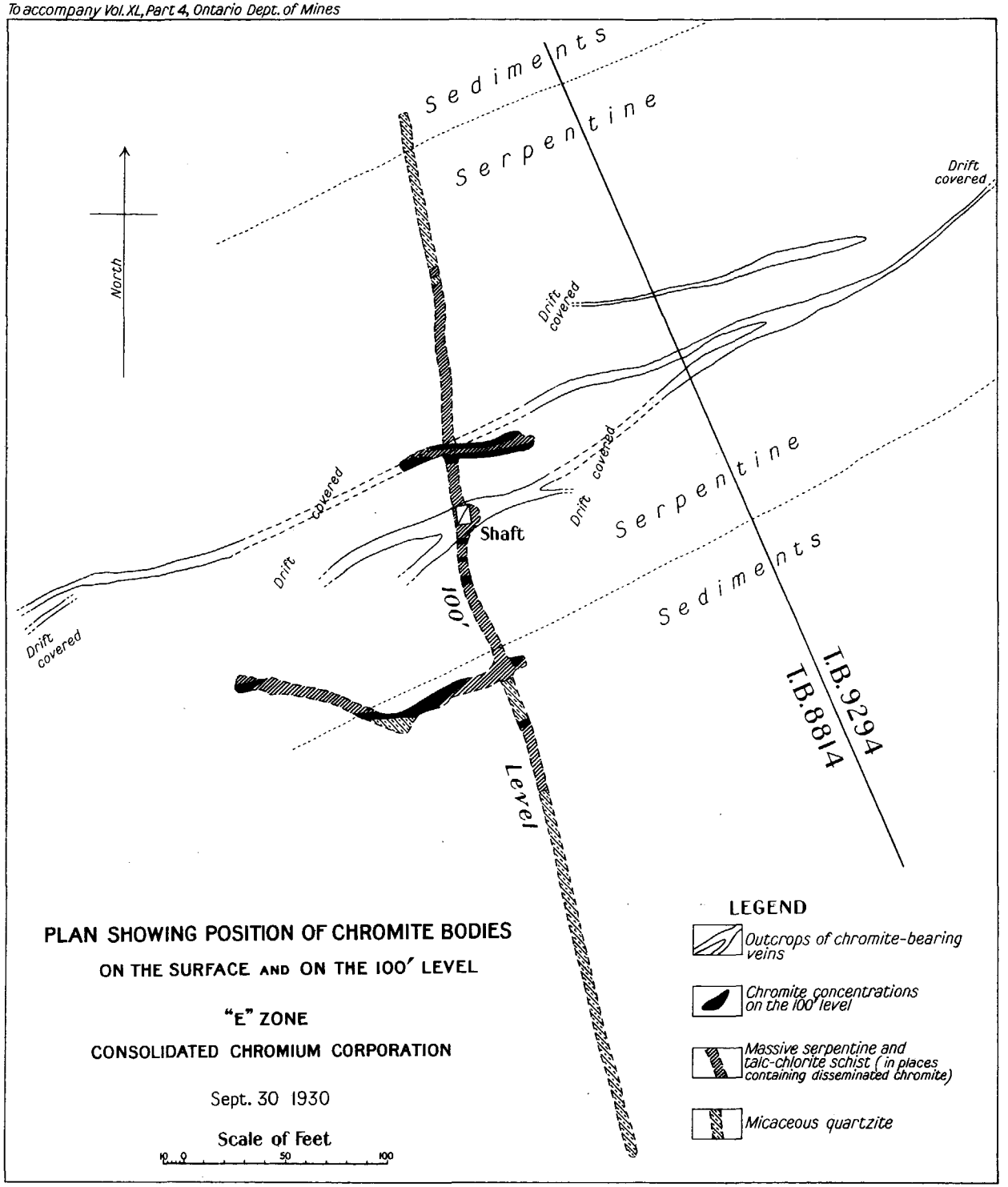
General geology of parts of Flett and Angus Townships in the vicinity of the O'Connor magnetite property

To accompany Vol. XL, Part 4, Ontario Dept. of Mines

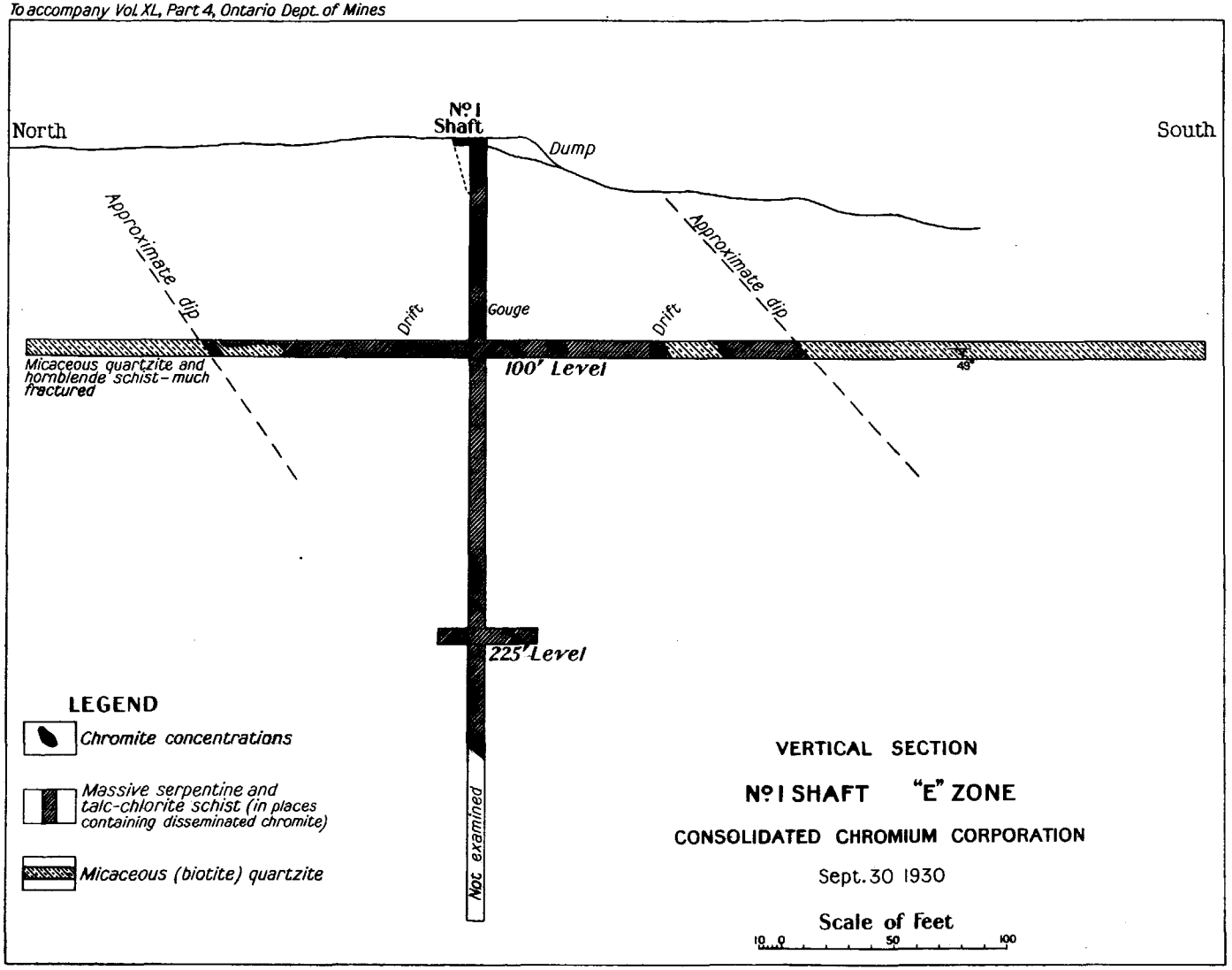


SKETCH MAP SHOWING THE GEOLOGY IN THE VICINITY OF THE CHROMITE DEPOSITS AT CHROME LAKE

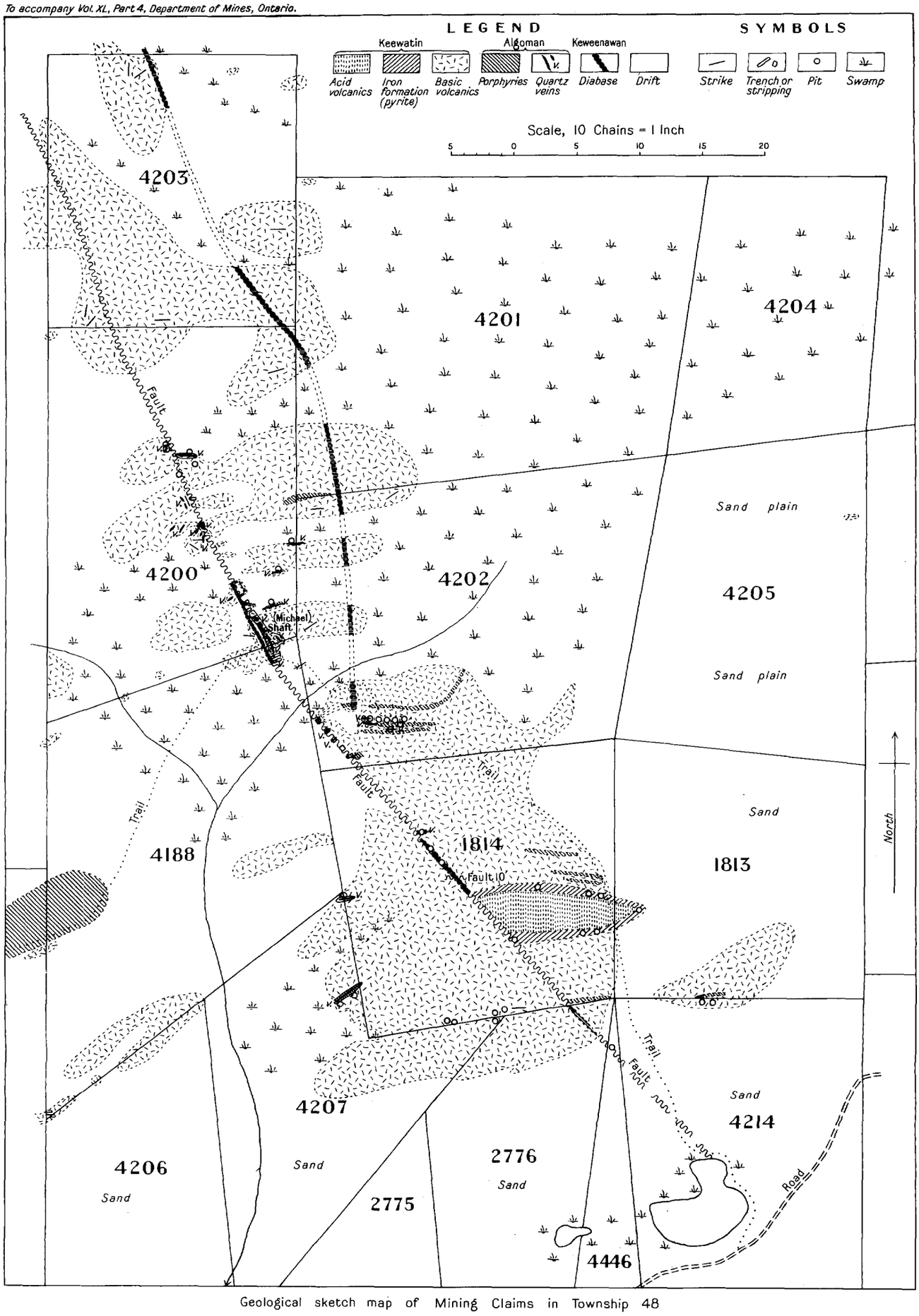
To accompany Vol. XL, Part 4, Ontario Dept. of Mines



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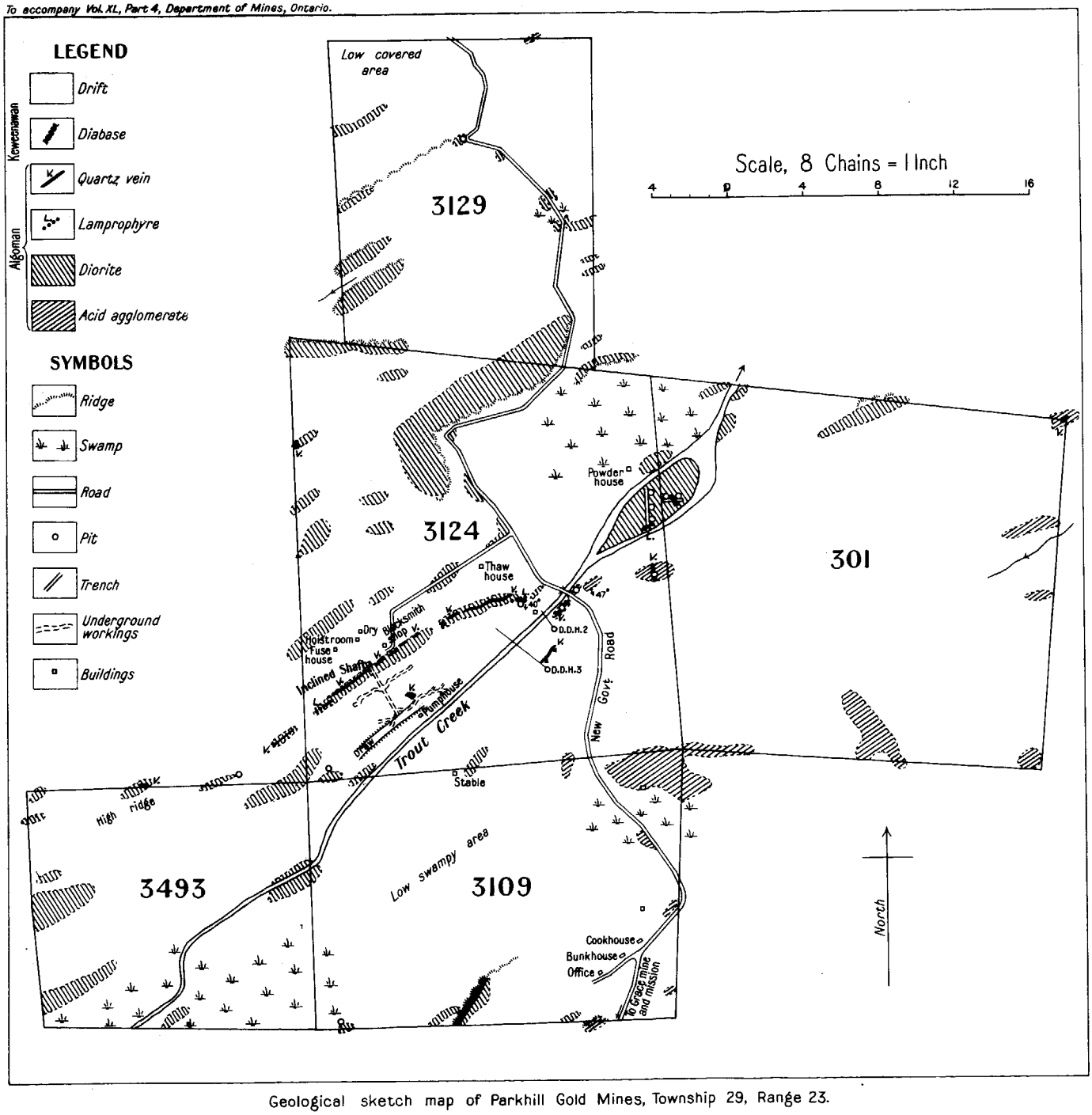


To accompany Vol. XL, Part 4, Department of Mines, Ontario.



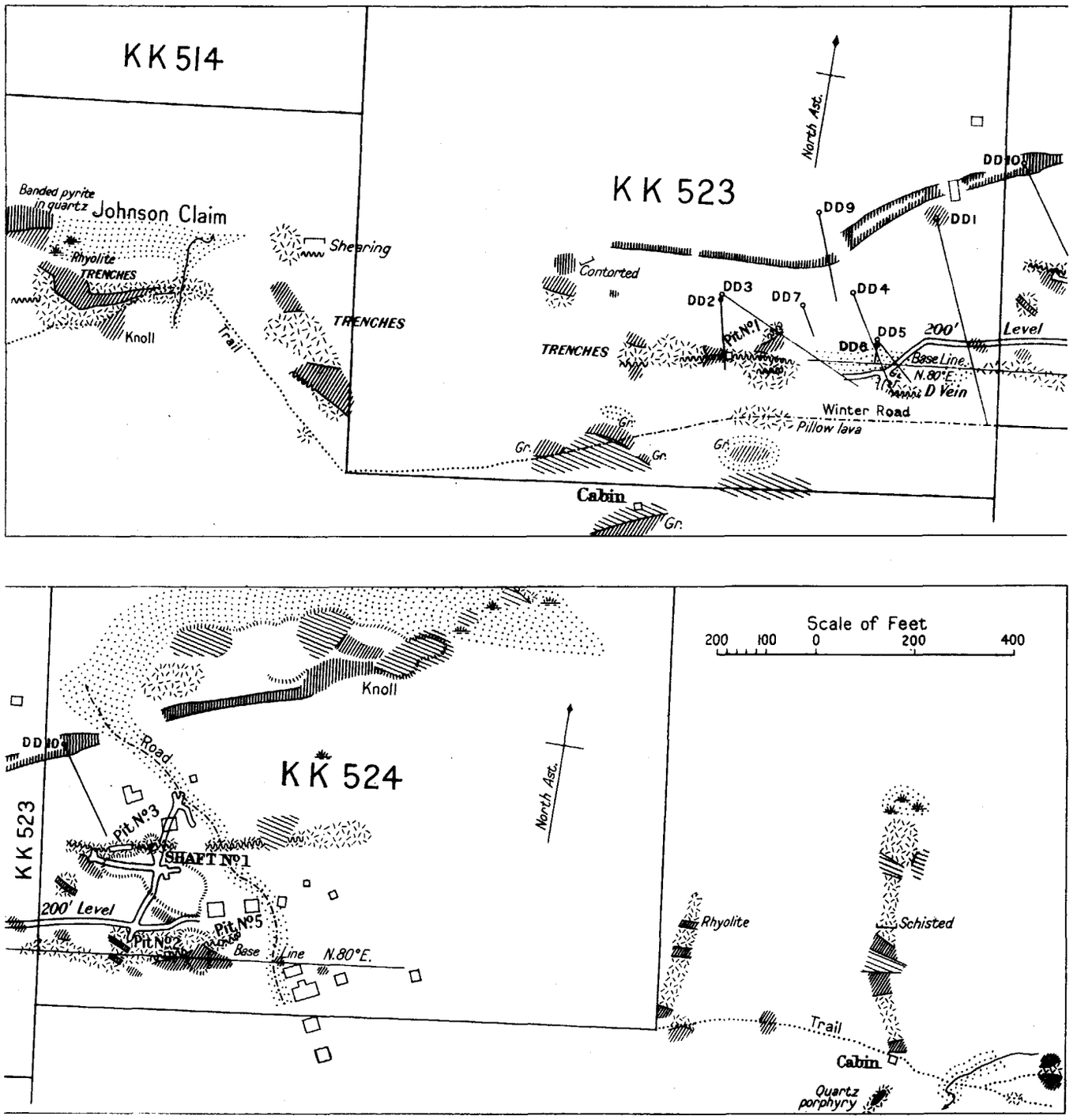
Geological sketch map of Mining Claims in Township 48

To accompany Vol. XL, Part 4, Department of Mines, Ontario.



Geological sketch map of Parkhill Gold Mines, Township 29, Range 23.

To accompany Vol. XL. Part 4, Ontario Dept. of Mines.



LEGEND

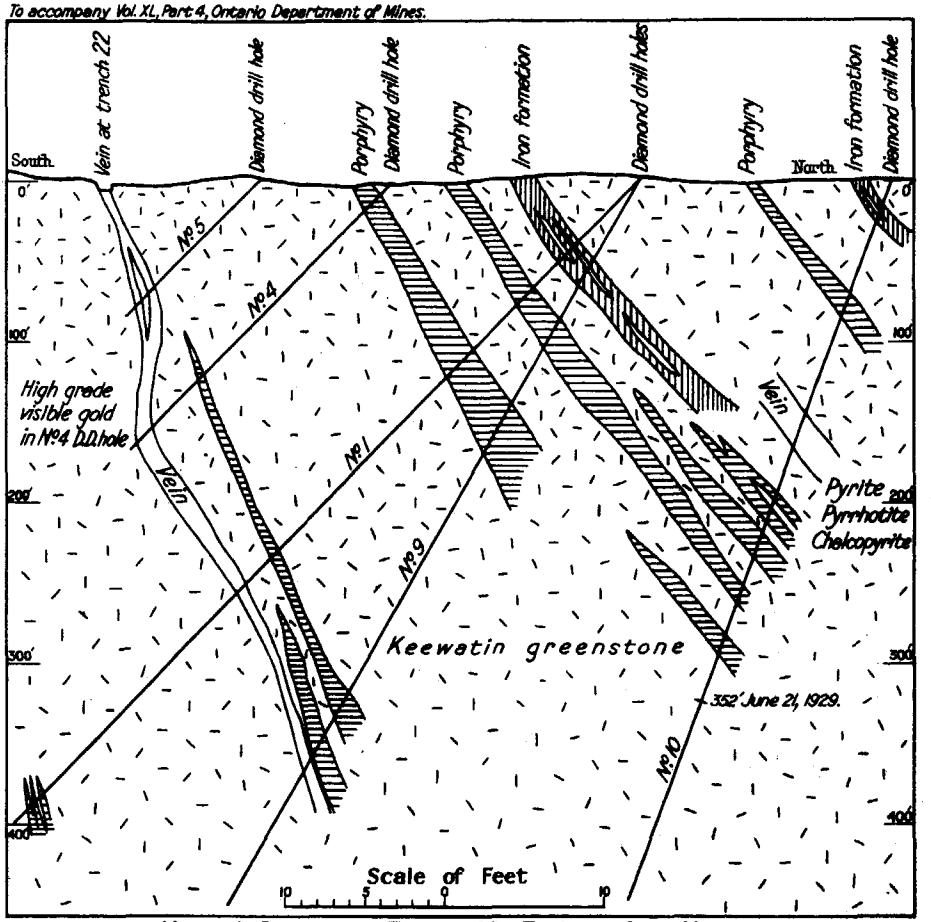
- Glacial and recent overburden
- Algoman
- Quartz and feldspar porphyry (including some quartzite) and pink granite (marked Gr.)
- Keewatin
- Iron formation
- Altered diabase and diorite.
- Basaltic greenstone

Symbols

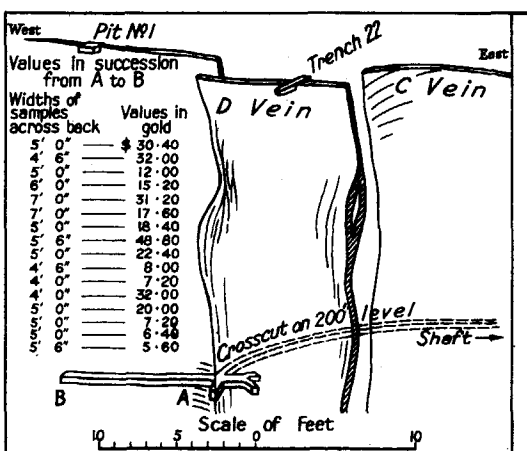
- Hill
- Swamp
- Building
- Dip and strike
- DD7 — Diamond-drill hole
- Geological boundary

Sketch Map showing Geology at Tashota Gold Mines Property

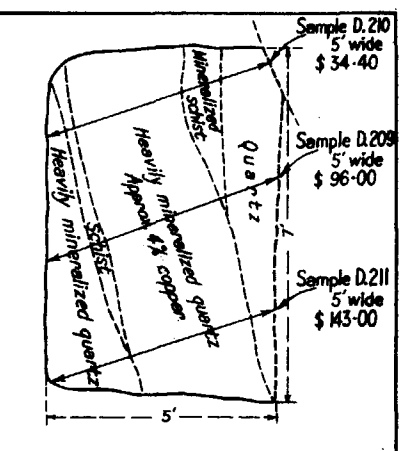
To accompany Vol. XL, Part 4, Ontario Department of Mines.



Vertical Section at Trench 22, Tashota Gold Mines.



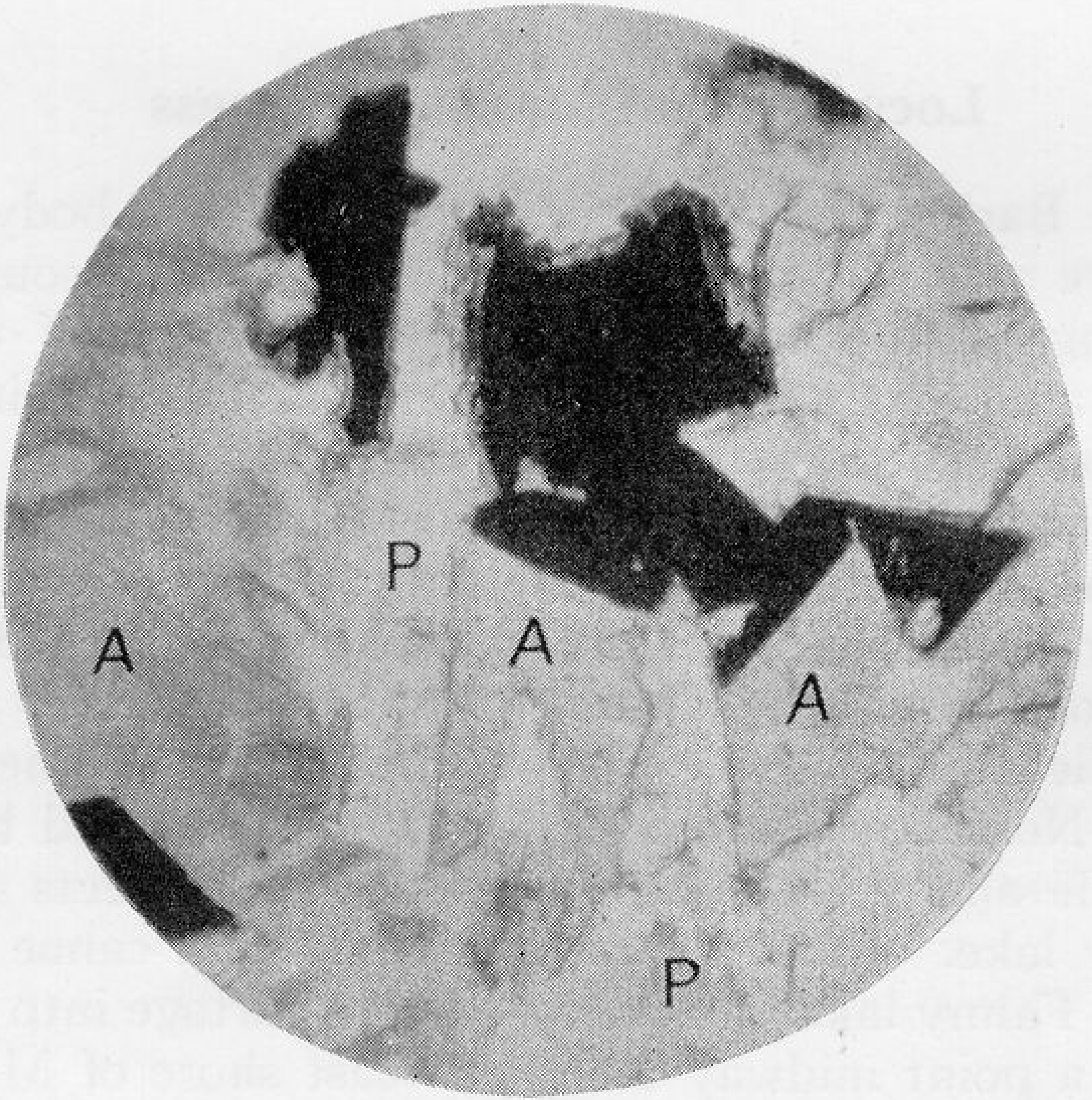
Diagrammatic sketch showing South Vein System.



Vertical Section of West Face at 39'6" west of Crosscut, 200 level.

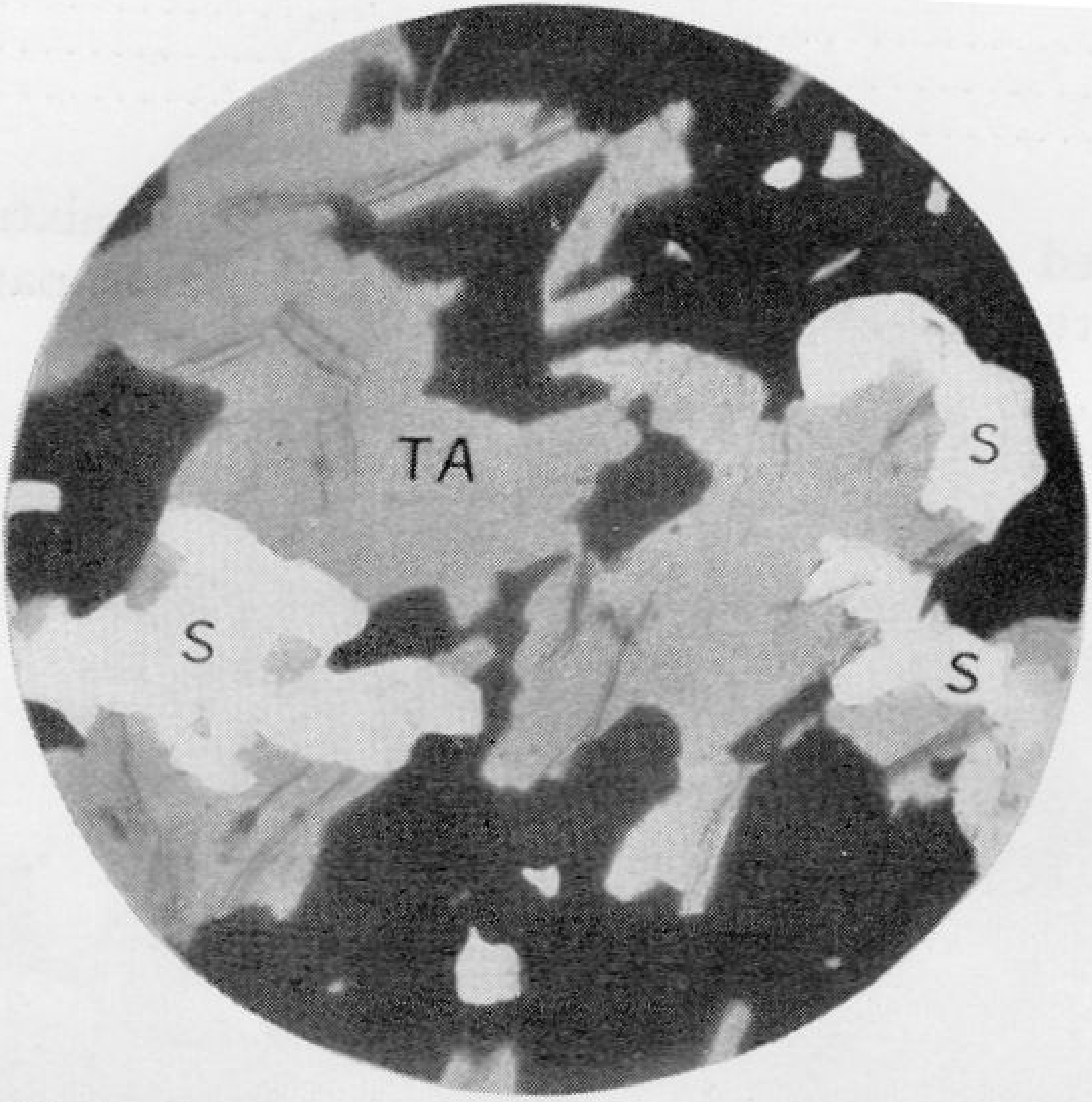



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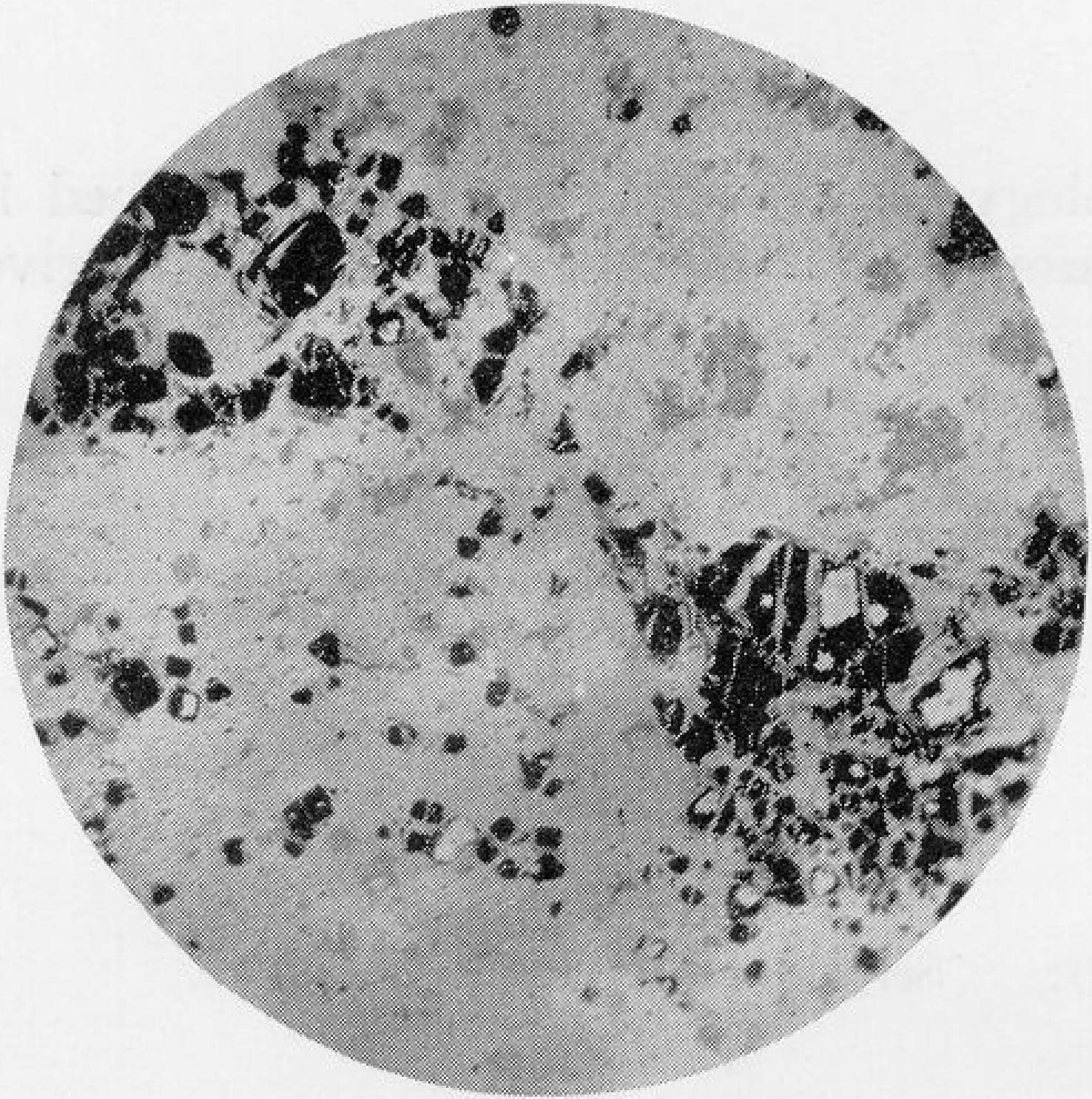

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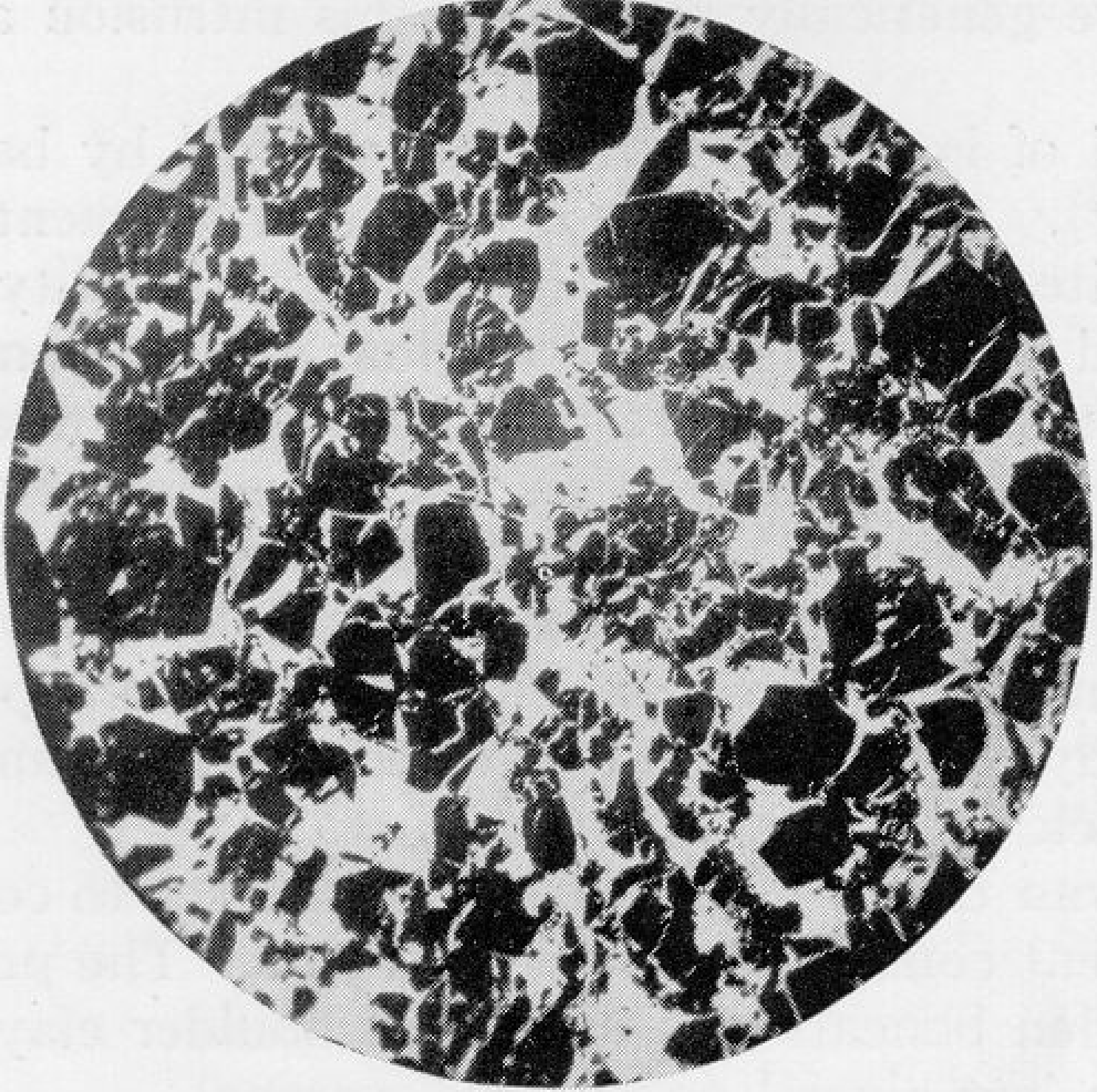


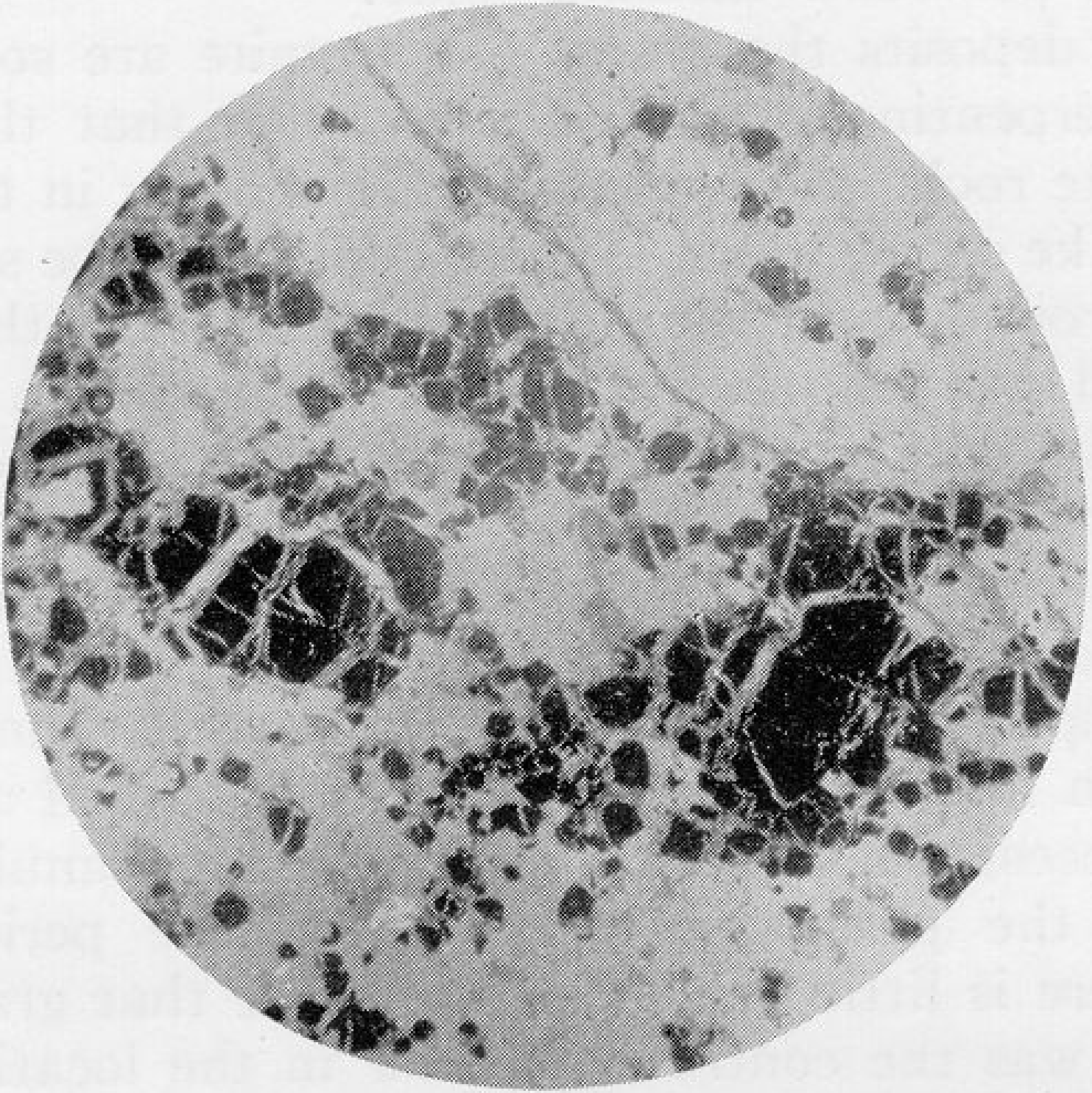


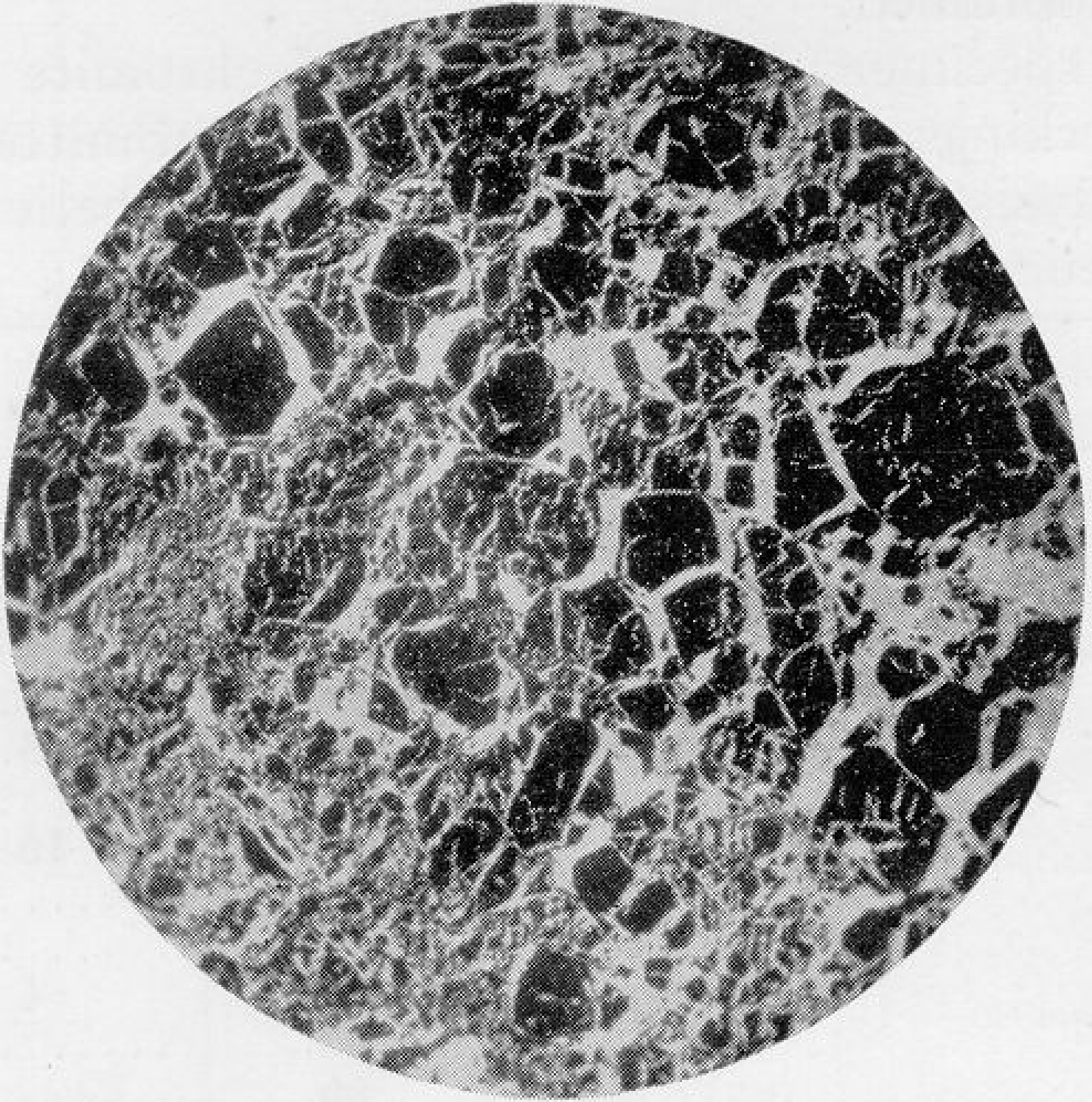

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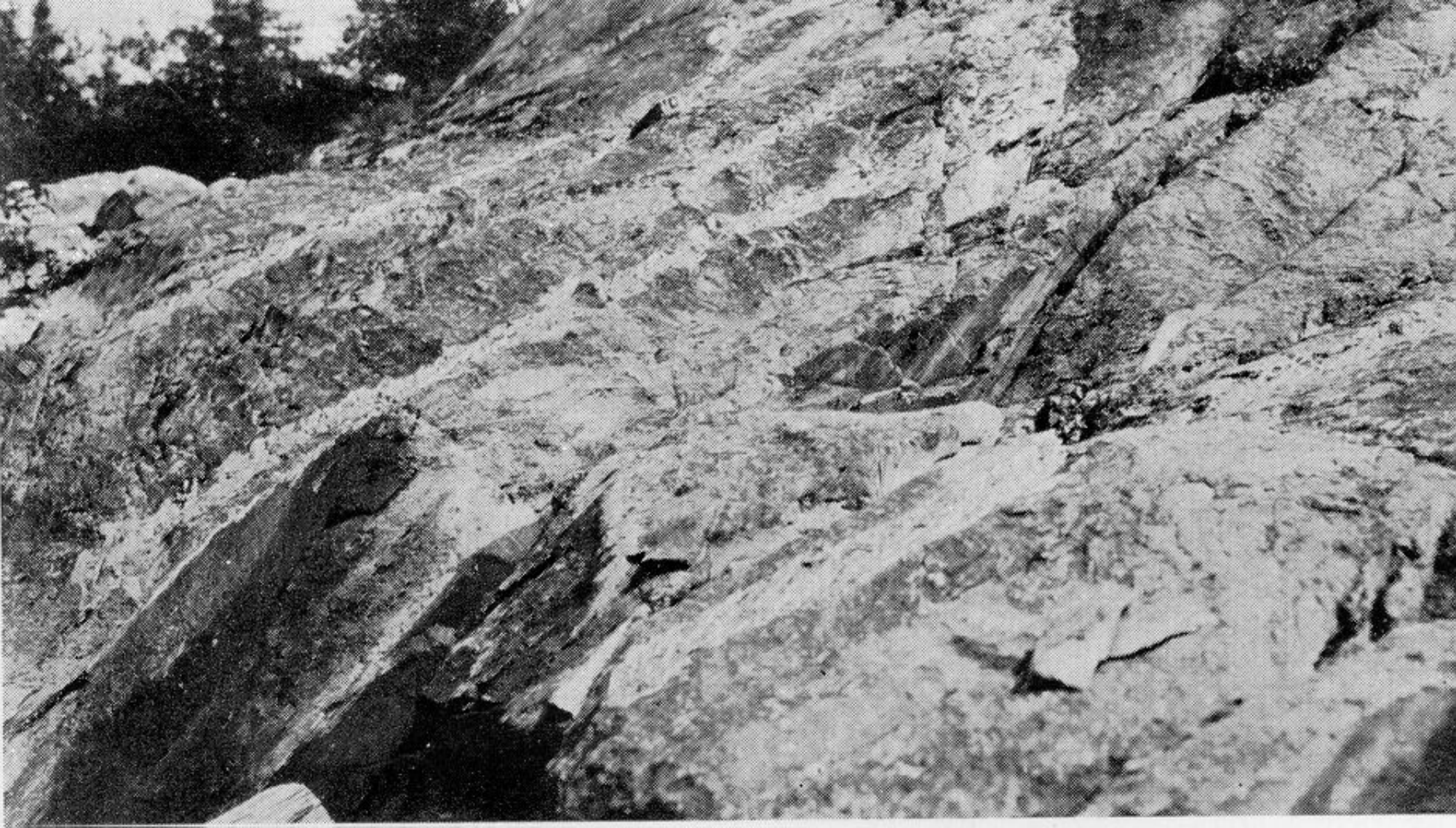












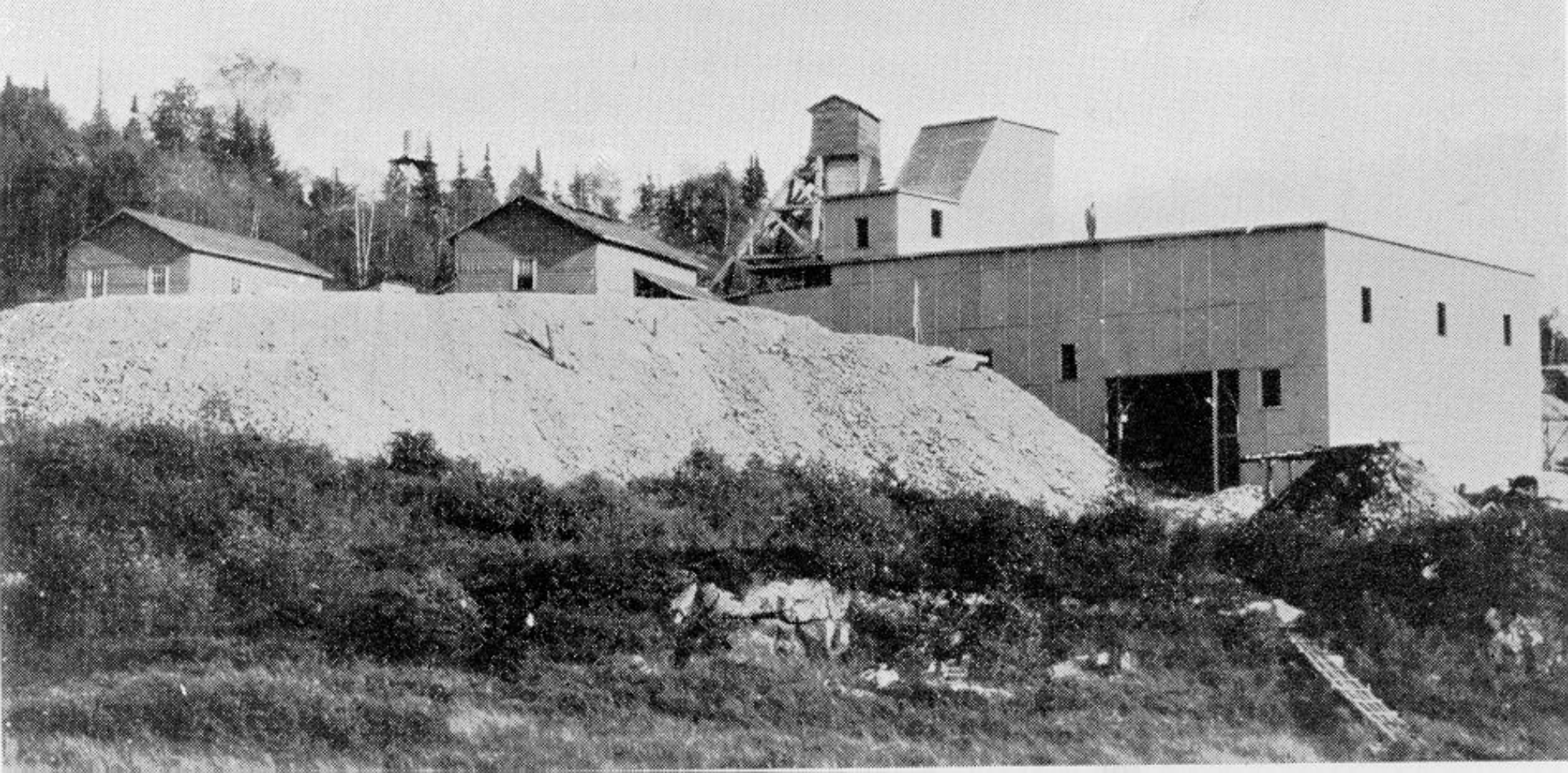




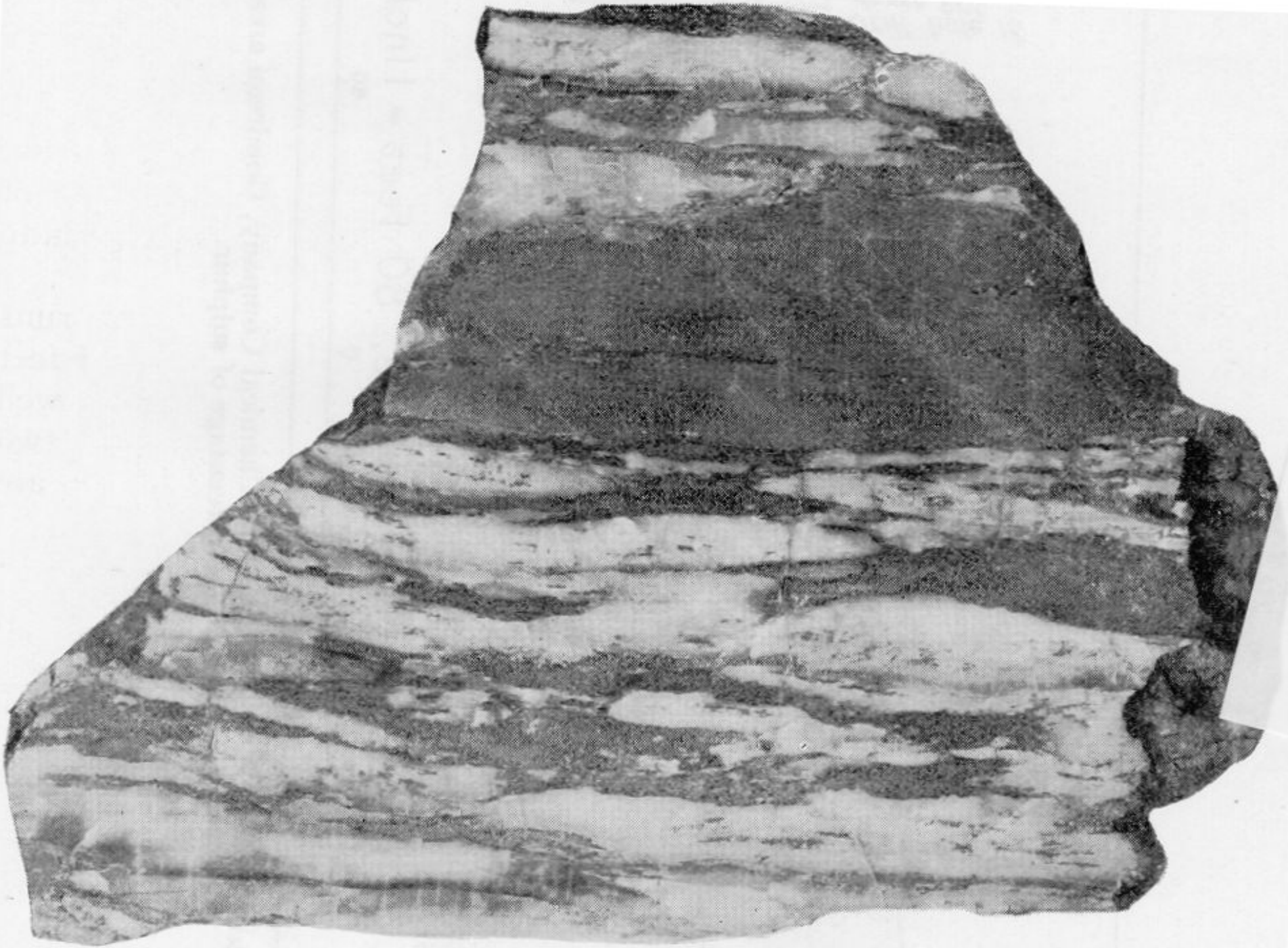






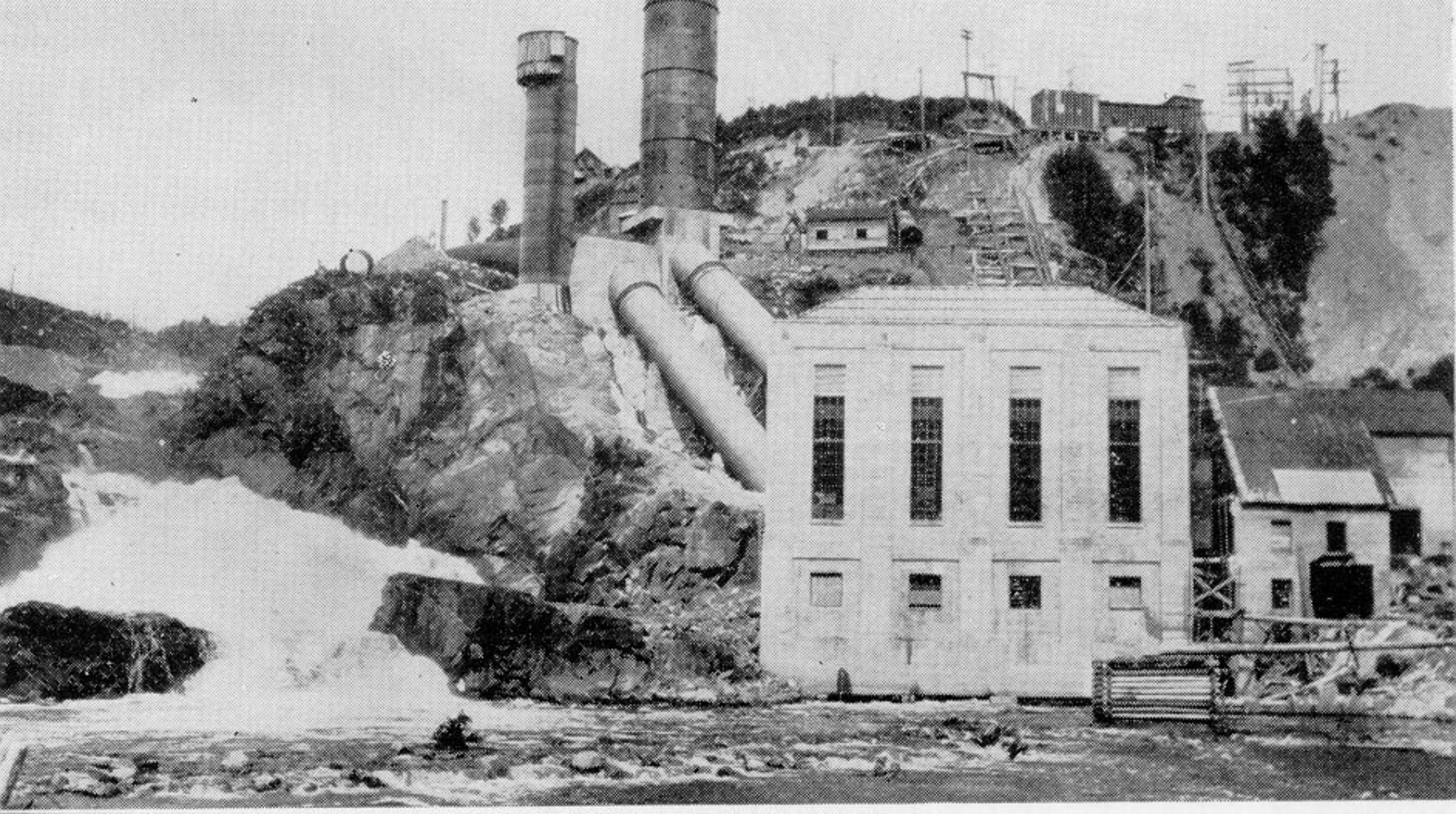


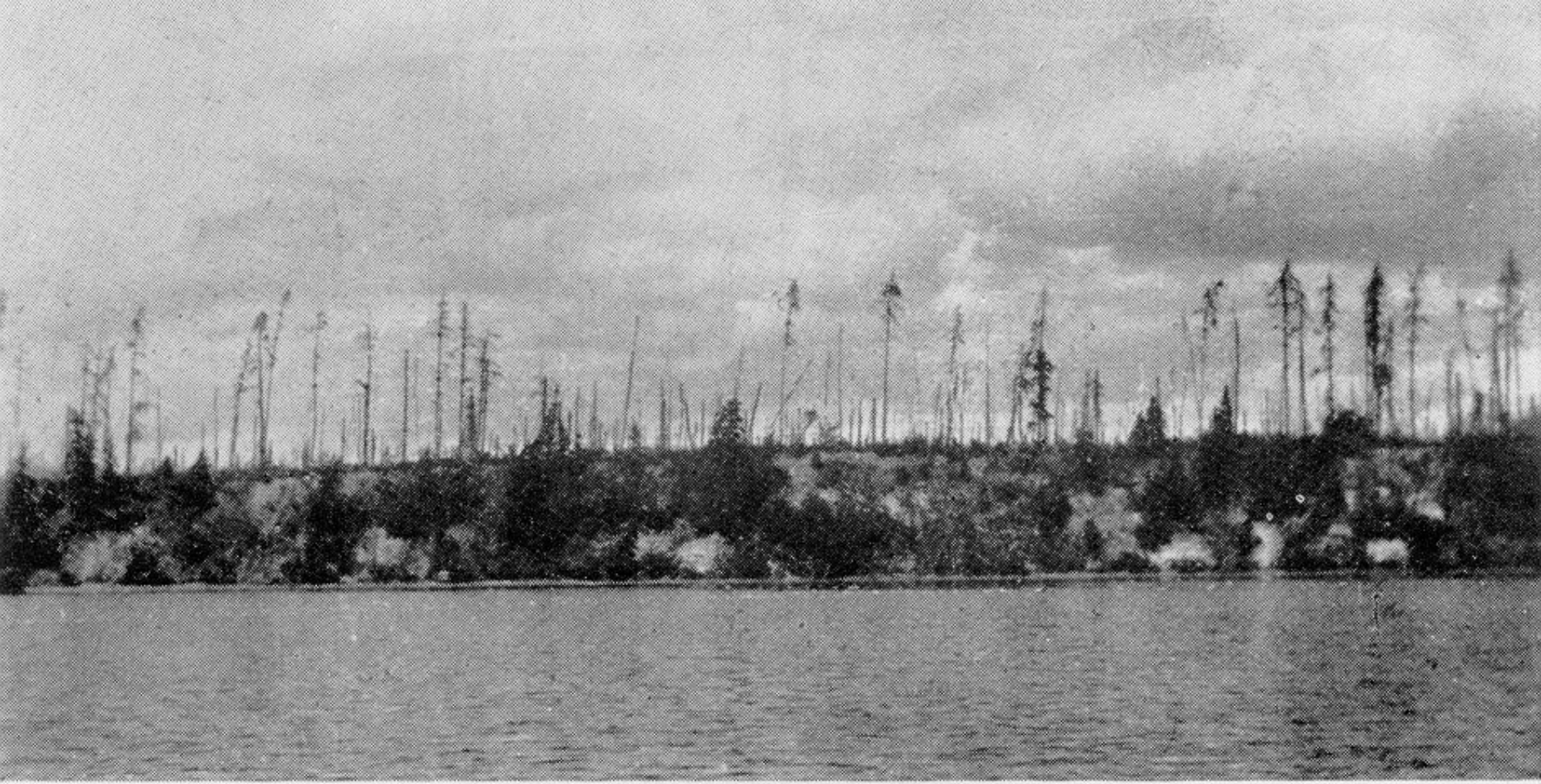


















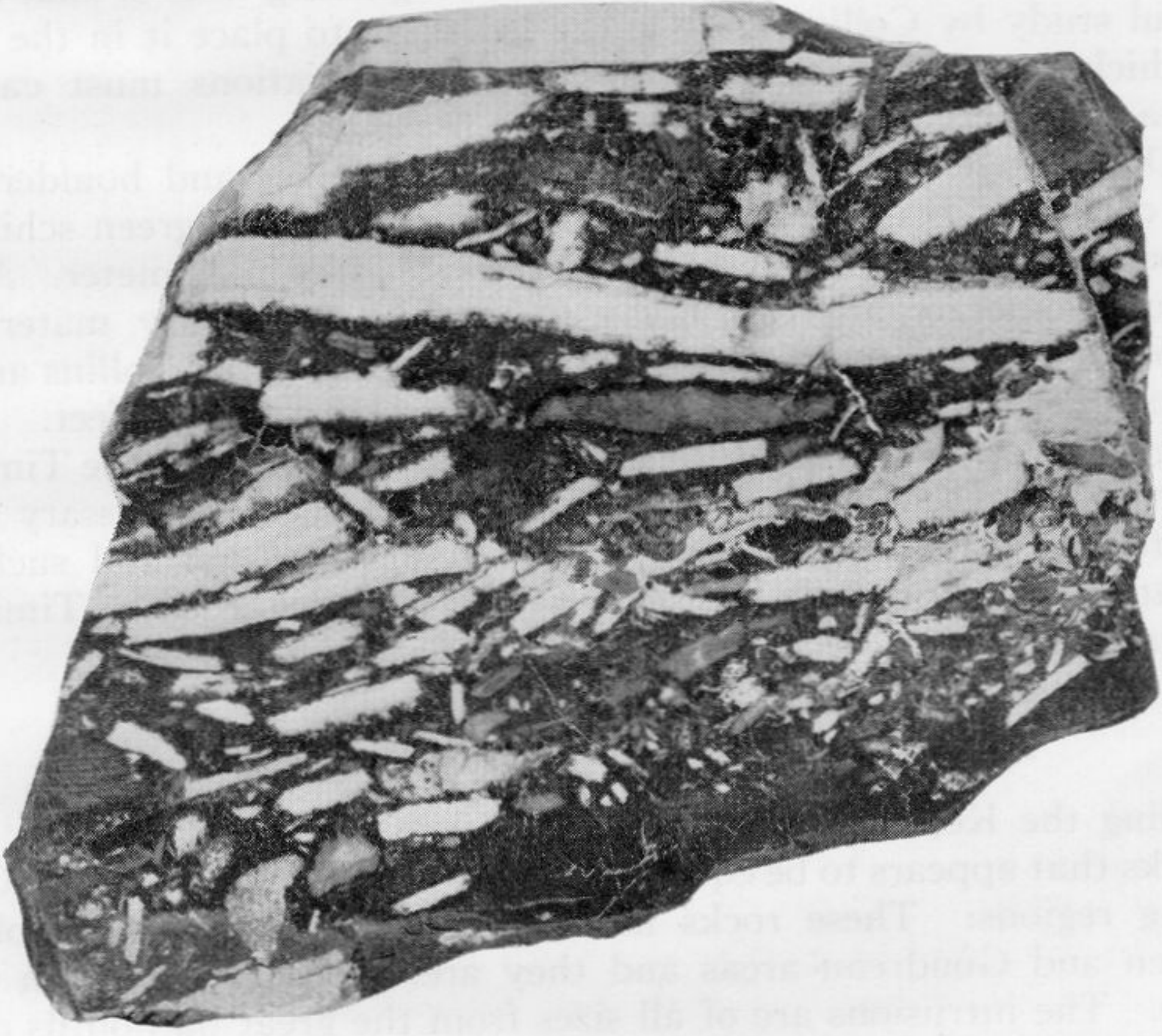






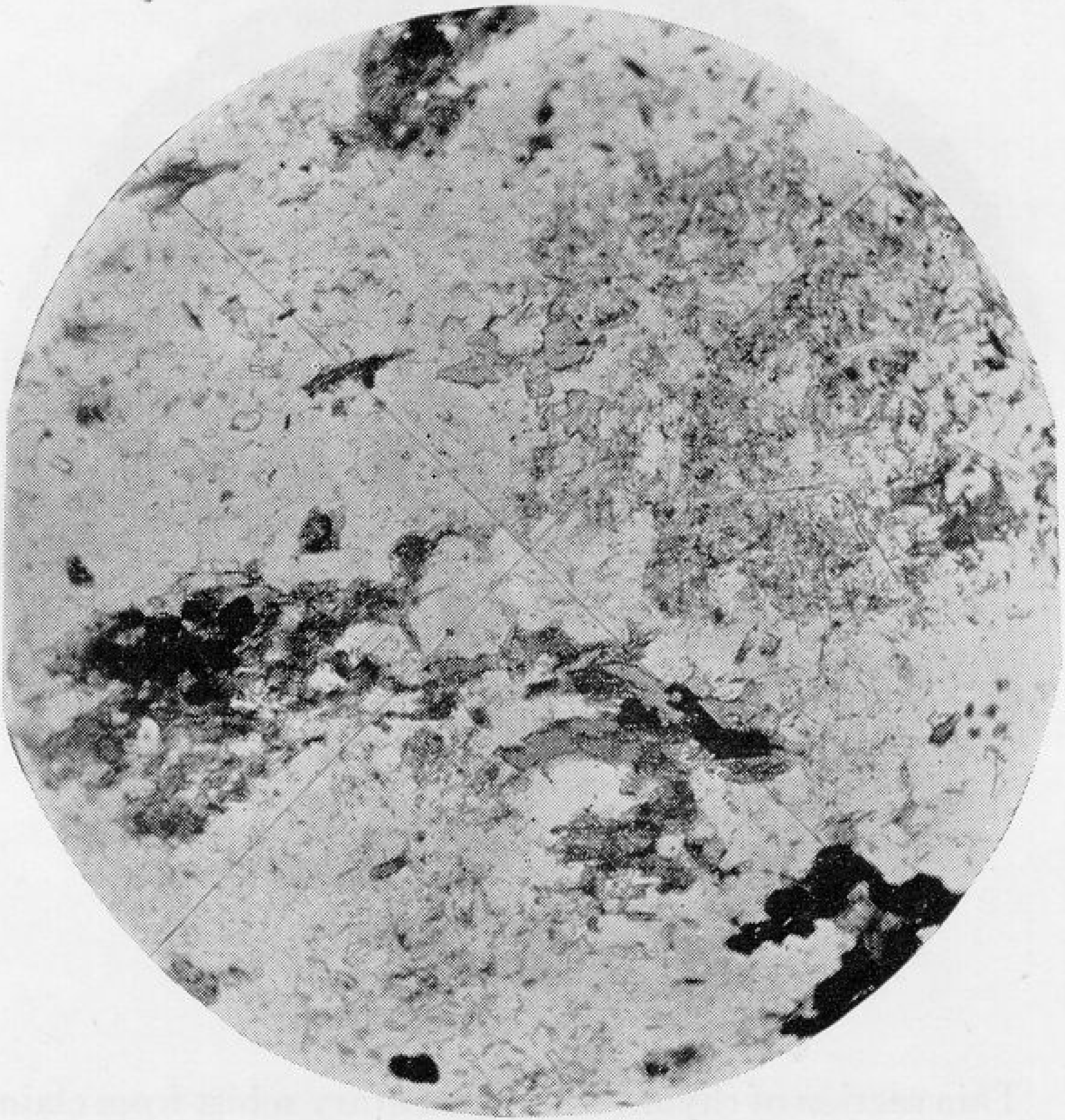


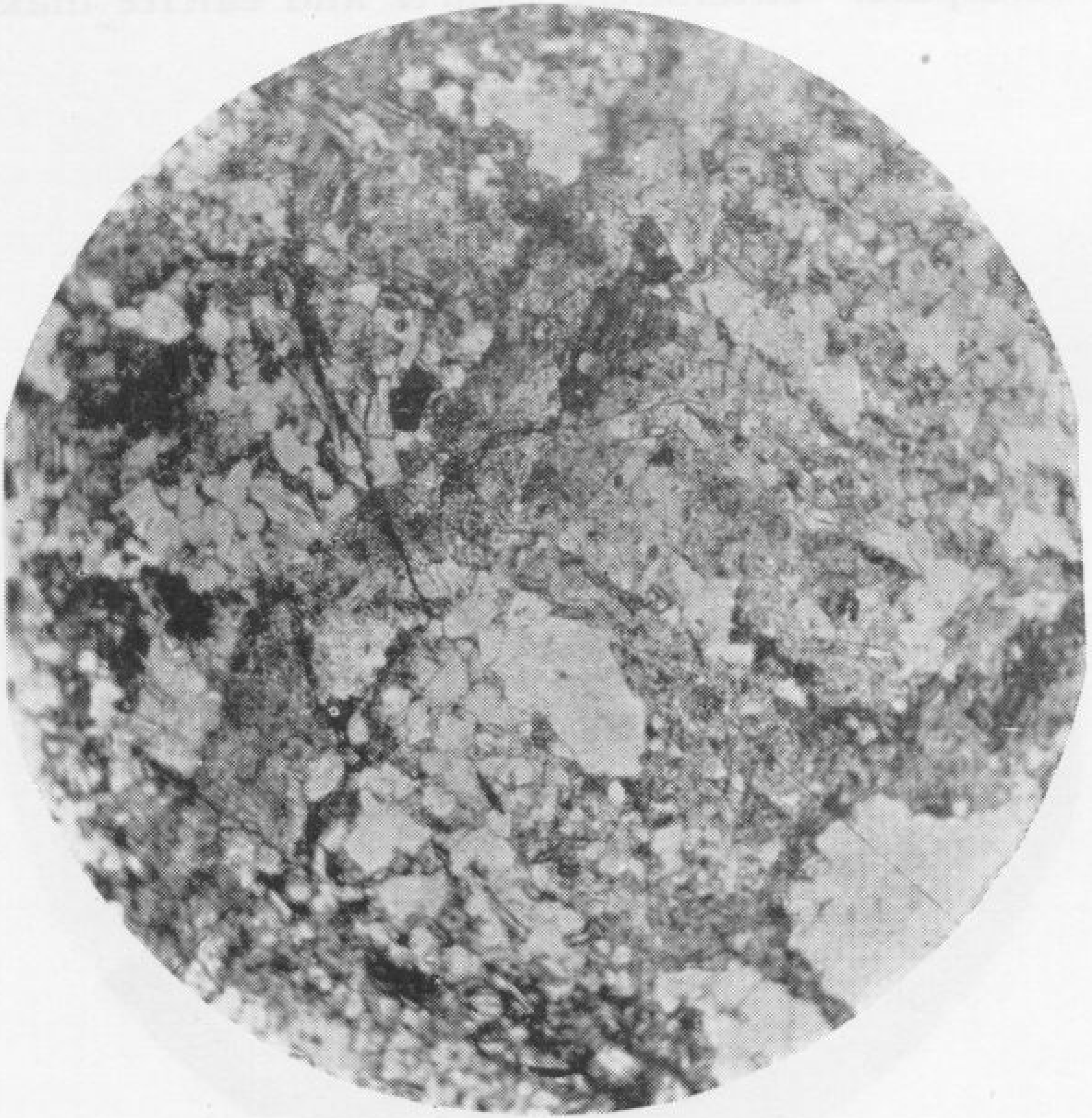


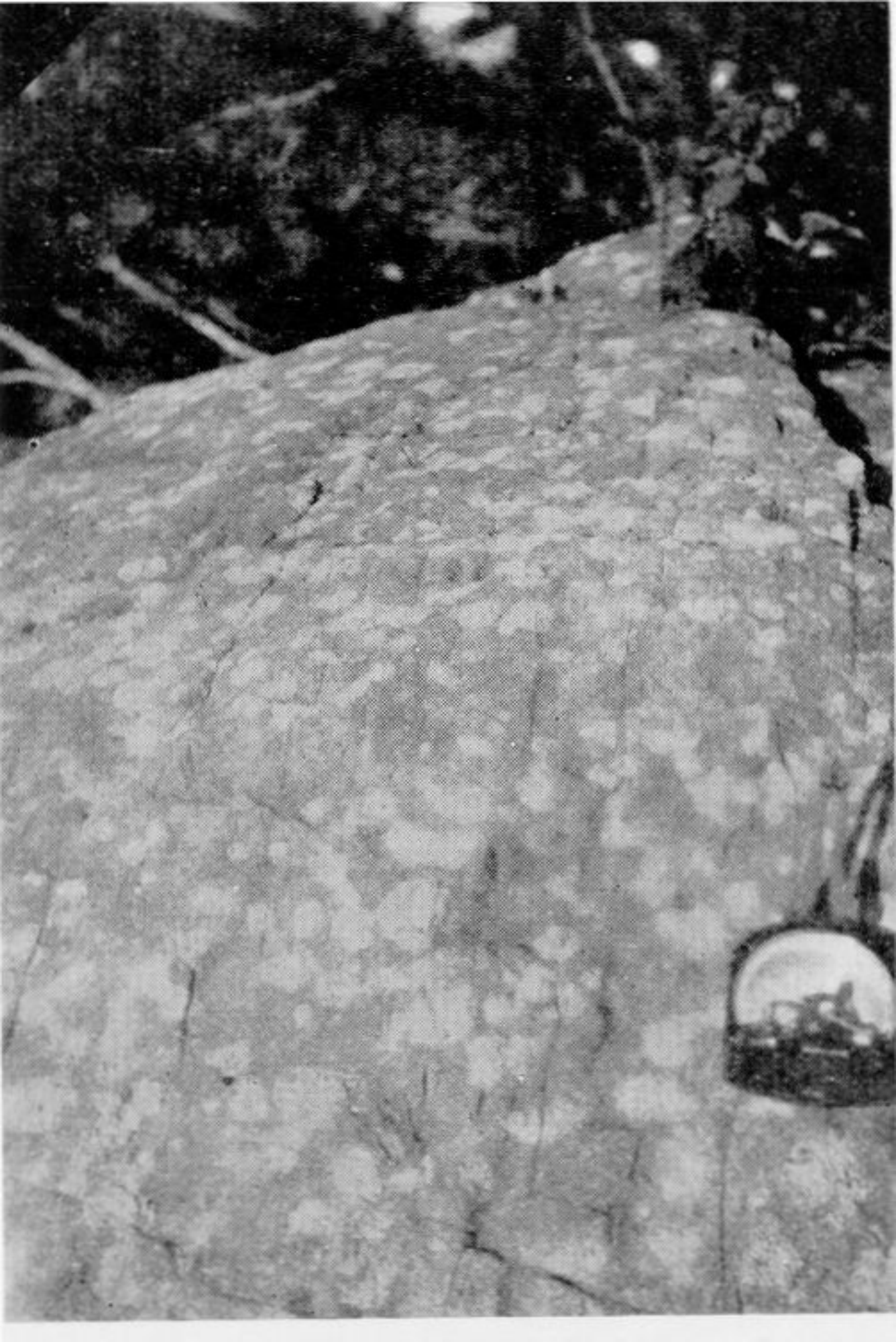


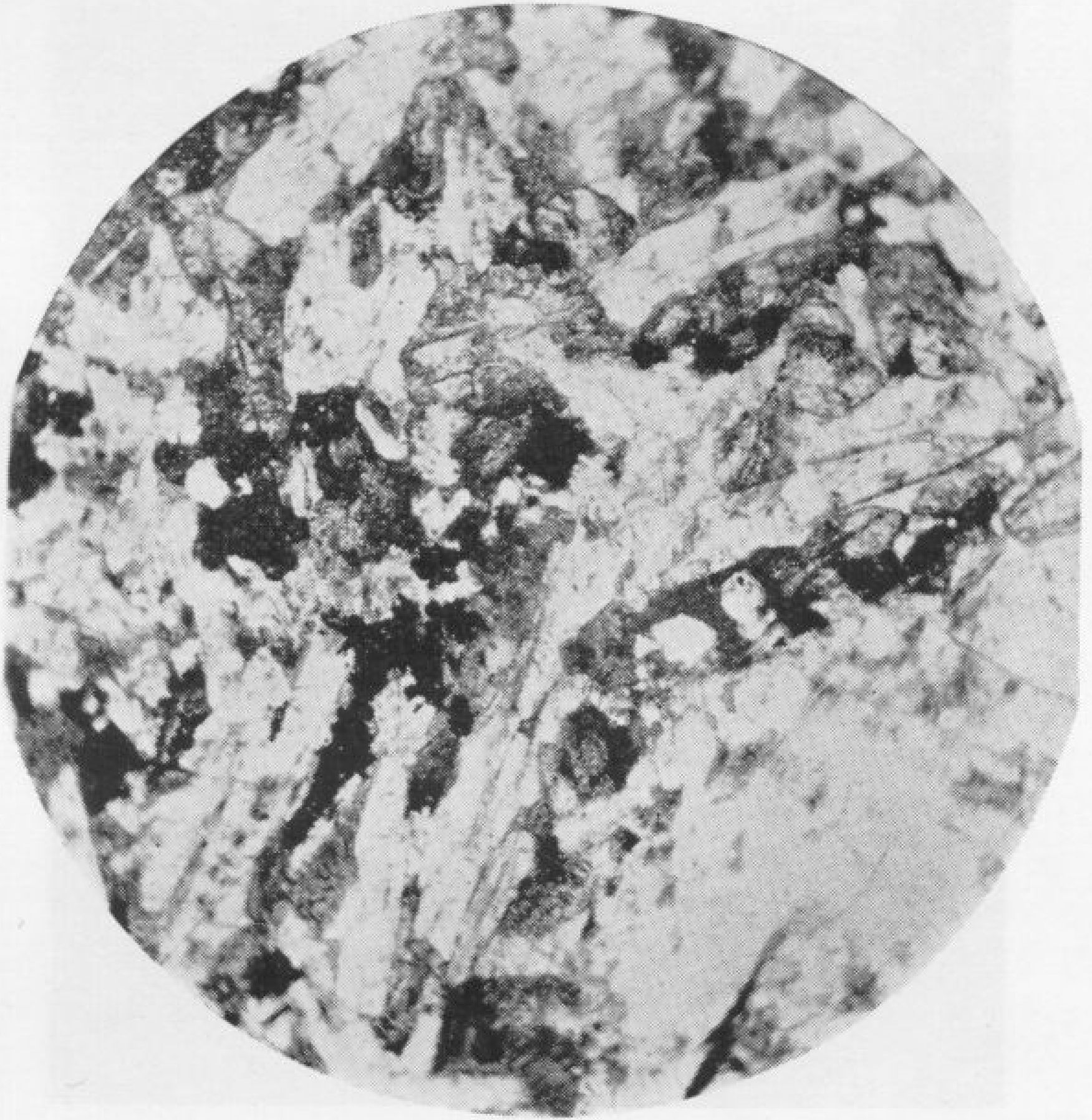








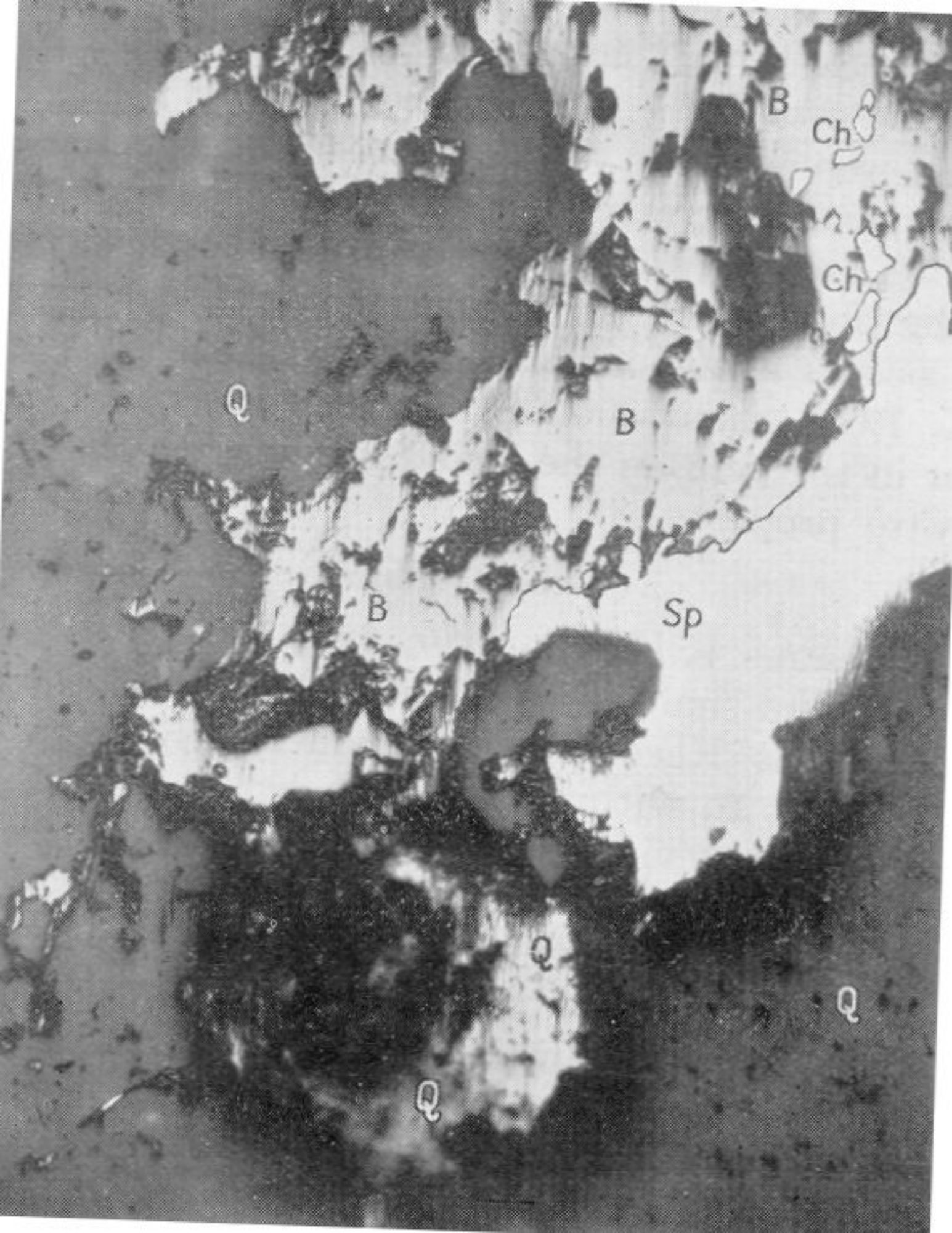











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PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. CHAS. MCCREA, *Minister of Mines* THOS. W. GIBSON, *Deputy Minister*

FORTIETH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XL, PART V, 1931

Natural Gas in 1930, by R. B. Harkness - - 1-53
Petroleum in 1930, by R. B. Harkness - - - 54-59

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1932

TABLE OF CONTENTS

Vol. XL, Part V

NATURAL GAS IN 1930 — PAGE

General 1
Table I—Natural Gas Production by Fields, 1927-1930 1
Table II—Domestic Consumption of Gas, 1921-1930 3
Analysis of Gas Consumption 3
Table III—Gas Consumption in Towns and Cities, 1930 4
Table IV—Gas Consumption in Townships, 1930 6
Gas Wells and Their Production 7
Table V—Gas Wells and Their Production, 1930 8
Exploratory Drilling 10
Leakage 11
Table VI—Leakage in Distribution Plants in Ontario, 1922-1930 11
Table VII—Leakage in Transmission Lines in Ontario, 1922-1930 12
Table VIII—Leakage on Rural Lines in Ontario, 1922-1930 12
Table IX—Leakage in Distribution Plants, 1930 13
Table X—Leakage in Transmission Lines, 1930 14
Table XI—Leakage on Rural Lines, 1930 15
Licenses Issued in 1930 16
Table XII—Operators Licensed to Lease and Prospect for Natural Gas. 16
Table XIII—Operators Licensed to Drill or Bore for Natural Gas 18
Table XIV—Operators Licensed to Produce Natural Gas 19
Table XV—Operators Licensed to Distribute Natural Gas 19

PAGE

Licenses Issued in 1930—*Continued.*
Table XVI—Operators Licensed to Operate Pipe Lines 20
Logs of Wells 20
Brant County 21
Dundas County 23
Elgin County 23
Essex County 23
Haldimand County 24
Kent County 39
Lambton County 44
Lincoln County 45
Manitoulin District 48
Middlesex County 48
Norfolk County 49
Welland County 50
York County 51
Surface Gas 51
Gas from Surface Drift Sold in Ontario 53
Analyses of Ontario Natural Gases ... 53

PETROLEUM IN 1930

General 54
Table I—Oil Produced in Ontario by Fields, 1923-1930 55
Table II—Oil Wells and Their Production, 1930 55
Price of Crude Petroleum 57
Petroleum Refining 57
Refined Petroleum Products Produced and Imported 57
Table III—Petroleum Refining Operations, 1926-1930 58
Table IV—Petroleum and Refined Products Imported in 1929 and 1930 59

SKETCH MAP AND GRAPHS

Graph of the natural gas industry in Ontario for the past forty years 2
Occurrences of surface gas in Southern Ontario ..... *insert facing* 52
Graph of the crude oil industry in Ontario for the past seventy years 54
Crude oil and products distilled in Ontario refineries (1915-1930) ..... *facing* 57

COLOURED MAP
(In pocket at back of report)

Map No. 40g—Natural Gas Pipe Lines in Southwestern Ontario. Scale, 10 miles to the inch.

NATURAL GAS IN 1930

By R. B. Harkness

General

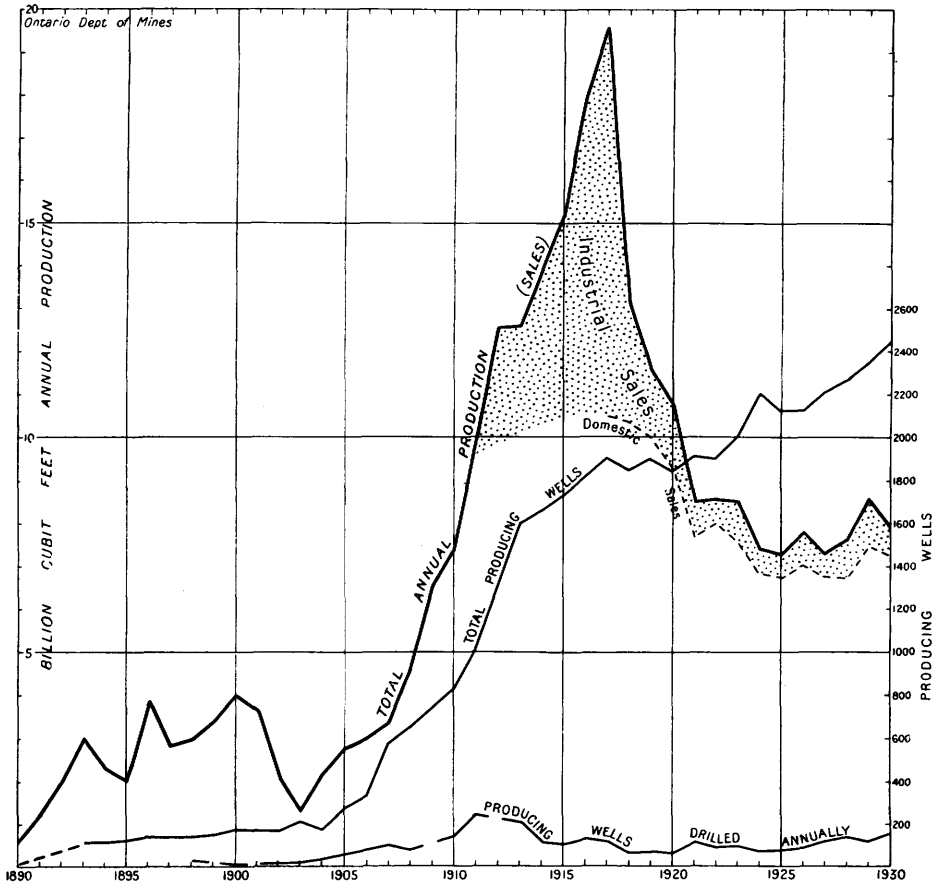
The natural gas production in Ontario in 1930 is below that of 1929, but well above the average for the last six years. The value, however, shows an increase, due to a higher average retail rate. Table I shows the production by fields for the past four years.

TABLE I—NATURAL GAS PRODUCTION BY FIELDS, 1927-1930

County	Field	1927	1928	1929	1930
		M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.
Essex	Kingsville	4,994,071	5,228,451	5,780,061	4,999,270
Kent	Tilbury				
	Dover	189,438	178,273	366,224	459,112
Lambton	Dawn	12,666	16,204	94,027	131,647
	Oil Springs				
Middlesex	Crumlin	.....	300	300	300
Elgin	Bayham	40,698	44,154	46,272	48,018
Norfolk	Norfolk	.....	.....	.....	277,971
Lincoln	Lincoln				
Haldimand	Haldimand	1,668,148	1,746,894	1,866,136	1,479,032
Wentworth	Wentworth				
Brant	Onondaga	13,224	13,804	31,558	58,637
Welland	Welland	278,967	301,847	298,688	408,475
Bruce	Amabel	224	240	107	858
Peel	Caledon	1,500	100	.....	.....
Wells in surface drift	Howard and Sarnia	52,278	42,473	39,814	20,088
Private wells	.....	60,000	60,000	60,000	60,000
Total produced		7,311,214	7,632,740	8,583,187	7,943,416
Value		$4,331,780	$4,535,312	$4,968,133	$5,061,588
		M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.
Imported mixed gas		103,040	116,639	138,352	144,577
Manufactured gas		.....	.....	3,986	3,248
Total distributed		7,414,254	7,749,379	8,725,525	8,091,241

The decrease in the consumption of natural gas from 8,583,187 M cubic feet in 1929 to 7,943,416 M cubic feet in 1930 is due both to the depression felt throughout the world (which has slowed down or shut down many Ontario industries) and to the milder fall and winter of 1930. The extension of gas lines in municipalities now being served with gas and the addition of new municipalities accounted for an increase of 3,144 in the number of consumers served in the province, but the quantity used per consumer is reduced 3,000 cubic feet. The new discoveries of gas, which will be discussed later, have very much improved the service to the municipalities in Lambton county that have been heretofore dependent on the Tilbury field, and has reduced the distance from the gas field by forty miles. The prosperous year of 1929, with the great increase in demand, had the effect of stimulating the search for gas. The number of wells drilled shows an increase of 17 per cent. over the previous year, and the number of

dry holes, a decrease of 8 per cent. The result of this activity was the extension of the De Clute and Dawn fields, the discovery of the Mosa (or Newberry) gas field, and the extension of the gas field in Middleton township. Some of the wells in the Kent fields were of considerable capacity. There does not appear to have been any cessation of activity at the end of the year, and the season of 1931 should also be a banner year. Comparing the apparent reserves of gas at the present time with those of five years ago gives a very favourable outlook for the future, especially in the Tilbury and Haldimand fields. The cleaning-out operations in the Tilbury field and the drilling in the Haldimand



Graph of the natural gas industry in Ontario for the past forty years.

field force a change in the estimate of reserves; and, although a definite statement cannot be made, it would appear that the lifetime of these fields has been extended by ten years or more and that the undrilled acreage holds supplies of gas hitherto unsuspected. The promise of these future supplies resulted in a very active campaign, and improved methods of prospecting are being tried, among these being core-drilling and the use of geophysical instruments. To date, the core-drilling has been more satisfactory than geophysics in the Kent and Lambton field. In the Haldimand-Norfolk field no better method has been found than following the indication given by highest remaining rock pressures and the thickest "sand," or, in undrilled areas, "wildcatting."

The graph on page 2 shows very clearly the history of the gas industry in Ontario—total production, total number of producing wells, and number of producing wells drilled each year for forty years.

Table II shows the number of gas consumers and the quantity of gas used for purely domestic cooking and heating. The amount of gas used by industries and for other purposes is shown in Tables III and IV.

TABLE II—DOMESTIC CONSUMPTION OF GAS, 1921-1930

Year	No. of pay consumers	Total quantity used	Quantity used per consumer
		M cu. ft.	M cu. ft.
1921	58,609	5,937,316	101.3
1922	63,229	6,028,947	95.3
1923	62,352	6,210,459	99.6
1924	61,100	5,933,595	97.1
1925	62,338	5,300,424	85.6
1926	63,695	5,595,521	87.8
1927	66,818	5,210,315	78
1928	70,259	5,699,553	71.2
1929	80,991	6,336,873	78.2
1930	84,135	6,332,519	75.2

The following table shows the capital invested, number of men employed, and wages paid in the natural gas industry for the years 1927 to 1930:—

	1927	1928	1929	1930
Capital invested in all natural gas operations, including drilling, producing and distributing	$31,987,879	$36,601,828	$35,162,736	$36,162,268
Number of men employed	1,123	1,209	1,323	1,328
Wages paid	$1,148,339	$1,497,999	$1,529,367	$1,545,648

Analysis of Gas Consumption

Tables III and IV give details concerning the gas consumed in Ontario during 1930. By comparing these tables with those published in previous years, the history of prices and quantity consumed can be traced from year to year. It will be found of interest to note the changes in the ratio of gas used to the price charged from year to year.

TABLE III—GAS CONSUMPTION IN TOWNS AND CITIES, 1930

Town or city	Population	No. of consumers		Quantity consumed, M cu. ft.			Distance from gas field	Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial		
							miles	
Alvinston	612	143	1	3,481	13	136	20	$0.55–.80
Aylmer	2,100	680	....	28,780	.....	.....	16	.90
Bartonville	350	85	....	3,582	.....	.....	19	.60
Belle River	810	172	....	17,298	.....	579	29	.55–.80
Belmont	350	70	....	3,022	.....	.....	9	1.00
Binbrook	100	19	....	1,487	.....	.....	1	.25–.40
Blenheim	1,572	567	2	61,547	332	1,083	20	.50–.75
Bothwell	653	107	....	2,892	.....	.....	14	.55–.80
Brantford	30,350	4,052	5	156,167	1,154	7,595	140	.80
Bridgeburg and Fort Erie	5,173	1,298	4	65,574	1,725	.....	8	1.00–1.30
Brigden	300	157	....	13,553	.....	1,462	30	.50–.75
Burlington	3,300	167	....	8,439	.....	.....	48	.75
Cainsville	600	132	....	5,995	.....	.....	4	.80
Caledonia	2,000	545	....	49,905	.....	.....	7	.60
Canfield	150	62	....	5,313	.....	602	1	.50–.60
Cayuga	790	215	1	20,778	54	529	6	.60
Chatham	16,970	4,115	1	485,024	5,435	35,916	22	.50–.75
Chippawa	1,100	12	....	511	.....	.....	5	.40
Coatsworth	100	31	1	2,453	43	24	4	.50–.75
Comber	658	141	....	16,552	.....	1,809	19	.50–.75
Cottam	300	90	3	9,414	217	736	35	.55
Courtland	380	52	....	4,124	.....	122	3	.60
Courtright	450	123	1	12,435	252	670	49	.50–.75
Crystal Beach	352	205	....	13,581	.....	.....	1	1.00–1.30
Delhi	840	292	....	25,169	.....	1,289	4	.60
Dorchester	477	111	1	7,993	18	.....	95	.60–.85
Dresden and Tupperville	1,450	498	1	54,682	132	647	30	.50–.75
Dundas	5,000	1,161	1	64,761	40	5,421	172	.70
Dunnville	3,500	997	3	101,983	410	9,741	7	.40–.60
Dutton	835	255	3	25,029	157	1,067	52	.55–.80
Echo Place	300	66	....	3,036	.....	.....	3	.80
Eden	80	27	....	1,299	.....	.....	11	.60
Essex	1,600	519	1	59,698	101	4,013	33	.55–.80
Fairground	40	15	....	656	.....	.....	1	.60
Fenwick	165	99	....	6,431	.....	.....	18	.75
Fingal	410	41	2	3,295	12	539	71	.55–.80
Fisherville	102	50	....	4,889	.....	241	2	.50–.55
Florence	278	56	....	1,424	.....	.....	5	.55–.80
Fonthill	750	235	....	6,223	.....	.....	25	.95–1.20
Galt	13,752	1,034	1	61,582	261	5,015	147	.80
Grimsby	1,888	59	....	2,089	.....	.....	10	.85
Hagersville	1,290	416	....	35,362	.....	.....	14	.60
Hamilton	143,129	8,295	4	223,035	622	217,573	47	.75
Hepworth	300	6	2	458	400	.....	1	.75
Highgate	410	114	3	11,112	445	.....	32	.50–.75
Ingersoll	5,100	964	2	43,069	313	3,372	100	.80
Inwood	250	68	....	1,580	.....	.....	14	.55–.80
Jarvis	460	202	....	19,780	.....	.....	9	.60
Kingsville	3,590	698	1	91,800	266	190	30	.55
Lake Shore	.....	389	....	8,407	.....	.....	16	1.00–1.30
Lambeth	486	84	....	5,621	.....	.....	85	.60–.85
Leamington	5,169	1,465	....	197,558	.....	4,497	20	.55
Lynedoch	151	47	....	3,486	.....	1,779	2	.60
Mabee	82	11	....	704	.....	.....	1	.60
Merlin	386	147	2	16,009	2,252	1,092	2	.50–.75
Merritton	2,596	370	....	14,481	.....	135	35	.75
Nelles Corners	100	1	4	.....	1,000	529	1	.50
Niagara Falls	18,539	3,045	....	114,535	.....	28,228	11	1.00–1.30
Oil Springs	512	125	....	4,836	.....	.....	2	.75
Paris	4,368	595	1	27,295	127	1,396	129	.80
Petrolia	3,148	745	1	84,621	412	.....	60	.55–.80

TABLE III—GAS CONSUMPTION IN TOWNS AND CITIES, 1930—*Continued*

Town or city	Population	No. of consumers		Quantity consumed, M cu. ft.			Distance from gas field	Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial		
							miles	
Port Burwell	650	233	....	15,371	.....	.....	3	$0.60
Port Colborne and Humberstone	5,661	1,778	5	91,138	568	2,766	5	.60–.95
Port Dover	1,650	553	1	50,348	150	454	1	.60
Port Rowan	669	239	....	15,704	.....	.....	1	.60
Ridgetown	1,895	645	3	68,002	2,293	1,096	28	.50–.75
Ridgeway	864	219	....	14,509	.....	.....	1	1.00–1.30
Rodney	680	243	2	22,539	156	664	40	.55–.80
Ruthven	438	48	....	6,846	.....	.....	25	.55
St. Anns	92	25	....	1,005	.....	.....	7	.85
St. Catharines	30,000	4,734	2	234,640	515	11,661	35	.75
St. George	550	98	....	3,882	.....	26	148	.80
St. Williams	300	109	....	6,520	.....	965	1	.60
Sarnia	18,503	4,583	1	359,325	1,232	11,274	55	.55–.80
Selkirk	585	139	1	13,217	99	.....	1	.60
Shedden	400	92	....	7,452	.....	.....	63	.55–.80
Simcoe	4,582	1,664	3	193,947	482	9,873	20	.60
Smithville	330	177	....	7,157	.....	.....	6	.75
Sombra and Port Lambton	2,000	147	....	14,711	.....	585	45	.55–.80
Stevensville	450	33	....	2,186	.....	.....	1	1.00–1.30
Straffordville	300	80	....	6,573	.....	595	6	.60
Thamesville	800	190	1	4,869	44	186	13	.55–.80
Thorold	4,932	990	....	40,078	.....	423	35	.75
Tilbury	2,000	494	2	50,171	494	634	14	.50–.75
Tillsonburg	3,257	1,003	1	80,047	377	2,894	16	.63
Vienna	284	77	1	3,882	107	.....	1	.60–.80
Vittoria	280	82	....	5,223	.....	.....	3	.60
Wallaceburg	4,530	1,175	1	128,261	292	109,241	19	.50–.75
Wallacetown	244	46	1	4,011	23	490	60	.55–.80
Waterford	1,096	14	....	75	.....	.....	30	.60
Welland	12,100	2,654	3	90,934	487	7,364	3	.45–1.30
Wellandport	140	16	....	247	.....	.....	3	.75
West Lorne	818	207	3	18,912	345	714	49	.55–.80
Wheatley	700	242	....	22,447	.....	1,412	12	.50–.65
Windsor (Border Cities)	85,900	14,779	....	1,677,111	.....	99,302	45	.55–.80
Woodstock	10,898	1,910	1	85,186	293	3,433	110	.80
Wyoming	475	102	....	2,253	.....	.....	65	.55–.80
Total	.....	76,362	84	5,674,674	24,150	604,079	.....	.....

TABLE IV—GAS CONSUMPTION IN TOWNSHIPS, 1930

Township	Population	No. of consumers		Quantity consumed, M cu. ft.			Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial	
ESSEX:							
Gosfield, North	2,190	98	2	9,886	303	175	$0.55
Gosfield, South	2,291	392	1	38,616	597	17,084	.50–.55
Maidstone	2,109	79	7	6,534	1,592	552	.55–.80
Mersea	3,825	454	2	47,263	400	23,834	.50–.55
Rochester	1,941	198	6	16,848	1,369	646	.55–.80
Sandwich, East	1,090	11	.....	2,615	.....	.....	.55–.80
Sandwich, South	1,433	113	.....	11,638	.....	523	.55–.80
Sandwich, West	2 754	1	.....	69	.....	.....	.55–.80
Tilbury, North	1,788	32	.....	1,659	.....	204	.50–.75
Tilbury, West	1,563	22	1	2,137	208	.....	.50–.75
LAMBTON:							
Brooke	2,350	9	.....	152	.....	.....	.55–.80
Dawn	2,307	65	3	4,963	581	1,349	.40–.65
Enniskillen	2,656	115	.....	7,063	.....	431	.55–.80
Moore	3,251	295	.....	22,013	.....	990	.50–.75
Plympton	2,531	5	.....	109	.....	.....	.55–.80
Sarnia	2,560	3	10	600	2,113	.....	.40
Sombra	2,875	57	.....	4,537	.....	630	.50–.75
KENT:							
Camden	1,305	13	.....	668	.....	.....	.50–.75
Chatham	4,940	91	.....	8,477	.....	736	.50–.75
Dover	3,600	426	1	45,195	153	3,404	.30–.80
Harwich	4,327	440	10	43,265	2,868	.....	.50–.75
Howard	2,768	174	3	19,231	442	.....	.50–.75
Orford	1,875	20	3	2,239	373	.....	.50–.75
Raleigh	3,676	576	24	63,451	6,357	865	.50–.75
Romney	1,510	74	37	7,884	10,795	500	.40–.65
Tilbury, East	2,914	237	72	23,777	23,078	9,740	.40–.65
Zone	800	7	.....	220	.....	.....	.55–.80
ELGIN:							
Aldborough	2,837	21	1	1,292	325	.....	.55–.80
Bayham	3,162	75	17	3,682	3,118	389	.60–.80
Dunwich	2,500	49	1	4,820	109	.....	.55–.80
Malahide	2,953	53	3	2,222	475	.....	.60–.80
Southwold	3,510	110	.....	8,548	.....	585	.55–.80
MIDDLESEX:							
North Dorchester	3,056	15	1	1,027	300	.....	.60–.85
Westminster	6,175	161	.....	18,148	.....	.....	.60–.85
NORFOLK:							
Charlotteville	2,600	16	7	1,186	985	.....	.60
Middleton	2,150	33	1	2,264	200	.....	.60
North Walsingham	1,520	5	4	375	588	.....	.....
South Walsingham	1,581	21	7	1,701	1,022	.....	.60
Townsend	3,715	32	.....	2,380	.....	.....	.60
Windham	3,205	2	3	174	478	.....	.60
Woodhouse	2,050	163	10	17,035	1,459	.....	.60
BRANT:							
Brantford	7,220	8	.....	286	.....	.....	.80
Burford	3,833	2	.....	151	.....	.....	.80
Onondaga	1,017	51	13	3,922	2,473	.....	.60–.70
South Dumfries	2,532	10	.....	346	.....	.....	.80
Tuscarora	800	1	.....	144	.....	.....	.30
OXFORD:							
East Oxford	1,724	9	.....	589	.....	.....	.80
West Oxford	1,810	54	.....	4,158	.....	.....	.80

TABLE IV—GAS CONSUMPTION IN TOWNSHIPS, 1930—*Continued*

Township	Population	No. of consumers		Quantity consumed, M cu. ft.			Net rate per M cu. ft.
		Pay	Free	Pay	Free	Industrial	
HALDIMAND.							
Canborough	902	82	49	6,290	8,093	492	$0.60
Dunn	800	119	10	7,275	2,615	.....	.60
Moulton	1,628	312	31	9,854	3,827	12,099	.50–.60
North Cayuga	1,309	5	12	153	2,076	.....	.60
Oneida	1,287	67	9	8,232	1,680	.....	.50–.60
Rainham	1,695	138	27	10,455	5,230	1,468	.40–.60
Seneca	1,561	150	53	12,242	7,630	.....	.60
Sherbrooke	300	82	11	4,653	1,189	.....	.50–.60
South Cayuga	510	58	16	3,752	2,812	.....	.60
Walpole	3,042	312	59	23,530	9,039	1,783	.40–.60
LINCOLN:							
Caistor	1,220	101	26	6,446	2,486	199	.50–.60
Gainsborough	2,017	23	2	1,932	229	.....	.50
Grantham	4,175	9	.....	581	.....	.....	.75
Louth	2,548	8	1	528	100	.....	.75
WELLAND:							
Bertie	3,298	189	69	12,666	13,315	.....	.50–1.30
Crowland	3,750	87	22	2,937	2,850	.....	.75–1.30
Humberstone	2,149	247	37	15,249	5,967	.....	.50–1.30
Pelham	2,365	60	2	3,944	115	.....	.75
Stamford	4,915	87	4	5,764	772	.....	1.00–1.30
Thorold	3,401	8	1	130	170	.....	.75–.80
Wainfleet	2,357	86	26	4,098	4,921	.....	.40–1.00
Willoughby	870	29	29	1,921	5,467	.....	1.00–1.30
WENTWORTH:							
Ancaster	4,550	55	.....	8,865	.....	.....	.70–.75
Barton	7,665	229	.....	10,051	.....	.....	.60–.75
Binbrook	1,109	72	21	9,614	4,186	786	.60
Glanford	1,415	125	4	14,690	664	393	.60
Saltfleet	4,706	135	.....	6,434	.....	.....	.75
Total	.....	7,773	771	657,845	148,194	79,857	.....

SUMMARY

	M cu. ft.
Total distribution to customers	7,188,799
Used by companies for all purposes	110,575
Used by private well-owners	74,000
Leakage in transmission lines	413,619
Leakage in distribution plants	288,367
Leakage in rural lines	15,881
Total amount of gas distributed	8,091,241

Gas Wells and Their Production

In Table V is given a summary by townships of the number of gas wells in Ontario, their production, and the number abandoned; the number of new wells drilled, with their open flow; and the rock pressure of each township. Only the acres under lease held by operating companies are herein reported.

TABLE V—GAS WELLS AND THEIR PRODUCTION, 1930

County	Township	No. of wells producing	No. of wells abandoned	Wells drilled			Production	Rock pressure, lbs. per sq. in.	Acres under lease	Rental paid
				No. dry	No. producing	Open flow				
						M cu. ft.	M cu. ft.			
Essex	Gosfield, South	20						171	5,898	$325
	Mersea	3						278		
Kent	Raleigh	30		7	11	24,301	4,999,278	606		
	Romney	147		1	3	357		229	132,428	
	Tilbury, East	137	3		2	399		229		
	Dover	9		3	1		459,112	360	14,662	179,054
Lambton	Dawn	18		5	4	7,131	124,411	667	91,143	
	Euphemia	3						345		
	Enniskillen	3					4,836	100	760	
	Sarnia	14					2,400	70	5,000	50
Middlesex	Dorchester, North	3					300	25	100	
	Mosa	1		4	1	1,048				
Elgin	Bayham	39	1				48,018	172		
	Malahide	1	1					215		
Norfolk	Charlotteville	15	1					224		
	Houghton	3						300		
	Middleton	25	1		1	300		294		
	North Walsingham	9					277,971	365		
	South Walsingham	13	1					333		
	Townsend	1						300		
	Windham	8						266		
	Woodhouse	53	3					267		
Haldimand	Canborough	126	3		1	28		96		
	Dunn	31	1	1	1	25		166		
	Moulton	88	8		1	17		123		
	North Cayuga	128	11	14	19	938		247		
	Oneida	23	3	3	3	102		119		
	Rainham	199	2	4	20	1,157		262	298,727	69,176
	Seneca	166	2	11	17	1,239		104		

	Sherbrooke	13	1	2	2	85	1,479,032	124		
	South Cayuga	56	2					158		
	Walpole	215		13	17	1,213		269		
Wentworth	Binbrook	42	1					81		
	Glanford	11						65		
Lincoln	Caistor	53	2	2	15	654		90		
	Gainsborough	5						100		
Welland	Bertie	89	2		8			85		
	Crowland	47	1		1	15		113		
	Humberstone	81	1				408,475	62		
	Wainfleet	36	4					114		
	Willoughby	38			1	15		35		
Brant	Onondaga	27			1	7	58,637	103		
	Tuscarora	44		2	28	2,517		142	44,315	
Bruce	Amabel	2					858	100	50	
Peel	Caledon	6								
Surface wells	Harwich	69					14,000[1]			
	Howard						6,088[2]			
	Sarnia	2								
Private wells[3]		300					60,000[4]			
Total		2,452	55	72	158	41,548	7,943,416			

[1]This gas is not metered and therefore must be estimated. The wells are owned privately, and the gas is used for domestic purposes.
[2]This gas is sold to the Union Natural Gas Company, and was used in Ridgetown.
[3]Principally in Haldimand, Norfolk, and Welland counties.
[4]Estimated.

Exploratory Drilling

Most of the exploratory drilling done in the past year was in the vicinity of old fields, following the work done in the year 1929.

The Union Natural Gas Company extended the Dawn field some distance into Euphemia township and pushed north with the De Clute field in Raleigh township, where two or three large producing wells were drilled by that company and the Highbank Oil Company. The wells of the old Oil Springs Oil and Gas Company at Oil Springs are being cleaned out and "shot," and production increased.

The Southern Ontario Company drilled a producing well in Mosa township, near North Newberry. The producing horizon is in the Grimsby sandstone (Red Medina). This is an unlooked-for extension of the Grimsby, which has not been heretofore recorded in any well within thirty miles eastward, where it is known to thin out and disappear.

The Norfolk and Haldimand fields have had a great deal of attention, and the number of new wells is more than usual. The Dominion Natural Gas Company led in these counties.

On the Tuscarora Indian Reserve the Ajax and Petrol Gas companies have drilled a number of producing wells. This Indian Reserve has all indications of holding a large reserve of gas for the future.

A well was begun in St. Vincent township, Grey county, but was closed down before the gas horizon was reached.

The year 1930 has been the most successful year on the basis of numbers of producing wells drilled since 1913. The number of feet drilled in 1930 was 232,940.

An example of the methods used to extend gas fields is to be found in the township of Middleton. A gas well was drilled by the Vacuum Gas and Oil Company in 1917 and has been producing continuously since that date. About five hundred feet distant another producing well was drilled by the Dominion Natural Gas Company. Following this, these and other companies drilled dry holes at all quarters of the compass, centred on these two producing wells, and the surrounding area was abandoned. The original rock pressure of these wells was 625 pounds, and the rock pressure in 1930 was 380 pounds.

The Vacuum well had produced one hundred million cubic feet of gas, and the open flow of the well had declined from 750 M cubic feet to 50 M cubic feet. It was the opinion of the Vacuum Company that this was a very much larger gas pool than was at first thought. The result of an enlarged drilling campaign in 1930 and the first half of 1931 has been 12 producing wells and 2 dry holes. The well drilled farthest from the original Vacuum Company well, about 3,630 feet distant, has a rock pressure of 495 pounds, which is 130 pounds less than the original well. The rock pressures of new wells and distances from the original well are as follows:—

Lbs.	Feet
385	630
410	1,290
425	2,185
435	2,930
495	3,630

This pressure is still 130 pounds less than the original pressure, and will indicate that the well has probably drained gas for a distance of a mile. It

must be said that in this instance the drainage has been in one direction only and the area very much restricted. However, it shows clearly that, where an area is first proved and the rock porous, drilling wells too close together is purely a waste of capital. The case in point shows that, even where an area has been abandoned, a careful study of "rock pressures" and "open flows" may indicate that an adjacent area is feeding a more restricted area.

Leakage

In the year 1921, when the natural gas industry was in a critical condition, the Ontario Government employed a natural gas engineer, Samuel S. Wyer, of Columbus, Ohio, to make a report and recommend the action to be taken in order that the remaining supply might be conserved. One of his recommendations (which were published in the report on natural gas in 1921) was that excessive leakage should be curtailed and that all gas should be measured. These recommendations were carried out, and the inspector of gas wells and lines made frequent tests to note progress. As a result of these tests, it became obvious that many plants were poorly designed and inadequate for the distribution of gas at low pressure. This was brought to the attention of the operating company and they were requested to remedy the matter.

In 1922, in the 17 distribution plants where leakage was measured, 251,845,000 cubic feet of gas was lost; 288,367,000 cubic feet of gas was lost in 1930 from 48 distributing plants. To get a basis for comparison, all sizes of pipe are figured at their equivalent length in 3-inch pipe. By comparing this mileage with the actual leakage it will be seen that the leakage remains practically constant, while the length of pipe is nearly trebled. On a basis of consumers, the leakage per consumer is reduced by 50 per cent. Table VI shows a comparison of the leakage in distribution plants from 1922 to 1930.

TABLE VI—LEAKAGE IN DISTRIBUTION PLANTS IN ONTARIO, 1922–1930

Year	Equivalent No. of miles of plants 3-inch pipe		Leakage		Average No. of consumers	Leakage per consumer	Average pressure, ounces per sq. in.	Percentage of leakage
			Actual	Allowable[1]				
			M cu. ft.	M cu. ft.		cu. ft.		
1922.....	17	461.87	251,845	92,374	24,839	10,139	5.31	11.41
1923.....	17	478.33	172,953	95,666	23,445	7,375	5.30	8.39
1924.....	31	734.53	226,758	146,906	36,099	6,281	5.65	6.15
1925.....	32	804.30	544,260	160,860	39,701	13,709	5.19	12.73
1926.....	37	808.39	305,921	161,778	40,190	7,611	5.35	7.13
1927.....	39	840.87	333,141	168,174	44,150	7,545	4.84	8.15
1928.....	42	873.97	346,717	174,794	47,428	7,310	4.90	7.53
1929.....	42	912.28	369,360	182,456	54,801	6,740	4.66	7.11
1930.....	48	1,247.84	288,367	249,568	54,372	5,304	4.71	5.62

[1]In good engineering practice it is considered that leakage of 200,000 cubic feet per mile of 3-inch pipe is allowable.

Transmission line leakage shows almost a parallel case. The 3-inch pipe equivalent shows the increase in pipe line capacity, whereas the percentage of leakage shows an improvement of nearly 50 per cent. in ten years (see Table VII).

TABLE VII—LEAKAGE IN TRANSMISSION LINES IN ONTARIO, 1922-1930

Year	No. of lines	Size of pipe lines	Equivalent miles of 3-inch pipe	Actual leakage	Average pressure on pipe lines, lbs. per sq. in.	Percentage of leakage
				M cu. ft.		
1922.....	6	.....	1,396.2	955,746	.....	16.60
1925.....	7	6- to 12-inch	1,397.4	432,728	12–120	8.17
1926.....	8	4- to 12-inch	1,402.1	534,324	5–120	8.01
1927.....	8	4- to 12-inch	1,403.3	573,144	12–120	10.45
1928.....	7	4- to 18-inch	1,519.04	394,805	25–100	6.86
1929.....	7	4- to 18-inch	1,589.63	578,962	25–100	8.78
1930.....	7	4- to 18-inch	1,700.19	413,619	25–100	7.09

The rural lines show the greatest improvement. Some shocking examples of lack of engineering advice were in evidence, especially in privately owned lines. By taking up many of these and relaying others with larger sized pipe, the improvements have been effected. In many lines the leakage has been reduced below that set as allowable in good engineering practice. The 10-year comparison is shown in Table VIII.

TABLE VIII—LEAKAGE ON RURAL LINES IN ONTARIO, 1922-1930

Year	No. of town-ships	No. of lines	Equivalent feet of 3-inch pipe	Leakage		Average No. of consumers	Leakage per consumer	Percent-age of leakage
				Actual	Allowable			
				M cu. ft.	M cu. ft.		cu. ft.	
1922.....	6	24	68,276	11,346	2,586	239	47,472	30.60
1923.....	11	102	585,655	69,476	22,184	2,114	32,864	14.33
1924.....	12	91	680,620	80,739	25,780	2,155	37,465	20.50
1925.....	14	81	502,631	64,285	19,039	1,748	36,776	23.03
1926.....	14	90	420,284	41,482	15,920	2,071	20,030	14.14
1927.....	15	90	558,295	51,692	21,147	2,275	22,721	17.98
1928.....	14	86	560,605	33,954	21,235	2,171	15,639	11.65
1929.....	11	76	545,486	17,313	20,663	1,886	9,180	7.09
1930.....	12	74	546,918	15,881	20,717	2,124	7,476	6.97

The annual tabulation of leakage in distributing plants, transmission lines, and rural lines is shown in Tables IX, X, and XI.

TABLE IX—LEAKAGE IN DISTRIBUTION PLANTS, 1930

Cities and towns	Company	Equivalent miles of 3-inch pipe in distribution plants	Volume received	Volume delivered	Leakage for year		Average No. of consumers	Leakage per consumer	Pressure distribution plants, ounces per sq. in.
					Actual	Allowable			
			M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.		cu. ft.	
Alvinston	Union Natural Gas Co	5.40	3,649	3,619	30	1,080	144	208	5
Belle River	Union Natural Gas Co	4.16	18,644	17,884	760	832	174	4,367	6
Belmont	Ontario Salt Co	1.67	8,531	3,022	5,509	334	70	78,700	6
Blenheim	Union Natural Gas Co	12.58	18,419	18,363	56	2,516	567	098	5
Bothwell	Union Natural Gas Co	5.30	3,603	2,892	711	1,060	107	6,645	5
Brantford	Brantford Gas Co	91.59	176,957	164,916	12,041	18,318	4,052	2,971	4
Brigden	Union Natural Gas Co	3.68	15,990	15,015	975	736	157	6,210	5
Cainsville	Dominion Natural Gas Co	5.23	26,460	25,907	553	1,046	132	4,189	4
Chatham	Union Natural Gas Co	78.93	532,775	526,342	6,433	15,786	4,115	1,563	6
Comber	Union Natural Gas Co	3.42	18,419	18,363	56	684	141	397	5
Courtright	Union Natural Gas Co	3.76	14,117	13,356	761	752	123	6,187	5
Dorchester	Southern Ontario Gas Co	2.86	9,902	9,020	882	572	111	7,946	4
Dresden	Union Natural Gas Co	12.55	55,744	55,464	280	2,510	498	562	5
Dundas	Dominion Natural Gas Co	12.27	74,311	70,222	4,089	2,454	1,161	3,521	4
Dunnville	Dominion Natural Gas Co	13 17	111,107	102,792	8,315	2,634	997	8,340	4
Fenwick	Dominion Natural Gas Co	1.37	6,874	6,383	491	274	99	4,959	4
Florence	Union Natural Gas Co	1.80	1,499	1,425	74	360	56	1,321	5
Galt	Dominion Natural Gas Co	30.69	75,137	66,858	8,279	6,138	1,034	8,016	4
Hagersville	Dominion Natural Gas Co	7.24	45,027	35,362	9,665	1,448	416	23,233	4
Ingersoll	Dominion Natural Gas Co	22.25	53,336	46,754	6,582	4,450	964	6,827	4
Inwood	Union Natural Gas Co	2.32	1,662	1,628	34	464	68	500	5
Kingsville	Southern Ontario Gas Co	14.71	103,251	96,566	6,685	2,942	698	9,577	4
Leamington	Leamington Corporation	25.47	228,181	202,055	26,126	5,094	1,465	17,883	10
Merlin	Union Natural Gas Co	2.78	20,132	19,352	780	556	147	5,306	6
Mount Hamilton	Dominion Natural Gas Co	23.44	74,787	57,788	16,999	4,688	2,500	6,799	4
Paris	Dominion Natural Gas Co	13.56	34,585	29,346	5,239	2,712	595	8,805	4
Petrolia	Union Natural Gas Co	16.22	93,993	85,034	8,959	3,244	745	12,025	6
Port Burwell	Dominion Natural Gas Co	3.84	7,575	5,952	1,623	768	148	10,662	4
Port Lambton	Union Natural Gas Co	1.94	6,716	6,268	448	388	70	6,400	5
Ridgetown	Union Natural Gas Co	18.16	77,608	70,262	7,346	3,632	645	11,389	5
St. Catharines	Dominion Natural Gas Co	53.38	308,622	280,202	28,420	10,676	4,734	6,003	4
St. George	Dominion Natural Gas Co	2.11	4,057	3,727	330	422	98	3,367	4
Sarnia	Union Natural Gas Co	95.05	405,045	371,820	33,225	19,010	4,583	7,249	5
Shedden-Fingal	Southern Ontario Gas Co	6.11	15,003	11,238	3,765	1,222	133	28,308	4

TABLE IX—LEAKAGE IN DISTRIBUTION PLANTS, 1930—*Continued*

Cities and towns	Company	Equivalent miles of 3-inch pipe in distribution plants	Volume received	Volume delivered	Leakage for year		Average No. of consumers	Leakage per consumer	Pressure distribution plants, ounces per sq. in.
					Actual	Allowable			
			M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.		cu. ft.	
Simcoe	Dominion Natural Gas Co	29.33	217,247	200,358	16,889	5,866	1,664	10,149	4
Sombra	Union Natural Gas Co	2.50	9,737	9,028	709	500	85	8,341	5
South London	Southern Ontario Gas Co	8.34	17,873	14,084	3,789	1,668	161	23,534	4
Straffordville	Dominion Natural Gas Co	1.34	7,717	7,161	556	268	80	6,950	4
Thamesville	Union Natural Gas Co	6.51	5,624	5,100	524	1,302	190	2,757	5
Thorold	Dominion Natural Gas Co	12.79	48,093	43,501	4,592	2,558	990	4,638	4
Tillsonburg	Dominion Natural Gas Co	23.15	91,828	83,541	8,287	4,630	1,003	8,262	4
Vienna	Dominion Natural Gas Co	1.04	1,601	1,440	161	208	19	8,473	4
Wallaceburg	Union Natural Gas Co	22.82	135,079	129,470	5,609	4,564	1,175	4,773	6
West Hamilton	Southern Ontario Gas Co	3.81	8,508	7,529	979	762	225	4,351	4
Wheatley	Southern Ontario Gas Co	3.61	26,626	23,859	2,767	722	242	11,433	4
Windsor	Union Natural Gas Co	480.88	1,802,822	1,776,413	26,409	96,176	14,779	1,786	5
Woodstock	Dominion Natural Gas Co	47.83	99,244	88,715	10,529	9,566	1,910	5,512	4
Wyoming	Union Natural Gas Co	4.88	2,366	2,320	46	976	102	450	5
Total			5,126,083	4,837,716	288,367				

TABLE X—LEAKAGE IN TRANSMISSION LINES, 1930

Transmission line	Size of pipe line	Equivalent miles of 3-in. pipe	Volume received	Volume delivered	Actual leakage	Average pressure on pipe lines
			M cu. ft.	M cu. ft.	M cu. ft.	lbs. per sq. in.
Dundas to Hamilton	6-inch	8.8	138,195	125,820	12,375	25
Gas field to Sarnia and Petrolia	6-, 8-, 10-, 12-in.	388.39	1,472,577	1,383,783	88,794	40–80
Dunnville to St. Catharines	8-inch	57.1	369,780	356,589	13,191	50
Kingsville to Hamilton	8-, 10-, 12-inch	710.5	1,524,633	1,316,897	207,736	85
Gas field to Windsor	8-, 10-, 12-, 18-in.	422.9	2,042,142	1,982,225	59,917	30–100
Gas field to Ridgetown	6-, 8-inch	81.08	267,759	237,493	30,266	30–80
Gas field to Bothwell	4-, 6-inch	31.42	12,684	11,344	1,340	30–50
Total			5,827,770	5,414,151	413,619	

TABLE XI—LEAKAGE ON RURAL LINES, 1930

Township	Equivalent feet of 3-inch pipe in all rural lines	Volume received	Volume delivered	Leakage for year		Average No. of consumers	Leakage per consumer	Average pressure on pipe lines	
				Actual	Allowable			Low pressure	High pressure
		M cu. ft.	M cu. ft.	M cu. ft.	M cu. ft.		cu. ft.	ozs.	lbs.
Chatham	7,450	5,314	5,278	36	283	52	692	5	.....
Dover	100,910	43,628	40,431	3,197	3,822	368	8,687	6	7
Enniskillen	16,394	3,556	3,380	176	621	39	4,513	6	.....
Harwich	100,370	37,565	35,502	2,063	3,800	390	5,289	5	5
Howard	17,770	10,688	9,943	745	673	97	7,680	5	4
Moore	38,819	13,566	12,386	1,180	1,471	218	5,412	6	.....
Raleigh	139,713	47,937	45,234	2,703	5,293	381	7,094	6	5
Raleigh (Blake system)	23,126	5,937	3,774	2,163	876	79	27,379	4	20
Rochester	34,180	20,475	19,990	485	1,296	186	2,607	5	16
Sandwich, East	1,432	1,153	1,081	72	54	14	5,142	5	4
Sandwich, South	8,667	7,931	7,402	529	328	77	6,870	5	6
Sombra	1,929	881	861	20	73	10	2,000	6	.....
Tilbury, East	56,158	28,942	26,430	2,512	2,127	213	11,793	6	5
Total	546,918	227,573	211,692	15,881	20,717	2,124	.....	.....	.....

Licenses Issued in 1930

The Natural Gas Conservation Act, 1921, and the Well Drillers' Act, 1925, provide that all operations connected with natural gas and the drilling of oil wells shall be carried on under license. Tables XII, XIII, XIV, XV, and XVI list the names of those to whom these licenses were issued in 1930.

TABLE XII—OPERATORS LICENSED TO LEASE AND PROSPECT FOR NATURAL GAS, 1930

License No.	Name	Address
353	Acme Gas and Oil Co., Ltd	Toronto, Ont.
337	Ajax Oil and Gas Co., Ltd	Toronto, Ont.
359	American Engineering Co., Ltd	Chatham, Ont.
343	Annett, Stan. C	Chatham, Ont.
352	Baker, John	Buckingham, Que.
373	Blain, Dr. E. B	Hamilton, Ont.
374	Brighton, Percy Lawrence	London, Ont.
427	Burdick, Lyle D	Hamilton, Ont.
379	Cameron, J. A	Toronto, Ont.
430	Carter, Lawrence	Brantford, Ont.
356	Central Development Co., Ltd	Chatham, Ont.
497	Central Oil Co., Ltd	Waterloo, Ont.
334	Cherry, Robert	Collingwood, Ont.
381	Clive, George	Chatham, Ont.
392	Comfort, Alex	Blackheath, Ont.
421	Cooper, E. J	Burlington, Ont.
423	Cowley, H. H	Port Colborne, Ont.
428	Culver, Gordon	Simcoe, Ont.
405	Culver, Rupert	Dunnville, Ont.
408	Davies, Jos. R	Buffalo, N.Y.
348	Dodd, J. G	Haileybury, Ont.
335	Dominion Natural Gas Co., Ltd	Buffalo, N.Y.
346	Doran, Benj	Meaford, Ont.
377	Ellwood, John	Chatham, Ont.
429	Fischer, E. F	Dunnville, Ont.
416	Flood, William	Brantford, Ont.
351	Flynn, E. Miles	Toronto, Ont.
354	Freeman, George	Toronto, Ont.
342	Geddes, Earl W	Chatham, Ont.
369	Gillies, Arthur	Selkirk, Ont.
338	Glenn, S. J	Long Branch, Ont.
368	Gray, Ira	Merlin, Ont.
418	Greenwood, J. W	Ingersoll, Ont.
372	Gregory, F. R	Petrolia, Ont.
410	Grierson, Andrew	Toronto, Ont.
387	Hoover, A. E	Selkirk, Ont.
365	Hottinger, E. C	Toronto, Ont.
370	Howard, W. C	Leamington, Ont.
411	Hurst, Clifford	Simcoe, Ont.
434	Hussey, W. J	Petrolia, Ont.
375	Industrial Natural Gas Co., Ltd	Port Robinson, Ont.
420	Ironside, E. H	Hamilton, Ont.
394	James, Francis Leigh	Tillsonburg, Ont.
361	Jasperson, Bon	Kingsville, Ont.
339	Joyce, Joseph	Chatham, Ont.
390	Kohler, Jacob	Cayuga, Ont.
431	Lambier, Chas. Nelson	Echo Place, Ont.
412	Leitch, W. S	Brantford, Ont.
407	Lewis, James R	Buffalo, N.Y.
395	Lewis, Wm. J	Brantford, Ont
371	Lynch, Jas. B	Batavia, N.Y.
435	MacPherson, G. A	Toronto, Ont.
400	McChesney, Jas. G	Selkirk, Ont.
376	McCrimmon, J. E	Brantford, Ont.

TABLE XII—OPERATORS LICENSED TO LEASE AND PROSPECT FOR NATURAL GAS, 1930—*Continued*

License No.	Name	Address
347	McGill, Joseph	Petrolia, Ont.
414	McMillan, R. R.	Brantford, Ont.
397	McNinch, S. E.	Canborough, Ont.
382	Mahaffy, A. M.	Toronto, Ont.
388	Mehlenbacher, L. B.	Cayuga, Ont.
349	Messer, Julius	Kirkland Lake, Ont.
396	Miller, R. F.	Selkirk, Ont.
424	Murdock, J. T.	St. Catharines, Ont.
425	Naylor, A. G.	St. Catharines, Ont.
341	Neath, Charles	Chatham, Ont.
345	Newton, Roy	Sarnia, Ont.
350	Norrington, R. W.	Toronto, Ont.
422	O'Brien, W. L.	Hamilton, Ont.
355	Patterson, W. C.	Jamestown, N.Y.
360	Pattinson, R. L.	Chatham, Ont.
419	Penfold, A. G.	Hamilton, Ont.
384	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.
358	Pure Gas and Oil Co., Ltd	Chatham, Ont.
404	Rahn, Clayton	Dunnville, Ont.
386	Raven, Christopher	Chatham, Ont.
340	Robinson, Henry	Chatham, Ont.
380	Rodgers, Alex	Tillsonburg, Ont.
385	Schier, Frank	Stevensville, Ont.
433	Shanahan, M. J.	Buffalo, N. Y.
406	Simpson, Charles	Simcoe, Ont.
409	Smith, C. E. J.	London, Ont.
363	Smith, Harry B	Windsor, Ont.
366	Smith, Dr. Luke	Oakville, Ont.
398	Smith, R. H.	Lowbanks, Ont.
393	Smiley, Thomas	Blackheath, Ont.
417	Snell, R. U.	Woodstock, Ont.
336	Southern Ontario Gas Co., Ltd	Buffalo, N.Y.
364	Stephens, Hugh	Aylmer, Ont.
399	Stover, F. C.	Chatham, Ont.
402	Sullivan, Geo. F.	Sarnia, Ont.
367	Thomson, W. Grant	Chatham, Ont.
391	Topp, Nathan	Cayuga, Ont.
357	United Development Co., Ltd	Chatham, Ont.
413	Vanderlip, W. J.	Brantford, Ont.
344	Vidler, Walter R.	Toronto, Ont.
415	Wallis, E. C.	Brantford, Ont.
378	Walter, H. A.	Buffalo, N.Y.
362	Welland County Gas Syndicate	Stevensville, Ont.
432	Westman, W. H.	Chatham, Ont.
426	Whittaker, John	Leamington, Ont.
401	Wilson, Leo	Sarnia, Ont.
389	Winger, S. W.	Hagersville, Ont.
403	Wood, J. George	Tillsonburg, Ont.

TABLE XIII—OPERATORS LICENSED TO DRILL OR BORE FOR NATURAL GAS, 1930

License No.	Name	Address
353	Baker, John	Buckingham, Que.
423	Cherry, Robert	Collingwood, Ont.
329	Culver and Bloomfield	Dunnville, Ont.
356	Erie Gas and Oil Syndicate	Fisherville, Ont.
399	Francis, Mrs. M. E	Bothwell, Ont.
326	Gregory, G. F	Petrolia, Ont.
357	Hoover, A. E	Selkirk, Ont.
358	Hoover, A. E	Selkirk, Ont.
359	Hoover, A. E	Selkirk, Ont.
373	Hoover, A. E	Selkirk, Ont.
410	Hussey, W. J	Petrolia, Ont.
363	Industrial Natural Gas Co., Ltd	Port Robinson, Ont.
367	Jackson, Percy L	Dunnville, Ont.
337	Jasperson, Bon	Kingsville, Ont.
370	Josh, Thomas	Petrolia, Ont.
413	Kervin and Dawson	Merlin, Ont.
339	Kiser Bros	Chatham, Ont.
340	Kiser Bros	Chatham, Ont.
341	Kiser Bros	Chatham, Ont.
342	Kiser Bros	Chatham, Ont.
352	Lauer, D. G	Tillsonburg, Ont.
387	Lauer, D. G	Tillsonburg, Ont.
343	Lentz and Miller	Muskegon, Ont.
330	Lymburner Bros. and Webber	Dunnville, Ont.
333	McCutcheon, Thos. J	Dunnville, Ont.
334	McCutcheon, Thos. J	Dunnville, Ont.
335	McCutcheon, Thos. J	Dunnville, Ont.
336	McCutcheon, Thos. J	Dunnville, Ont.
368	McKechnie, Sam	Dunnville, Ont.
369	McKechnie, Sam	Dunnville, Ont.
349	McKillop, Wm	Brantford, Ont.
338	McLister, J. J	Dunnville, Ont.
424	Mason, Chester F	Courtright, Ont.
365	Pattinson, R. L	Chatham, Ont.
366	Pattinson, R. L	Chatham, Ont.
362	Penn-Ryan Oil and Gas, Ltd	Toronto, Ont.
364	Penn-Ryan Oil and Gas, Ltd	Toronto, Ont.
332	Perkins, J. E	Dunnville, Ont.
372	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.
419	Randall, A. E	Onondaga, Ont.
420	Randall, A. E	Onondaga, Ont.
344	Schafer and Benner	Delhi, Ont.
331	Seynuck, Tony	Acton, Ont.
360	Smith, Harry B	Windsor, Ont.
345	Stover, F. H., and Son	Chatham, Ont.
346	Stover, F. H., and Son	Chatham, Ont.
347	Stover, F. H., and Son	Chatham, Ont.
348	Stover, F. H., and Son	Chatham, Ont.
355	Sundy, Basil K	Selkirk, Ont.
351	Wicks, Frank	Sarnia, Ont.
402	Willits, G. E	Bothwell, Ont.
361	Wilson, Anthony	Thornhill, Ont.

TABLE XIV—OPERATORS LICENSED TO PRODUCE NATURAL GAS, 1930

License No.	Name	Address
498	Acme Gas and Oil Co., Ltd	Toronto, Ont.
448	Ajax Oil and Gas Co., Ltd	Toronto, Ont.
511	American Engineering Co., Ltd	Chatham, Ont.
493	Canboro Gas and Oil Co., Ltd	Cayuga, Ont.
500	Canfield Natural Gas Co	Canfield, Ont.
459	Central Pipe Line Co., Ltd	Chatham, Ont.
496	Cliff Gas Co., Ltd	Rochester, N.Y.
461	Coleman, J. A	Wellandport, Ont.
446	Dominion Natural Gas Co., Ltd	Buffalo, N.Y.
455	Dunn Natural Gas Co	Dunnville, Ont.
490	Enterprise Gas Co	Cayuga, Ont.
463	Erie Gas and Oil Syndicate	Fisherville, Ont.
462	Fisherville Gas Co	Fisherville, Ont.
509	Gifford, Arthur, and Son	Cayuga, Ont.
502	Grimsby Natural Gas Co., Ltd	Ridgway, Pa.
464	Haldimand Gas Fields Syndicate	Cayuga, Ont.
469	Industrial Natural Gas Co., Ltd	Port Robinson, Ont.
450	Jasperson, Bon	Kingsville, Ont.
504	Lincoln Gas Co., Ltd	Toronto, Ont.
467	Midfield Natural Gas Co., Ltd	Hamilton, Ont.
465	Niece, Hosea, and Son	Lowbanks, Ont.
449	Oil Springs Oil and Gas Co., Ltd	Oil Springs, Ont.
458	Patterson, W. C	Jamestown, N.Y.
454	Petrol Oil and Gas Co., Ltd	Toronto, Ont.
471	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.
451	Provincial Natural Gas Co	Niagara Falls, Ont.
456	Rainham Gas and Oil Syndicate	Fisherville, Ont.
491	Seneca Gas Syndicate	Cayuga, Ont.
515	Smith, Robt. H	Lowbanks, Ont.
476	Smith Oil and Gas Syndicate	Windsor, Ont.
473	South Cayuga Gas Syndicate	Cayuga, Ont.
447	Southern Ontario Gas Co., Ltd	Buffalo, N.Y.
468	Springvale Gas and Oil Co., Ltd	Hagersville, Ont.
460	Stevensville Natural Gas and Fuel Co	Stevensville, Ont.
475	Stony Creek Gas and Oil Syndicate	Selkirk, Ont.
452	Union Natural Gas Co., Ltd	Chatham, Ont.
506	Vacuum Gas and Oil Co., Ltd	Toronto, Ont.
453	Yager, J. J	Selkirk, Ont.

TABLE XV—OPERATORS LICENSED TO DISTRIBUTE NATURAL GAS, 1930

License No.	Name	Address
353	Brantford Gas Co	Buffalo, N.Y.
368	Central Pipe Line Co., Ltd	Chatham, Ont.
361	Chatham Gas Co., Ltd	Chatham, Ont.
369	Coleman, J. A	Wellandport, Ont.
352	Dominion Natural Gas Co., Ltd	Buffalo, N.Y.
370	Fisherville Gas Co	Fisherville, Ont.
366	Grimsby Natural Gas Co., Ltd	Grimsby, Ont.
372	Industrial Natural Gas Co., Ltd	Port Robinson, Ont.
367	Lake Shore Natural Gas Co., Ltd	Fort Erie, Ont.
357	Leamington, Town of	Leamington, Ont.
354	Manufacturers Natural Gas Co., Ltd	Buffalo, N.Y.
394	Midfield Natural Gas Co., Ltd	Hamilton, Ont.
356	Oil Springs Oil and Gas Co., Ltd	Oil Springs, Ont.
386	Ontario Salt Co., Ltd	Hamilton, Ont.
374	Port Colborne–Welland Natural Gas and Oil Co., Ltd	Port Colborne, Ont.

TABLE XV—OPERATORS LICENSED TO DISTRIBUTE NATURAL GAS, 1930—*Continued*

License No.	Name	Address
358	Provincial Natural Gas Co	Niagara Falls, Ont.
355	Southern Ontario Gas Co., Ltd	Buffalo, N.Y.
371	Springvale Gas and Oil Co., Ltd	Hagersville, Ont.
359	Union Natural Gas Co., Ltd	Chatham, Ont.
360	Windsor Gas Co., Ltd	Windsor, Ont.

TABLE XVI—OPERATORS LICENSED TO OPERATE PIPE LINES, 1930

License No.	Name	Address
81	Central Pipe Line Co., Ltd	Chatham, Ont.
78	Dominion Natural Gas Co., Ltd	Buffalo, N.Y.
79	Southern Ontario Gas Co., Ltd	Buffalo, N.Y.
80	Union Natural Gas Co., Ltd	Chatham, Ont.

Logs of Wells

The logs of oil and gas wells drilled in Ontario in 1930 are given on the pages following. They show the formation, total depth, and occurrences of gas, oil, and water as reported by the drillers.

These logs are on file in the office of the Natural Gas Commissioner, and they give the length of casing used as well as other information regarding the texture of formations. In many cases samples of drill cuttings are available to the public. The source of the information for the logs that follow is the company or person whose name appears at the top of each log.

ABBREVIATIONS

Tp	Township.
Con	Concession.
Pt	Part.
E. ½	East half.
N. ½	North half.
N	North.
S.E	Southeast.
B.F	Broken Front.
E.P.R	East of Plank Road.
E.S.C.R	East of Stoney Creek Road.
M.I.R	Moravian Indian Reserve.
N.T.R	North of Talbot Road.
R.R	River Range.
S.L.R	South of Longwoods Road.
S.T.R	South of Talbot Road.
T.R	Talbot Road.
W.F.C	West of Fairchilds Creek.
W.S.C.R	West of Stoney Creek Road.

Brant County

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 30, con. II, W.F.C., Onondaga tp.

Completed December 20, 1930.
Open flow: 75,000 cu. ft.
Rock pressure: 132 lbs.

Formation	Thickness, ft.
Surface	90
Shale	26
Niagara	251
Shale	47
Clinton	24
Red Medina	20
Grey shale	60
White Medina	11
Red shale	35
Total depth	564

Gas at 417, 426, and 522 feet.
Water at 91 and 110 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 54, R.R., Onondaga tp.

Completed October 16, 1930.
Open flow: 190,000 cu. ft.
Rock pressure: 155 lbs.

Formation	Thickness, ft.
Surface	49
Salina	20
Guelph and Niagara	256
Rochester	49
Clinton	26
Red Medina	16
Cabot Head	57
White Medina	17
Queenston	50
Total depth	540

Gas at 374 and 483 feet.
Water at 49 and 330 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 53, R.R., Onondaga tp.

Completed November 1, 1930.
Open flow: 53,280 cu. ft.
Rock pressure: 145 lbs.

Formation	Thickness, ft.
Surface	50
Salina	30
Guelph and Niagara	245
Rochester	45
Clinton	17
Red Medina	22
Cabot Head	59
White Medina	22
Queenston	60
Total depth	550

Gas at 372 and 486 feet.
Water at 50 and 331 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 53, R.R., Onondaga tp.

Completed November 20, 1930.
Open flow: 101,500 cu. ft.
Rock pressure: 145 lbs.

Formation	Thickness, ft.
Surface	47
Salina	39
Guelph and Niagara	234
Rochester	54
Clinton	24
Red Medina	17
Cabot Head	65
White Medina	12
Queenston	51
Total depth	543

Gas at 374 and 486 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 49, R.R., Onondaga tp.

Completed December 7, 1930.
Open flow: 53,280 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	40
Salina	40
Guelph and Niagara	247
Rochester	44
Clinton	19
Red Medina	22
Cabot Head	58
White Medina	23
Queenston	50
Total depth	543

Gas at 373 and 484 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 48, R.R., Tuscarora tp.

Completed August 25, 1929.
Open flow: 71,000 cu. ft.

Formation	Thickness, ft.
Clay	74
Salina	15
Guelph and Niagara	246
Rochester	43
Clinton	14
Red Medina	20
Cabot Head	76
White Medina	24
Queenston	103
Total depth	615

Gas at 493 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 48, R.R., Tuscarora tp.

Completed July 25, 1929.
Open flow: 82,680 cu. ft.

Formation	Thickness, ft.
Clay	139
Salina	15
Guelph and Niagara	246
Rochester	49
Clinton	30
Red Medina	16
Cabot Head	10
White Medina	60
Queenston	110
Total depth	675

Gas at 395, 510, and 523 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 48, R.R. Tuscarora tp.

Completed November 27, 1930.
Open flow: 92,160 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Clay	119
Salina	15
Guelph and Niagara	246
Rochester	35
Clinton	25
Red Medina	15
Cabot Head	55
White Medina	25
Queenston	105
Total depth	640

Gas at 416 and 525 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 46, R.R., Tuscarora tp.

Completed January 17, 1929.
Open flow: 63,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Sand	20
Clay	52
Salina	15
Guelph and Niagara	256
Rochester	55
Clinton	23
Red Medina	20
Cabot Head	63
White Medina	18
Queenston	101
Total depth	623

Gas at 398, 504, and 540 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 48, R.R., Tuscarora tp.

Completed August 22, 1929.
Dry hole.

Formation	Thickness, ft.
Clay	88
Salina	15
Guelph and Niagara	260
Rochester	57
Clinton	30
Red Medina	17
Cabot Head	58
White Medina	29
Queenston	108
Total depth	662

Gas at 422 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 45, R.R., Tuscarora tp.

Completed January 30, 1930.
Open flow: 33,600 cu. ft.
Rock pressure: 135 lbs.

Formation	Thickness, ft.
Sand	18
Clay	46
Salina	15
Guelph and Niagara	259
Rochester	55
Clinton	21
Red Medina	20
Manitoulin	65
White Medina	18
Queenston	99
Total depth	616

Gas at 395 feet.
Water at 64 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 40, R.R., Tuscarora tp.

Completed June 18, 1930.
Open flow: 89,920 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Clay	69
Salina	20
Guelph and Niagara	256
Rochester	45
Clinton	20
Red Medina	20
Cabot Head	65
White Medina	20
Queenston	58
Total depth	573

Gas at 390, 500, and 525 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 48, R.R., Tuscarora tp.

Completed June 18, 1930.
Open flow: 50,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Sand	15
Clay	75
Salina	5
Guelph and Niagara	253
Rochester	52
Clinton	21
Red Medina	20
Cabot Head	61
White Medina	20
Queenston	51
Total depth	573

Gas at 400 and 507 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 38, R.R., Tuscarora tp.

Completed July 11, 1930.
Open flow: 150,000 cu. ft.
Rock pressure: 140 lbs.

Formation	Thickness, ft.
Clay	63
Salina	15
Guelph and Niagara	257
Rochester	55
Clinton	20
Red Medina	30
Cabot Head	45
White Medina	21
Queenston	53
Total depth	559

Gas at 393 and 505 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 48, R.R., Tuscarora tp.

Completed October 14, 1930.
Open flow: 4,331 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	64
Salina	15
Guelph and Niagara	242
Rochester	36
Clinton	33
Red Medina	25
Cabot Head	44
White Medina	26
Queenston	50
Total depth	535

Gas at 358 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 37, R.R., Tuscarora tp.

Completed September 16, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	101
Salina	24
Guelph and Niagara	265
Rochester	50
Clinton	30
Red Medina	12
Cabot Head	53
White Medina	25
Queenston	50
Total depth	610

PETROL OIL AND GAS CO., TORONTO
Lot 24, con. V, Tuscarora tp.

Completed November 29, 1930.
Open flow: 70,500 cu. ft.

Formation	Thickness, ft.
Surface	86
Salina	83
Guelph and Niagara	248
Rochester	49
Clinton	22
Red Medina	20
Cabot Head	52
White Medina	15
Queenston	64
Total depth	639

Gas at 466 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 24, con. V, Tuscarora tp.

Completed December 17, 1930.
Open flow: 16,849 cu. ft.
Rock pressure: 205 lbs.

Formation	Thickness, ft.
Surface	75
Salina	73
Guelph and Niagara	265
Rochester	31
Clinton	22
Red Medina	20
Cabot Head	50
White Medina	24
Total depth	560

Queenston at 560 feet.
Gas at 446 feet.

Dundas County

MRS. SARAH ARMSTRONG, CHESTERVILLE
Lots 4 and 5, con. VII, Williamsburgh tp.

Completed 1912.
Open flow: Strong.
Small flow in 1930.

Formation	Thickness, ft.
Trenton limestone	130
Total depth	130

Gas at 130 feet.
Water at 130 feet.

WALTER CARR, CHESTERVILLE
Lot 6, con. VII, Williamsburgh tp.

Completed 1913.
Open flow: Strong.
Small flow in 1930.

Formation	Thickness, ft.
Trenton limestone	120
Total depth	120

Gas at 100 feet.
Water at 100 feet.

Elgin County

WESTERN PENINSULA OIL AND GAS CO., PORT BRUCE
Lot 5, con. I, Malahide tp.

Completed May 28, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	146
Hardpan	11
Soapstone	10
Top rock	6
Lower lime	127
Total depth	300

Show of oil at 235 to 247 feet.
Water at 145 feet.

WESTERN PENINSULA OIL AND GAS CO., PORT BRUCE
Lot 5, con. I, Malahide tp.

Completed November 28, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	175
Clay and hardpan	125
Hardpan	6
Total depth	306

WESTERN PENINSULA OIL AND GAS CO., PORT BRUCE
Lot 5, con. I, Malahide tp.

Completed July 12, 1930.
Dry hole.

Formation	Thickness, ft.
Surface clay	197
Hardpan	8
Soapstone	12
Top rock	6
Corniferous lime	82
Total depth	305

Oil and gas at 57 feet.

Essex County

CANADIAN STEEL CORP., OJIBWAY
Lot 29, con. I, Anderdon tp.

Commenced June 10, 1914.
Dry hole.

Formation	Thickness, ft.
Surface	48
Limestone	152
White sandstone	70
Limestone	49
White sandstone	10
Limestone	246
Light soft limestone with gypsum	15
Dark limestone with bands of gypsum	404
Salt	101
Salt and limestone	100
Brown and grey limestone	90
Limestone and gypsum	53
Brown limestone	22
White crystal limestone	12
Brown limestone	16
Total depth	1,388

Water at 1,360 feet.

CANADIAN STEEL CORP., OJIBWAY
Lot 7, con. I, Anderdon tp.

Completed 1914.
Dry hole.

Formation	Thickness, ft.
Surface	11
Brown and grey lime	97
White sandstone	25
Brown and grey lime	199
White sandstone	66
Grey limestone	23
White sandstone	10
Brown and grey lime	262
Dark calcareous shale with gypsum	18
Light-grey limestone with gypsum	529
Limestone	160
Fine "sandy" limestone	210
Grey limestone	24
Slate (Rochester)	11
Red shale (Cabot Head)	13
Manitoulin (Slate	62
Manitoulin (Limestone and shale	70
Red shale (Queenston)	97
Dark-grey shale and limestone	505
Trenton limestone	174
Total depth	2,566

Show of gas at 1,450 feet.
Show of oil at 2,396 and 2,494 feet.
Salt water at 1,291, 1,325, 1,350, 2,445, 2,530, and 2,566 feet.
Gypsum beds at 502, 520, 570, 628, and 633 feet.

OLGA GAS AND OIL CO. (COMMUNITY WELL), TORONTO
Lot 32, con. I, Gosfield South tp.

Completed April 8, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	850
Lime	90
Lime	120
Niagara lime (hard)	245
Shale	95
Red and grey shale	485
Grey shale	80
Brown shale	210
Trenton (hard and dark)	428
Total depth	2,603

CANADIAN STEEL CORP., OJIBWAY
Lot 10, con. I, Sandwich West tp.

Commenced June 20, 1914.
Dry hole.

Formation	Thickness, ft.
Surface	58
Limestone	129
White sandstone	130
Limestone	65
White sandstone	8
Limestone	200
Gypsum	5
Grey limestone with gypsum at points	165
Total depth	760

CANADIAN SALT CO., SANDWICH
City of Sandwich.

Completed 1930.
Dry hole.

Formation	Thickness, ft.
Surface	90
Limestone	355
White sandstone	65
Lime	30
Sandstone	5
Lime	10
Sandstone	45
Limestone	125
Dark lime	35
Blue lime	220
Salt	20
Salt and lime	110
Brown lime	260
Salt	130
Lime	10
Salt	82
Grey lime	8
Total depth	1,600

Haldimand County

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 8, con. I, Canborough tp.

Completed November 19, 1930.
Open flow: 28,000 cu. ft.
Rock pressure: 154 lbs.

Formation	Thickness, ft.
Surface	73
Lime and shale	60
Niagara	227
Guelph	20
Shale	25
Clinton	30
Red Medina	32
Grey shale	60
White Medina	13
Big red	35
Total depth	575

Gas at 425, 450, and 532 feet.
Water at 75 and 275 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 4, con. I, Dunn tp.

Completed July 8, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	35
Flint	30
Lime and shale	375
Niagara	225
Shale	58
Clinton rock	28
Red Medina	40
Grey shale	55
White Medina	14
Red shale	1
Total depth	861

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 4, con. I, Dunn tp.

Completed August 14, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	35
Flint	40
Lime and shale	346
Niagara	225
Shale	58
Clinton rock	30
Red Medina	40
Grey shale	55
White Medina	18
Red shale	3
Total depth	850

W. C. PATTERSON, JAMESTOWN, N.Y.
Lots 3 and 4, con. II and III, Dunn tp.

Completed January 18, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	51
Lime and shale	259
Niagara	225
Shale	55
Clinton rock	35
Red Medina	40
Grey shale	55
White Medina	15
Red shale	3
Total depth	738

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 3, con. I, Dunn tp.

Completed June 4, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	34
Flint	30
Lime and shale	366
Niagara	225
Shale	58
Clinton rock	30
Red Medina	43
Grey shale	55
White Medina	15
Red shale	3
Total depth	859

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 6, con. I, north of Dover road, Dunn tp.

Completed November 15, 1930.
Open flow: 60,000 cu. ft.

Formation	Thickness, ft.
Surface	86
Lime and shale	254
Niagara	225
Shale	55
Clinton rock	30
Red Medina	40
Grey shale	51
White Medina	14
Red shale	26
Total depth	781

Gas at 622, 660, and 746 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 8, second range from Grand River, Moulton tp.
Completed December 30, 1930.
Open flow: 15,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Surface	98
Lime and shale	236
Niagara	230
Shale	55
Clinton	25
Red Medina	41
Grey shale	50
White Medina	20
Red shale	27
Total depth	782

Gas at 621 and 750 feet.
Water at 100, 160, and 400 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 24, con. I, North Cayuga tp.
Completed January 31, 1929.
Open flow: 285,000 cu. ft.
Rock pressure: 265 lbs.

Formation	Thickness, ft.
Surface	41
Lime and shale	249
Niagara	225
Shale	53
Clinton rock	27
Red Medina	40
Grey shale	55
White Medina	16
Red shale	30
Total depth	736

Gas at 575 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 25, con. I, North Cayuga tp.
Completed February 27, 1929.
Open flow: 225,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	40
Lime and shale	257
Niagara	225
Shale	53
Clinton rock	30
Red Medina	40
Grey shale	55
White Medina	12
Red shale	31
Total depth	743

Gas at 583 and 605 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 25, con. I, North Cayuga tp.
Completed March 19, 1929.
Open flow: 260,000 cu. ft.
Rock pressure: 245 lbs.

Formation	Thickness, ft.
Surface	47
Lime and shale	243
Niagara	230
Shale	53
Clinton rock	27
Red Medina	40
Grey shale	53
White Medina	12
Red shale	14
Total depth	719

Gas at 583 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 13, con. I, North Cayuga tp.
Completed May 25, 1929.
Open flow: 60,000 cu. ft.
Rock pressure: 300 lbs.

Formation	Thickness, ft.
Surface	53
Lime and shale	209
Niagara	225
Shale	50
Clinton rock	27
Red Medina	38
Grey shale	55
White Medina	18
Red shale	102
Total depth	777

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 15, con. I, North Cayuga tp.
Completed July 23, 1929.
Open flow: 65,000 cu. ft.
Rock pressure: 258 lbs.

Formation	Thickness, ft.
Surface	60
Lime and shale	204
Niagara	230
Shale	50
Clinton rock	27
Red Medina	38
Grey shale	55
White Medina	18
Red shale	119
Total depth	801

Gas at 579 and 676 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 19, E. ½ of N. ½, con. I, North Cayuga tp.
Completed November 4, 1929.
Open flow: 60,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	45
Lime and shale	203
Niagara	230
Shale	49
Clinton rock	27
Red Medina	38
Grey shale	52
White Medina	18
Red shale	123
Total depth	785

Gas at 564, 587, and 659 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 18, con. I, North Cayuga tp.
Completed October 10, 1929.
Open flow: 106,000 cu. ft.
Rock pressure: 275 lbs.

Formation	Thickness, ft.
Surface	54
Lime and shale	204
Niagara	230
Shale	50
Clinton rock	27
Red Medina	38
Grey shale	51
White Medina	18
Red shale	123
Total depth	795

Gas at 563 and 669 feet.

W. C. Patterson, Jamestown, N.Y.
Lot 18, N. ½, con. I, North Cayuga tp.

Completed December 18, 1929.
Open flow: 116,000 cu. ft.
Rock pressure: 345 lbs.

Formation	Thickness, ft.
Surface	66
Lime and shale	205
Niagara	230
Shale	50
Clinton rock	27
Red Medina	38
Grey shale	55
White Medina	18
Red shale	27
Total depth	716

Gas at 576 and 593 feet.

W. C. Patterson, Jamestown, N.Y.
Lot 20, con. I, North Cayuga tp.

Completed January 3, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	73
Lime and shale	216
Niagara	225
Shale	50
Clinton rock	27
Red Medina	40
Grey shale	53
White Medina	18
Red shale	3
Total depth	705

W. C. Patterson, Jamestown, N.Y.
Lot 13, con. I, North Cayuga tp.

Completed June 27, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	46
Lime and shale	199
Niagara	230
Shale	55
Clinton rock	27
Red Medina	38
Grey shale	55
White Medina	18
Red shale	3
Total depth	671

W. C. Patterson, Jamestown, N.Y.
Lot 16, con. I, North Cayuga tp.

Completed August 17, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	63
Lime and shale	204
Niagara	230
Shale	50
Clinton rock	27
Red Medina	38
Grey shale	55
White Medina	18
Red shale	5
Total depth	690

W. C. Patterson, Jamestown, N.Y.
Lot 12, con. I, North Cayuga tp.

Completed November 23, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	40
Lime and shale	202
Niagara	230
Shale	50
Clinton rock	28
Red Medina	40
Grey shale	55
White Medina	18
Red shale	5
Total depth	668

Union Natural Gas Co., Chatham
Lot 28, Jones tract, North Cayuga tp.

Completed December 18, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	26
Flint	60
Lime and shale	367
Niagara	240
Casing shale	38
Clinton	29
Red Medina sand	30
Red Medina shale	7
Grey shale	50
White Medina	16
Red shale	6
Total depth	869

Gas at 795 feet.
Sulphur water at 65 feet.

W. C. Patterson, Jamestown, N.Y.
Lot 19, E. ½ of N. ½, con. I, North Cayuga tp.

Completed September 10, 1929.
Open flow: 38,000 cu. ft.
Rock pressure: 245 lbs.

Formation	Thickness, ft.
Surface	50
Lime and shale	210
Niagara	230
Shale	50
Clinton rock	27
Red Medina	38
Grey shale	51
White Medina	18
Red shale	100
Total depth	774

Gas at 658 feet.

Dominion Natural Gas Co., Dunnville
Lot 28, con. I, S.T.R., North Cayuga tp.

Completed November 28, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	56
Lime and shale	248
Niagara	225
Shale	50
Clinton	27
Red Medina	40
Grey shale	51
White Medina	20
Red shale	3
Total depth	720

Water at 60 and 335 feet.

Dominion Natural Gas Co., Dunnville
Lot 24, con. I, North Cayuga tp.

Completed December 22, 1930.
Open flow: 76,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Surface	41
Lime and shale	250
Niagara	230
Shale	50
Clinton	30
Red Medina	40
Grey shale	50
White Medina	13
Red shale	4
Total depth	708

Gas at 577 feet.
Water at 80 and 350 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 8, con. I, S.T.R., North Cayuga tp.
Completed November 22, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	43
Lime and shale	210
Niagara	225
Shale	30
Clinton	32
Red Medina	37
Grey shale	53
White Medina	18
Red shale	3
Total depth	681

Gas at 675 feet.
Water at 48 and 260 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 3, Jones tract, North Cayuga tp.
Completed November 21, 1930.
Dry hole.

Formation	Thickness ft.
Surface	15
Lime and shell rock	123
Lime and shale	254
Niagara	220
Blue shale	53
Clinton	29
Red Medina	42
Grey shale	55
White Medina	17
Red shale	5
Total depth	813

Water at 104 and 400 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 42, con. I, North Cayuga tp.
Completed November 1, 1930.
Open flow: 34,000 cu. ft.
Rock pressure: 360 lbs.

Formation	Thickness, ft.
Surface	49
Lime and shale	263
Niagara	230
Shale	53
Clinton	28
Red Medina	40
Grey shale	49
White Medina	12
Red shale	2
Total depth	726

Gas at 599 and 613 feet.
Water at 55 and 400 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 10, con. I, North Cayuga tp.
Completed October 13, 1930.
Open flow: 50,000 cu. ft.
Rock pressure: 290 lbs.

Formation	Thickness, ft.
Surface	54
Lime and shale	205
Niagara	252
Shale	34
Clinton	31
Red Medina	38
Grey shale	52
White Medina	18
Red shale	4
Total depth	688

Gas at 548 and 568 feet.
Water at 57 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 42, con. I, North Cayuga tp.
Completed October 1, 1930.
Dry hole.

Formation	Thickness, ft.
Clay	41
Gravel	39
Lime and shale	256
Niagara	230
Grey shale	53
Clinton	28
Red Medina	40
Blue shale	50
White Medina	12
Red shale	2
Total depth	751

Water at 42 and 422 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 11, con. I, S.T.R., North Cayuga tp.
Completed August 30, 1930.
Open flow: 18,000 cu. ft.
Rock pressure, 260 lbs.

Formation	Thickness, ft.
Surface	62
Lime and shale	190
Niagara	252
Shale	34
Clinton	30
Red Medina	40
Grey shale	51
White Medina	18
Red shale	20
Total depth	697

Gas at 562, 578, and 673 feet.
Water at 65 and 260 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 40, con. I, N.T.R., North Cayuga tp.
Completed August 9, 1930.
Open flow: 43,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	32
Gravel	28
Lime and shale	255
Niagara	230
Shale	50
Clinton	26
Red Medina	40
Grey shale	48
White Medina	12
Red shale	3
Total depth	724

Gas at 600 and 656 feet.
Water at 40 and 410 feet.

DOMINION NATURAL GAS CO., SELKIRK
Lot 40, con. I, North Cayuga tp.
Completed September 3, 1930.
Open flow: 16,000 cu. ft.
Rock pressure: 354 lbs.

Formation	Thickness, ft.
Surface	42
Lime and shale	254
Niagara	230
Shale	50
Clinton	28
Red Medina	40
Gray shale	47
White Medina	12
Red shale	3
Total depth	706

Gas at 614 feet.
Water at 55 and 400 feet.

DOMINION NATURAL GAS CO., SELKIRK
Lot 36, con. I, N.T.R., North Cayuga tp.

Completed July 9, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	12
Shell rock	12
Hard rock	40
Shell rock	6
Gravel	13
Lime and shale	258
Niagara	230
Shale	50
Clinton rock	28
Red Medina	38
Grey shale	50
White Medina	12
Red shale	3
Total depth	752

Water at 95, 180, and 425 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 12, con. I, S.T.R., North Cayuga tp.

Completed June 27, 1930.
Open flow: 60,000 cu. ft.
Rock pressure: 300 lbs.

Formation	Thickness, ft.
Surface	51
Lime and shale	218
Niagara	243
Shale	34
Clinton	31
Red Medina	39
Grey shale	48
White Medina	16
Red shale	42
Total depth	722

Gas at 589 and 668 feet.
Water at 60 and 295 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 38, con. I, N.T.R., North Cayuga tp.

Completed June 6, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	20
Gravel	3
Shell rock	57
Lime and shale	262
Niagara	230
Grey shale	50
Clinton	28
Red Medina	40
Blue Shale	52
White Medina	12
Red shale	5
Total depth	759

Water at 80 and 450 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 11, con. I, S.T.R., North Cayuga tp.

Completed June 2, 1930.
Open flow: 78,000 cu. ft.
Rock pressure: 288 lbs.

Formation	Thickness, ft.
Surface	50
Lime and shale	220
Niagara	260
Shale	24
Clinton	32
Red Medina	38
Grey shale	56
White Medina	17
Big red	7
Total depth	704

Gas at 556 and 578 feet.
Water at 66 and 308 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 11, con. I, S.T.R., North Cayuga tp.

Completed April 21, 1930.
Open flow: 13,000 cu. ft.
Rock pressure: 297 lbs.

Formation	Thickness, ft.
Surface	58
Lime and shale	232
Niagara	238
Shale	31
Clinton	28
Red Medina	37
Grey shale	48
White Medina	13
Big red shale	5
Total depth	690

Gas at 569 feet.
Water at 80 and 311 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 41, con. I, N.T.R., North Cayuga tp.

Completed May 5, 1930.
Open flow: 55,000 cu. ft.
Rock pressure: 375 lbs.

Formation	Thickness, ft.
Surface	15
Shell rock	15
Lime and shale	289
Niagara	230
Grey shale	50
Clinton	28
Red Medina	40
Blue shale	50
White Medina	12
Red shale	13
Total depth	742

Gas at 640 feet.
Water at 30 and 425 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 40, con. I, N.T.R., North Cayuga tp.

Completed March 12, 1930.
Open flow: 50,000 cu. ft.
Rock pressure: 375 lbs.

Formation	Thickness, ft.
Surface	23
Shell rock	20
Gravel	10
Lime and shale	282
Niagara	230
Grey shale	50
Clinton	27
Red Medina	40
Blue shale	50
White Medina	12
Red shale	3
Total depth	747

Gas at 641 feet.
Water at 60 and 400 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 41, con. I, N.T.R., North Cayuga tp.

Completed April 10, 1930.
Open flow: 83,000 cu. ft.
Rock pressure: 375 lbs.

Formation	Thickness, ft.
Surface	18
Hard rock	19
Shell rock	31
Lime and shale	285
Niagara	230
Shale	50
Clinton	27
Red Medina	40
Grey shale	50
White Medina	12
Red shale	4
Total depth	766

Gas at 656 and 660 feet.
Water at 68, 90, and 425 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 10, con. I, North Cayuga tp.
Completed January 30, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	58
Lime and shale	158
Niagara	224
Shale	52
Clinton	28
Red Medina	43
Shale	60
White Medina	10
Red shale	4
Total depth	637

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 40, con. I, N.T.R., North Cayuga tp.
Completed February 10, 1930.
Open flow: 46,000 cu. ft.
Rock pressure: 352 lbs.

Formation	Thickness, ft.
Surface	21
Flint	55
Lime and shale	293
Niagara	230
Grey shale	50
Clinton	27
Red Medina	40
Blue shale	50
White Medina	12
Red shale	5
Total depth	783

Gas at 674 feet.
Water at 440 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 10, con. I, N.T.R., North Cayuga tp.
Completed January 2, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	48
Lime and shale	170
Niagara	230
Shale	52
Clinton	26
Red Medina	41
Shale	60
White Medina	10
Red shale	5
Total depth	642

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 37, con. I, N.T.R., North Cayuga tp.
Completed January 6, 1930.
Open flow: 30,000 cu. ft.
Rock pressure: 360 lbs.

Formation	Thickness, ft.
Surface	5
Hard lime	50
Lime and shale	292
Niagara	230
Grey shale	50
Clinton	28
Red Medina	40
Blue shale	54
White Medina	12
Red shale	6
Total depth	767

Gas at 651 feet.
Water at 125 and 425 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 42, con. I, Oneida tp.
Completed November 28, 1930.
Open flow: 44,800 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	61
Lime and shale	256
Niagara	230
Shale	53
Clinton	28
Red Medina	40
Grey shale	52
White Medina	14
Red shale	6
Total depth	740

Gas at 626 and 646 feet.
Water at 65 and 410 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 42, con. I, N. of Cayuga, Oneida tp.
Completed December 29, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	42
Lime and shale	260
Niagara	230
Shale	52
Clinton	28
Red Medina	40
Grey shale	48
White Medina	11
Red shale	4
Total depth	715

Gas at 626 feet.
Water at 90 and 400 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 37, B.F., Oneida tp.
Completed November 27, 1930.
Open flow: 11,000 cu. ft.
Rock pressure: 198 lbs.

Formation	Thickness, ft.
Surface	41
Lime and shale	144
Niagara	245
Shale	36
Clinton	22
Red Medina	32
Shale	57
White Medina	12
Red shale	5
Total depth	594

Gas at 470 feet.
Water at 43 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 36, Andross estate and R.R., Oneida tp.
Completed November 13, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	49
Lime and shale	156
Niagara	240
Shale	32
Clinton	30
Red Medina	34
Shale	53
White Medina	12
Red shale	5
Total depth	611

Gas at 481, 497, and 604 feet.
Water at 295 feet.

DOMINION NATURAL GAS CO., BLACHKEATH
Lot 47, con. I, N. of Cayuga, Oneida tp.
Completed October 10, 1930.
Dry hole.

Formation	Thickness, ft.
Lime and shale	380
Niagara	200
White shale	50
Casing shale	30
Clinton	25
Red Medina	35
Grey shale	60
White Medina	10
Red shale	5
Total depth	795

Gas at 662 feet.
Water at 150 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 26, con. III, Oneida tp.
Completed November 27, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	30
Lime and shale	290
Niagara	200
White lime	50
Casing shale	30
Clinton	33
Red Medina	35
Grey shale	65
White Medina	12
Red shale	5
Total depth	750

RAINHAM GAS AND OIL SYNDICATE, FISHERVILLE
Lot 2, N. ½, con. II, Rainham tp.
Dompleted November 27, 1929.
Cry hole.

Formation	Thickness, ft.
Surface	19
Flint	96
Lime and shale	364
Niagara	272
Casing shale	42
Clinton	30
Red Medina sand	18
Red Medina shale	20
Grey shale	56
White Medina	18
Red shale	5
Total depth	940

Water at 45 feet.

RAINHAM GAS AND OIL SYNDICATE, FISHERVILLE
Lot 5, S. ½, con. III, Rainham tp.
Completed September 9, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	23
Flint	87
Lime and shale	350
Niagara	257
Casing shale	40
Clinton	33
Red Medina sand	22
Red Medina shale	16
Grey shale	58
White Medina	14
Red shale	5
Total depth	905

Water at 60 feet.

RAINHAM GAS AND OIL SYNDICATE, FISHERVILLE
Lot 4, S. ½, con. II, Rainham tp.
Completed October 17, 1929.
Open flow: 92,000 cu. ft.
Rock pressure: 410 lbs.

Formation	Thickness, ft.
Surface	32
Flint	88
Lime and shale	340
Niagara	280
Casing shale	42
Clinton	28
Red Medina sand	25
Red Medina shale	13
Grey shale	52
White Medina	23
Red shale	5
Total depth	928

Gas at 782 and 810 feet.
Water at 80 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 12, con. IV, Rainham tp.
Completed December 11, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	10
Flint	90
Lime and shale	362
Niagara	240
Grey shale	52
Clinton	28
Red Medina	40
Blue shale	53
White Medina	20
Red shale	4
Total depth	899

Water at 54 and 525 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 11, con. III, Rainham tp.
Completed October 8, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	27
Flint	69
Lime and shale	366
Niagara	237
Shale	55
Clinton	29
Red Medina	42
Grey shale	55
White Medina	17
Red shale	6
Total depth	903

Water at 30, 115, and 472 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 12, con. IV, Rainham tp.
Completed November 1, 1930.
Open flow: 43,000 cu. ft.
Rock pressure: 458 lbs.

Formation	Thickness, ft.
Surface	10
Flint	90
Lime and shale	361
Niagara	240
Shale	52
Clinton rock	28
Red Medina	43
Grey shale	55
White Medina	15
Red shale	3
Total depth	897

Gas at 757, 789, and 803 feet.
Water at 25 and 525 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 10, con. III, Rainham tp.

Completed August 23, 1930.
Open flow: 45,000 cu. ft.
Rock pressure: 278 lbs.

Formation	Thickness, ft.
Surface	28
Flint	65
Lime and shale	370
Niagara	222
Grey shale	64
Clinton	31
Red Medina	42
Blue shale	55
White Medina	19
Red shale	6
Total depth	902

Gas at 752 and 783 to 810 feet.
Water at 556 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 12, con. III, Rainham tp.

Completed September 13, 1930.
Open flow: 15,000 cu. ft.
Rock pressure: 279 lbs.

Formation	Thickness, ft.
Surface	19
Flint	90
Lime and shale	355
Niagara	240
Grey shale	52
Clinton	28
Red Medina	40
Blue shale	56
White Medina	16
Red shale	4
Total depth	900

Gas at 761 and 803 feet.
Water at 35 and 555 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 8, con. III, Rainham tp.

Completed July 25, 1930.
Open flow: 15,000 cu. ft.
Rock pressure: 335 lbs.

Formation	Thickness ft.
Surface	37
Flint	78
Lime and shale	357
Niagara	228
Grey shale	54
Clinton	29
Red Medina	42
Blue shale	55
White Medina	16
Red shale	7
Total depth	903

Gas at 779 and 798 to 803 feet.
Water at 42 and 473 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 11, con. III, Rainham tp.

Completed August 9, 1930.
Open flow: 104,000 cu. ft.
Rock pressure: 300 lbs.

Formation	Thickness, ft.
Surface	21
Flint	90
Lime and shale	353
Niagara	240
Shale	52
Clinton	28
Red Medina	40
Grey shale	57
White Medina	20
Red shale	4
Total depth	905

Gas at 761, 786, and 902 to 907 feet.
Water at 25 and 552 feet.

DOMINION NATURAL GAS CO., SELKIRK
Lot 13, con. II, Rainham tp.

Completed June 30, 1930.
Open flow: 21,000 cu. ft.
Rock pressure: 252 lbs.

Formation	Thickness, ft.
Surface	14
Flint	85
Lime and shale	360
Niagara	240
Grey shale	52
Clinton	28
Red Medina	40
Blue shale	54
White Medina	16
Red shale	2
Total depth	891

Gas at 789 feet.
Water at 21, 98, and 500 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 7, con. II, Rainham tp.

Completed June 23, 1930.
Open flow: 82,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	17
Flint	78
Lime and shale	400
Niagara	231
Grey shale	59
Clinton	30
Red Medina	42
Blue shale	55
White Medina	15
Red shale	6
Total depth	933

Gas at 790 to 810 feet and 835 feet.
Water at 98 and 520 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 8, con. II, Rainham tp.

Completed May 9, 1930.
Open flow: 90,000 cu. ft.
Rock pressure: 415 lbs.

Formation	Thickness, ft.
Surface	10
Flint	93
Lime and shale	385
Niagara	241
Grey shale	48
Clinton	30
Red Medina	42
Blue shale	56
White Medina	17
Red shale	7
Total depth	929

Gas at 792 and 825 to 837 feet.
Water at 96 and 510 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 13, con. II, Rainham tp.

Completed May 21, 1930.
Open flow: 115,000 cu. ft.
Rock pressure: 278 lbs.

Formation	Thickness, ft.
Surface	13
Flint	90
Lime and shale	349
Niagara	240
Grey shale	52
Clinton	28
Red Medina	40
Blue shale	57
White Medina	16
Red shale	53
Total depth	938

Gas at 766, 790, and 879 feet.
Water at 19 and 500 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lots 9 and 10, con. II, Rainham tp.

Completed April 1, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	24
Flint	88
Lime and shale	371
Niagara	255
Grey shale	34
Clinton	28
Red Medina	44
Blue shale	52
White Medina	15
Red shale	6
Total depth	917

Water at 140 and 535 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 14, con. II, Rainham tp.

Completed April 14, 1930.
Open flow: 42,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Surface	16
Flint	90
Lime and shale	357
Niagara	240
Grey shale	52
Clinton	29
Red Medina	40
Blue shale	57
White Medina	16
Red shale	5
Total depth	902

Gas at 780 and 796 feet.
Water at 30 and 480 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 8, con. II, Rainham tp.

Completed February 19, 1930.
Open flow: 24,000 cu. ft.
Rock pressure: 418 lbs.

Formation	Thickness, ft.
Surface	10
Flint	96
Lime and shale	379
Niagara	233
Grey shale	67
Clinton	29
Red Medina	42
Blue shale	54
White Medina	12
Red shale	2
Total depth	924

Gas at 819 feet.
Water at 510 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 5, con. II, Rainham, tp.

Completed February 20, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	22
Flint	97
Lime and shale	376
Niagara	246
Grey shale	57
Clinton	27
Red Medina	40
Blue shale	54
White Medina	15
Red shale	4
Total depth	938

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 9, con. II, Rainham tp.

Completed January 23, 1930.
Open flow: 63,000 cu. ft.
Rock pressure: 325 lbs.

Formation	Thickness, ft.
Surface	13
Flint	81
Lime and shale	367
Niagara	251
Grey shale	60
Clinton	30
Red Medina	42
Blue shale	58
White Medina	12
Red shale	3
Total depth	917

Gas at 827 feet.
Water at 460 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 13, con. II, Rainham tp.

Completed January 29, 1930.
Open flow: 71,000 cu. ft.
Rock pressure: 305 lbs.

Formation	Thickness, ft.
Surface	15
Flint	90
Lime and shale	355
Niagara	240
Shale	52
Clinton	29
Red Medina	40
Grey shale	57
White Medina	16
Red shale	51
Total depth	945

Gas at 892 feet.
Water at 500 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 2, con. I, E.P.R., Seneca tp.

Completed November 12, 1930.
Open flow: 39,000 cu. ft.
Rock pressure: 140 lbs.

Formation	Thickness, ft.
Surface	97
Lime and shale	26
Niagara	190
White lime	19
Shale	46
Clinton	24
Red Medina	41
Shale	43
White Medina	10
Red shale	47
Total depth	543

Gas at 381, 408, and 492 feet.
Water at 85, 100, and 125 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 1, con. I, 3rd range, Seneca tp.

Completed December 22, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	100
Shale and lime	29
Niagara	196
White lime	15
Shale	40
Clinton	20
Red Medina	32
Grey shale	51
White Medina	14
Red shale	5
Total depth	502

Gas at 484 and 493 feet.
Water at 80 and 115 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 14, con. I, W.S.C.R., Seneca tp.
Completed September 9, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	80
Shale	58
Niagara	210
Shale	57
Clinton	32
Red Medina	41
Shale	35
White Medina	12
Red shale	3
Total depth	528

Gas at 425 and 519 feet.
Water at 70 and 138 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 14, con. I, W.S.C.R., Seneca tp.
Completed October 2, 1930.
Open flow: 30,600 cu. ft.
Rock pressure: 134 lbs.

Formation	Thickness, ft.
Surface	82
Shale	54
Niagara	205
Guelph	35
Shale	39
Clinton	35
Red Medina	42
Shale	34
White Medina	10
Red shale	49
Total depth	585

Gas at 425 and 534 feet.
Water at 76 and 140 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 12, con. V, E.S.C.R., Seneca tp.
Completed July 8, 1930.
Open flow: 50,000 cu. ft.
Rock pressure: 95 lbs.

Formation	Thickness, ft.
Surface	42
Lime and shale	32
Niagara	233
Shale	35
Clinton	21
Red Medina	43
Shale	55
White Medina	10
Red shale	52
Total depth	523

Gas at 349, 370, 380, and 468 feet.
Water at 42 and 45 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 11, con. V, Seneca tp.
Completed August 2, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	40
Shale	16
Niagara	224
Shale	40
Clinton	24
Red Medina	42
Shale	60
White Medina	10
Red shale	5
Total depth	461

Gas at 361 and 452 feet.
Water at 40 and 50 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 3, con. II, W.S.C.R., Seneca tp.
Completed July 4, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	73
Shale	52
Niagara	210
Grey shale	25
Shale	27
Clinton	27
Red Medina	41
Shale	47
White Medina	9
Red shale	4
Total depth	515

Gas at 503 feet.
Water at 76 and 140 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 10, con. III, Seneca tp.
Completed June 23, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	80
Lime and shale	64
Niagara	230
Shale	50
Clinton	24
Red Medina	44
Shale	58
White Medina	10
Red shale	51
Total depth	611

Gas at 429, 552, and 557 feet.
Water at 76 and 95 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 13, con. I, W.S.C.R., Seneca tp.
Completed May 30, 1930.
Open flow: 73,500 cu. ft.

Formation	Thickness, ft.
Surface	84
Grey shale	51
Niagara	204
Guelph	42
Shale	35
Clinton	25
Red Medina	40
Shale	52
White Medina	10
Red shale	46
Total depth	589

Gas at 436 and 539 to 543 feet.
Water at 190 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 15, con. I, Seneca tp.
Completed May 29, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	44
Lime and shale	186
Niagara	230
Shale	54
Clinton	26
Red Medina	42
Shale	56
White Medina	10
Red shale	2
Total depth	650

Gas at 517 and 555 feet.
Water at 43 and 60 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 8, con. I, E.S.C.R., Seneca tp.

Completed May 6, 1930.
Open flow: 21,000 cu. ft.
Rock pressure: 126 lbs.

Formation	Thickness, ft.
Surface	48
Lime and shale	118
Niagara	228
Shale	52
Clinton	24
Red Medina	41
Shale	60
White Medina	10
Red shale	44
Total depth	625

Gas at 486 and 576 feet.
Water at 48 and 55 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 13, con. II, W.S.C.R., Seneca tp.

Completed May 3, 1930.
Open flow: 12,000 cu. ft.

Formation	Thickness, ft.
Surface	77
Shale	56
Niagara	206
Guelph	40
Shale	53
Clinton	26
Red Medina	40
Shale	46
White Medina	10
Red shale	5
Total depth	559

Gas at 447 and 449 feet.
Water at 81 and 135 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 13, con. I, W.S.C.R., Seneca tp.

Completed April 9, 1930.
Open flow: 75,500 cu. ft.
Rock pressure: 120 lbs.

Formation	Thickness, ft.
Surface	85
Lime and shale	45
Niagara	205
Guelph lime	40
Shale	41
Clinton	25
Red Medina	40
Grey shale	55
White Medina	10
Red shale	50
Total depth	596

Gas at 430, 457, and 541 feet.
Water at 90 and 130 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 6, con. II, Seneca tp.

Completed April 5, 1930.
Open flow: 28,800 cu. ft.
Rock pressure: 110 lbs.

Formation	Thickness, ft.
Surface	41
Lime and shale	100
Niagara	230
Shale	51
Clinton	25
Red Medina	43
Grey shale	60
White Medina	10
Red shale	50
Total depth	610

Gas at 442, 467, and 556 feet.
Water at 40 and 90 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Nelles tract, W.S.C.R., Seneca tp.

Completed March 6, 1930.
Open flow: 18,000 cu. ft.
Rock pressure: 110 lbs.

Formation	Thickness, ft.
Surface	64
Lime and shale	95
Niagara	210
Guelph and lime	28
Shale	37
Clinton	23
Red Medina	41
Shale	60
White Medina	12
Red shale	50
Total depth	620

Gas at 566 feet.
Water at 82 and 165 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 7, con. I, Seneca tp.

Completed March 15, 1930.
Open flow: 38,700 cu. ft.
Rock pressure: 100 lbs.

Formation	Thickness, ft.
Surface	54
Lime and shale	118
Niagara	228
Shale	47
Clinton	25
Red Medina	43
Shale	60
White Medina	10
Red shale	5
Total depth	590

Gas at 480 and 484 feet.
Water at 53 and 58 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 3, Nelles tract, south of and fronting on Stoney Creek Road, Seneca tp.

Completed January 13, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	89
Shale	105
Niagara	206
Guelph and lime	28
Shale	38
Clinton	27
Red Medina	41
Grey shale	51
White Medina	9
Red shale	4
Total depth	598

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 9, con. I, Seneca tp.

Completed February 18, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	32
Lime and shale	163
Niagara	225
Shale	59
Clinton	25
Red Medina	41
Shale	60
White Medina	10
Red shale	25
Total depth	640

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 9, con. II, Sherbrooke tp.

Completed September 3, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	71
Lime and shale	146
Brown lime	218
Niagara	230
Shale	57
Clinton	37
Red Medina	40
Grey shale	60
White Medina	10
Red shale	3
Total depth	872

Gas at 724 and 863 feet.
Water at 71 and 80 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 6, con. I, Sherbrooke tp.

Completed December 10, 1930.
Open flow: 27,000 cu. ft.
Rock pressure: 370 lbs.

Formation	Thickness, ft.
Surface	39
Flint	46
Lime and shale	374
Niagara	222
Shale	57
Clinton	31
Red Medina	42
Grey shale	57
White Medina	14
Red shale	52
Total depth	934

Gas at 752 and 875 feet.
Water at 38, 80, and 670 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 8, con. III, Sherbrooke tp.

Completed September 25, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	167
Lime and shale	258
Niagara	222
Shale	57
Clinton	36
Red Medina	44
Grey shale	55
White Medina	10
Red shale	1
Total depth	850

Water at 165 and 175 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 6, con. I, Sherbrooke tp.

Completed November 15, 1930.
Open flow: 58,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	44
Flint	46
Lime and shale	373
Niagara	222
Shale	59
Clinton	31
Red Medina	41
Grey shale	56
White Medina	15
Red shale	52
Total depth	939

Gas at 775, 816, and 887 feet.
Water at 43 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 5, con. XII, Walpole tp.

Completed December 26, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	17
Lime and slate	30
Sharp sand	57
Lime and gypsum	333
Niagara	215
White lime and slate	40
Black shale	39
Clinton	36
Red Medina	30
Grey shale	50
White Medina	5
Red shale	19
Total depth	871

Gas at 747 feet.
Fresh water at 40 feet.

RAINHAM GAS AND OIL CO., FISHERVILLE
Lot 24, con. III, Walpole tp.

Completed October 29, 1930.
Open flow: 36,000 cu. ft.

Formation	Thickness, ft.
Surface	8
Flint	132
Lime and shale	369
Niagara	247
Casing shale	44
Clinton	33
Red Medina sand	20
Red Medina shale	17
Grey shale	67
White Medina	16
Red shale	8
Total depth	961

Gas at 842 feet.
Fresh water at 78 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 4, con. II, Walpole tp.

Completed November 26, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	22
Flint	158
Lime and shale	355
Niagara	291
Grey shale	39
Clinton	26
Red Medina	45
Blue shale	66
White Medina	10
Red shale	3
Total depth	1,015

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 9, con. IV, Walpole tp.

Completed November 29, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	43
Flint	90
Lime and shale	385
Niagara	262
Grey shale	55
Clinton	28
Red Medina	38
Blue shale	55
White Medina	15
Red shale	1
Total depth	972

Water at 83 and 542 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 8, con. II, Walpole tp.

Completed October 15, 1930.
Open flow: 23,000 cu. ft.
Rock pressure: 207 lbs.

Formation	Thickness, ft.
Surface	26
Flint	164
Lime and shale	345
Niagara	255
Grey shale	86
Clinton	25
Red Medina	40
Blue shale	65
White Medina	15
Red shale	50
Total depth	1,071

Gas at 896, 919, and 1,019 feet.
Water at 102 and 585 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 10, con. IV, Walpole tp.

Completed October 24, 1930.
Open flow: 203,000 cu. ft.
Rock pressure: 462 lbs.

Formation	Thickness, ft.
Surface	28
Flint	95
Lime and shale	389
Niagara	263
Grey shale	52
Clinton	28
Red Medina	41
Blue shale	62
White Medina	12
Red shale	5
Total depth	975

Gas at 842, 861 to 867, and 966 feet.
Water at 73 and 568 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 13, con. III, Walpole tp.

Completed September 19, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	22
Flint	118
Lime and shale	389
Niagara	275
Shale	53
Clinton	26
Red Medina	45
Shale	55
White Medina	15
Red shale	6
Total depth	1,004

Water at 55, 78, and 560 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 3, con. I, Walpole tp.

Completed October 14, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	26
Flint	158
Lime and shale	354
Niagara	317
Grey shale	36
Clinton	26
Red Medina	45
Blue shale	68
White Medina	10
Red shale	3
Total depth	1,043

Water at 90 and 550 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 23, con. VIII, Walpole tp.

Completed August 25, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	25
Flint	70
Lime and shale	385
Niagara	250
Grey shale	37
Clinton	25
Red Medina	35
Blue shale	65
White Medina	10
Red shale	4
Total depth	906

Water at 50 and 510 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 3, con. I, Walpole tp.

Completed September 8, 1930.
Open flow: 160,000 cu. ft.
Rock pressure: 429 lbs.

Formation	Thickness, ft.
Surface	24
Flint	155
Lime and shale	361
Niagara	313
Grey shale	34
Clinton	25
Red Medina	47
Blue shale	68
White Medina	12
Red shale	60
Total depth	1,099

Gas at 907, 922 to 927, and 1,033 feet.
Water at 93 and 600 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 16, con. III, Walpole tp.

Completed August 2, 1930.
Open flow: 56,000 cu. ft.
Rock pressure: 276 lbs.

Formation	Thickness, ft.
Surface	19
Flint	130
Lime and shale	375
Niagara	257
Grey shale	57
Clinton	29
Red Medina	40
Blue shale	58
White Medina	14
Red shale	58
Total depth	1,037

Gas at 853, 885, and 975 feet.
Water at 86 and 530 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 15, con. I, Walpole tp.

Completed September 1, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	47
Flint	113
Lime and shale	365
Niagara	230
Grey shale	97
Clinton	27
Red Medina	40
Blue shale	60
White Medina	15
Red shale	5
Total depth	999

Water at 65 and 565 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. II, Walpole tp.

Completed July 22, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	14
Flint	111
Lime and shale	405
Niagara	230
Grey shale	90
Clinton	25
Red Medina	35
Blue shale	60
White Medina	15
Red shale	5
Total depth	990

Water at 48 and 542 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 3, con. II, Walpole tp.

Completed July 28, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	31
Flint	156
Lime and shale	353
Niagara	307
Grey shale	33
Clinton	26
Red Medina	45
Blue shale	65
White Medina	10
Red shale	2
Total depth	1,028

Water at 50, 115, and 548 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 17, con. III, Walpole tp.

Completed June 23, 1930.
Open flow: 25,000 cu. ft.
Rock pressure: 318 lbs.

Formation	Thickness, ft.
Surface	18
Flint	132
Lime and shale	368
Niagara	266
Grey shale	55
Clinton	25
Red Medina	40
Blue shale	60
White Medina	16
Red shale	5
Total depth	985

Gas at 864 and 888 feet.
Water at 43 and 540 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. VIII, Walpole tp.

Completed July 17, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	11
Flint	78
Lime and shale	392
Niagara	250
Grey shale	40
Clinton	25
Red Medina	35
Blue shale	62
White Medina	12
Red shale	3
Total depth	908

Water at 60 and 486 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. VII, Walpole tp.

Completed June 12, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	15
Flint	73
Lime and shale	390
Niagara	250
Grey shale	38
Clinton	27
Red Medina	35
Blue shale	62
White Medina	13
Red shale	5
Total depth	908

Water at 80 and 500 feet.

DOMINION NATURAL GAS CO., SELKIRK
Lot 23, con. III, Walpole tp.

Completed June 25, 1930.
Open flow: 15,000 cu. ft.
Rock pressure: 300 lbs.

Formation	Thickness, ft.
Surface	23
Flint	90
Lime and shale	382
Niagara	230
Grey shale	88
Clinton	24
Red Medina	38
Blue shale	55
White Medina	15
Red shale	4
Total depth	949

Gas at 828 feet.
Water at 60 and 510 feet.

DOMINION NATURAL GAS CO., SELKIRK
Lot 17, con. III, Walpole tp.

Completed May 20, 1930.
Open flow: 42,000 cu. ft.
Rock pressure: 273 lbs.

Formation	Thickness, ft.
Surface	18
Flint	130
Lime and shale	367
Niagara	272
Grey shale	48
Clinton	25
Red Medina	45
Blue shale	60
White Medina	15
Red shale	60
Total depth	1,040

Gas at 880 and 978 feet.
Water at 52 and 528 feet.

DOMINION NATURAL GAS CO., SELKIRK.
Lot 3, con. II, Walpole tp.

Completed June 12, 1930.
Open flow: 82,000 cu. ft.
Rock pressure: 322 lbs.

Formation	Thickness, ft.
Surface	22
Flint	158
Lime and shale	355
Niagara	312
Grey shale	33
Clinton	24
Red Medina	45
Blue shale	64
White Medina	10
Red shale	2
Total depth	1,025

Gas at 883 to 904 feet and 924 feet.
Water at 62, 110, and 580 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. VIII, Walpole tp.

Completed May 5, 1930.
Open flow: 41,000 cu. ft.
Rock pressure: 423 lbs.

Formation	Thickness, ft.
Surface	18
Flint	67
Lime and shale	390
Niagara	250
Grey shale	38
Clinton	25
Red Medina	35
Blue shale	65
White Medina	10
Red shale	59
Total depth	957

Gas at 894 to 898 feet.
Water at 50 and 490 feet.

DOMINION NATURAL GAS CO., SELKIRK
Lot 23, con. III, Walpole tp.

Completed May 22, 1930.
Open flow: 113,000 cu. ft.
Rock pressure: 408 lbs.

Formation	Thickness, ft.
Surface	13
Flint	92
Lime and shale	385
Niagara	230
Grey shale	103
Clinton	29
Red Medina	38
Blue shale	57
White Medina	14
Red shale	5
Total depth	966

Gas at 826 and 860 feet.
Water at 65 and 510 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 23, con. III, Walpole tp.

Completed April 18, 1930.
Open flow: 221,000 cu. ft.
Rock pressure: 347 lbs.

Formation	Thickness, ft.
Surface	22
Flint	85
Lime and shale	392
Niagara	230
Grey shale	99
Clinton	25
Red Medina	38
Blue shale	55
White Medina	15
Red shale	4
Total depth	965

Gas at 831 to 845 feet.
Water at 65 and 518 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 2, con. I, Walpole tp.

Completed May 1, 1930.
Open flow: 16,000 cu. ft.
Rock pressure: 452 lbs.

Formation	Thickness, ft.
Surface	28
Flint	152
Lime and shale	360
Niagara	323
Grey shale	40
Clinton	25
Red Medina	40
Blue shale	65
White Medina	9
Red shale	2
Total depth	1,044

Gas at 933 feet.
Water at 69, 100, and 580 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 2, con. I, Walpole tp.

Completed March 25, 1930.
Open flow: 85,000 cu. ft.
Rock pressure: 457 lbs.

Formation	Thickness, ft.
Surface	25
Flint	155
Lime and shale	358
Niagara	328
Grey shale	35
Clinton	25
Red Medina	45
Blue shale	64
White Medina	10
Red shale	2
Total depth	1,047

Gas at 946 to 956 feet.
Water at 40, 60, and 560 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. I, Walpole tp.

Completed April 10, 1930.
Open flow: 18,000 cu. ft.
Rock pressure: 235 lbs.

Formation	Thickness, ft.
Surface	8
Flint	130
Lime and shale	370
Niagara	251
Grey shale	66
Clinton	26
Red Medina	42
Blue shale	58
White Medina	12
Red shale	1
Total depth	964

Gas at 831 and 863 feet.
Water at 60 and 530 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 19, con. IX, Walpole tp.

Completed March 15, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	3
Flint	63
Lime and shale	380
Niagara	250
Grey shale	35
Clinton	45
Red Medina	35
Blue shale	55
White Medina	10
Red shale	4
Total depth	880

Water at 50 and 480 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. II, Walpole tp.

Completed March 21, 1930.
Open flow: 72,000 cu. ft.
Rock pressure: 390 lbs.

Formation	Thickness, ft.
Surface	11
Flint	100
Lime and shale	389
Niagara	230
Grey shale	111
Clinton	27
Red Medina	35
Blue shale	60
White Medina	15
Red shale	5
Total depth	983

Gas at 844, 876, and 881 feet.
Water at 65 and 540 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 19, con. VIII, Walpole tp.

Completed January 28, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	25
Flint	45
Lime and shale	390
Niagara	250
Grey shale	41
Clinton	24
Red Medina	35
Blue shale	67
White Medina	10
Red shale	2
Total depth	889

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 20, con. III, Walpole tp.

Completed February 20, 1930.
Open flow: 49,000 cu. ft.
Rock pressure: 218 lbs.

Formation	Thickness, ft.
Surface	30
Flint	70
Lime and shale	370
Niagara	240
Grey shale	95
Clinton	22
Red Medina	38
Blue shale	65
White Medina	15
Red shale	7
Total depth	952

Gas at 849 feet.
Water at 525 feet

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 1, con. I, Walpole tp.

Completed January 30, 1930.
Open flow: 46,000 cu. ft.
Rock pressure: 348 lbs.

Formation	Thickness, ft.
Surface	22
Flint	145
Lime and shale	360
Niagara	321
Shale	45
Clinton	25
Red Medina	44
Blue shale	65
White Medina	10
Red shale	2
Total depth	1,039

Gas at 938 feet.
Water at 570 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. III, Walpole tp.

Completed January 21, 1930.
Open flow: 31,000 cu. ft.
Rock pressure: 410 lbs.

Formation	Thickness, ft.
Surface	26
Flint	74
Lime and shale	370
Niagara	240
Grey shale	96
Clinton	25
Red Medina	35
Blue shale	65
White Medina	15
Red shale	60
Total depth	1,006

Gas at 941 feet.
Water at 560 feet.

Kent County

OLGA GAS AND OIL CO., TORONTO
Lot 2, con. III, Dover East tp.

Completed May 29, 1930.
Open flow: 500,000 cu. ft.
Rock pressure: 1,200 lbs.

Formation	Thickness, ft.
Surface	60
Soapstone	140
Lime	1,610
Niagara lime	150
Grey shale	80
Shale and Medina	100
Red shale	285
Grey shale with lime shells	105
Grey shale	100
Brown lime	167
Trenton (grey and hard)	403
Total depth	3,200

Show of gas at 2,820, 2,890, 2,927, and 3,070 to 3,080 feet.
Salt water at 460 feet.

ACME GAS AND OIL CO., TORONTO
Lot 2, con. IV, Dover East tp.

Completed January 11, 1930.
Open flow: show.

Formation	Thickness, ft.
Surface	73
Hamilton shale and lime	209
Onondaga lime	153
Detroit River	665
Salina	500
Guelph and Niagara	245
Rochester / Clinton / Cabot Head	150
Manitoulin	30
Queenston	350
Hudson River	240
Utica brown shale	140
Collingwood black shale	17
Trenton	423
Total depth	3,195

Gas at 2,900 feet.
Water at 1,840 feet.

ACME GAS AND OIL CO., TORONTO
Lot 2, con. IV, Dover East tp.

Completed April 23, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	74
Soapstone	194
Limestone	177
Water sand	430
Salina	535
Guelph	340
Niagara	206
Medina shales	101
White Medina	35
Red shale	308
Hudson River shale	267
Utica shale	120
Trenton lime	393
Total depth	3,180

Water at 445 and 1,780 feet.

OLGA GAS AND OIL CO., TORONTO
Pt. lot 3, con. III, Dover East tp.

Completed December 4, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	390
Lime	640
Salina lime	345
Lime	380
Niagara lime	140
Clinton and Red Medina shale	110
White Medina	50
Red shale	245
Grey shale	250
Brown shale	200
Black shale	32
Trenton	583
Total depth	3,365

*Show of gas at 1,580, 1,660, 3,220, and 3,270 feet.
Water at 710 and 1,660 feet.
Salt at 1,815 feet.

OLGA GAS AND OIL CO., TORONTO
Lot 5, con. III, Dover West tp.

Completed December 10, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	240
Lime	740
Salina lime	50
Lime and gypsum	30
Lime	680
Niagara lime	205
Grey shale	40
Red Medina shale	35
Grey shale	36
White Medina	114
Big red shale	250
Grey shale	30
Lime shell	10
Grey shale	180
Grey and blue shale	100
Utica brown shale	130
Trenton	445
Total depth	3,315

BASIC RESOURCES, LIMITED, TORONTO
Lot 2, M.I.R., Orford tp.

Completed March 8, 1930.
Dry hole.

Formation	Thickness, ft.
Sand	8
Gravel	2
Clay	24
Stones	11
Hardpan	46
Gravel	21
Hardpan	8
Gravel and boulders	33
Sand	32
Pipe clay	10
Soap proper	18
Middle lime	12
Lower soap	22
Dark streak	9
Lower lime	106
Total depth	362

Oil at 293 feet.

BASIC RESOURCES, LIMITED, TORONTO
Lot 3, M.I.R., Orford tp.

Completed April 2, 1930.
Dry hole.

Formation	Thickness, ft.
Sand	5
Gravel	5
Clay	40
Gravel	80
Upper soapstone	94
Middle lime	11
Lower soapstone	23
Dark streak	7
Onondaga limestone	158
Oriskany sand	3
Total depth	426

BASIC RESOURCES, LIMITED, TORONTO
Lot 3, M.I.R., Orford tp.

Completed January 27, 1930.
Small oil well.

Formation	Thickness, ft.
Surface	3
Gravel	8
Clay	19
Gravel	25
Hardpan	7
Gravel	60
Hardpan	4
Upper soapstone	103
Middle lime	6
Lower soapstone	25
Black lime	4
Soapstone	2
Onondaga limestone	37
Total depth	303

Oil at 297 and 300 feet.

BASIC RESOURCES, LIMITED, TORONTO
Lot 4, M.I.R., Orford tp.

Completed February 15, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	3
Gravel	6
Clay	22
Hardpan	90
Gravel	9
Shale	125
Black streak	4
Shale	3
Lower lime (Onondaga)	141
Total depth	403

Oil at 315 feet.
Oil and water at 380 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 131, T.R., Raleigh tp.

Completed August 1, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	160
Black shale	20
Soap	115
Shale and soap	77
Green lime	43
Lime sand	5
Grey lime	340
Sharp sand	110
Grey lime	163
Grey shale	5
Blue lime	312
Salt	150
Brown lime	360
Niagara lime	53
Total depth	1,913

Gas at 415, 1,520, and show of oil and gas at 1,630 feet.

AMERICAN ENGINEERING CO., CHATHAM
Lot 147, W. ½, S.T.R., Raleigh tp.

Completed June 24, 1930.
Rock pressure: 601 lbs.

Formation	Thickness, ft.
Drift and shale	195
Soap	70
Lime	305
Sharp sand	165
Lime	825
Total depth	1,560

Gas at 250, 700, 1,420, 1,490, 1,527, 1,538, 1,550, 1,555, and 1,560 feet.
Water at 195, 615, and 695 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 144, T.R., Raleigh tp.

Completed November 18, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	182
Soap	92
Onondaga and Detroit River hard lime	136
Grey lime	170
Sharp lime	250
Brown lime	265
Slate and lime	100
Hard grey lime	128
Slate and lime	152
Grey lime	194
Total depth	1,669

Show of gas at 200 and 310 feet.
Water at 200, 310, 1,600, and 1,630 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 16, con. XV., Raleigh tp.

Completed October 24, 1930.

Formation	Thickness, ft.
Surface	185
Soap	30
Black shale	10
Soap	34
Onondaga and Detroit River limestone (brown)	301
Sharp lime	235
Brown and grey lime	190
Grey lime and gypsum	10
Grey and brown lime	120
Blue shale	15
Blue and brown lime	311
Total depth	1,441

Gas at 950, 1,185, 1,414, and 1,425 feet.
Water at 185, 425, and 790 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 144, T.R., Raleigh tp.

Completed February 25, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	181
Soap and shells	105
Onondaga and Detroit River brown lime	324
Brown and grey sharp lime	215
Brown lime	259
Lime and gypsum	21
Blue and brown lime	490
Total depth	1,595

Show of gas at 320, 1,430, and 1,569 feet.
Water at 320, 730, 815, and 1,595 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 144, T.R., Raleigh tp.

Completed February 7, 1930.

Formation	Thickness, ft.
Surface	195
Soap	30
Black shale	10
Soap	38
Onondaga and Detroit River brown lime	322
Brown and grey sharp lime	225
Brown lime	195
Lime and gypsum	70
Blue and brown lime	450
Grey lime	210
Total depth	1,745

Gas at 1,538 feet.
Show of oil at 440 feet.
Water at 305 and 1,740 to 1,745 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 146, T.R., Raleigh tp.

Completed March 10, 1930.

Formation	Thickness, ft.
Surface	195
Upper soap	60
Middle lime	3
Lower soap	14
Onondaga and Detroit River brown lime	298
Brown and grey sharp lime	195
Brown lime	215
Lime and gypsum	25
Blue and brown lime	560
Total depth	1,565

Gas at 1,410, 1,420, 1,480 to 1,485, 1,520, 1,528, 1,535, 1,541, and 1,555 feet.
Water at 305 and 720 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 15, con. XIV, Raleigh tp.

Completed May 17, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	175
Soap	85
Onondaga and Detroit River grey and brown lime	310
Brown and grey sharp lime	185
Brown lime	230
Lime and gypsum	15
Blue and brown lime	290
Blue shale and brown lime	125
Brown and grey lime	270
Grey lime	175
Rochester blue shale	30
Clinton dolomite	7
Cabot Head: Red shale	13
Cabot Head: Blue shale	50
Cabot Head: Red shale	20
Cabot Head: Blue shale	25
Manitoulin blue shale and lime	50
Queenston red shale	10
Total depth	2,065

Gas at 1,215 to 1,220 feet.
Show of oil at 300 feet and 1,567 to 1,572 feet.
Water at 425, 1,740, 1,775, and 1,790 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 145, T.R., Raleigh tp.

Completed April 18, 1930.

Formation	Thickness, ft.
Surface	198
Soap	75
Onondaga and Detroit River brown lime	307
Grey and brown sharp lime	165
Hard brown lime	803
Grey lime	10
Total depth	1,558

Gas at 1,430, 1,493, 1,533, 1,538, and 1,544 feet.
Water at 198, 410, 675, and 1,573 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 16, con. XIV, Raleigh tp.

Completed June 12, 1930.

Formation	Thickness, ft.
Surface	177
Soap	83
Onondaga and Detroit River brown lime	330
Brown and grey sharp lime	230
Brown lime	195
Lime and gypsum	95
Hard grey lime	165
Grey lime and slate	160
Hard brown lime	283
White lime (bottom of Niagara)	157
Total depth	1,875

Oil at 490 feet.
Water at 295, 305, 420, 490, 720, 770, 1,630, 1,795, 1,810, and 1,825 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 14, con. XV, Raleigh tp.

Completed July 3, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	180
Upper soap	71
Middle lime	4
Lower soap	22
Onondaga and Detroit River brown lime	273
Brown and grey sharp lime	130
Brown lime	265
Lime and gypsum	15
Blue and brown lime	720
Grey lime	75
Total depth	1,755

Water at 650, 1,730, and 1,755 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 15, con. XV, Raleigh tp.

Completed August 12, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	190
Soap	82
Onondaga and Detroit River brown lime	298
Brown and grey sharp lime	250
Brown lime	210
Blue and brown lime	675
Grey lime	81
Total depth	1,786

Gas at 306 and 1,350 feet.
Water at 306, 425, 820, 1,640, 1,760, and 1,786 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 147, T.R., Raleigh tp.

Completed July 22, 1930.

Formation	Thickness, ft.
Surface	190
Soap	75
Onondaga and Detroit River brown lime	345
Brown and grey sharp lime	136
Hard grey lime	803
Grey and brown lime	25
Total depth	1,574

Gas at 1,425, 1,495, 1,500, 1,534, 1,538, 1,542, 1,550, 1,560, 1,565, and 1,570 feet.
Water at 314, 675, and 690 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 147, T.R., Raleigh tp.

Completed August 29, 1930.

Formation	Thickness, ft.
Surface	223
Soap	46
Onondaga and Detroit River brown lime	311
Brown and grey sharp lime	170
Brown lime	280
Lime and gypsum	76
Grey and brown lime	474
Total depth	1,580

Gas at 1,501 and 1,543 feet.
Water at 570 and 770 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 142, T.R., Raleigh tp.

Completed September 23, 1930.

Formation	Thickness, ft.
Surface	180
Soap	78
Onondaga and Detroit River:	
Grey lime	72
Brown lime	220
Brown and grey sharp lime	245
Brown lime	190
Lime and gypsum	15
Blue and brown lime	525
Grey lime	35
Total depth	1,560

Gas at 1,220, 1,235, 1,400, 1,405 to 1,430, 1,475, 1,532, 1,547, 1,549, 1,552, and 1,555 feet.
Water at 180, 425, and 525 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 146, T.R., Raleigh tp.

Completed October 9, 1930.

Formation	Thickness, ft.
Surface	207
Soap	63
Onondaga and Detroit River lime	230
Brown and grey sharp lime	280
Hard grey and brown lime	543
Slate and lime	87
Blue and brown lime	115
Grey lime	45
Total depth	1,570

Gas at 183, 1,495, 1,530 to 1,542, 1,547, and 1,557 feet.
Water at 290, 700, and 760 feet.

SMITH OIL AND GAS SYNDICATE, WINDSOR
S.E. pt. gore A, con. II, Romney tp.

Completed November 11, 1929.
Open flow: 300,000 cu. ft.
Rock pressure: 195 lbs.

Formation	Thickness, ft.
Surface	148
Hardpan	2
Top rock	13
Grey lime	277
Sharp sand	145
Grey lime	170
Dark lime	20
Grey lime and gypsum	45
Grey lime	340
Brown lime	15
Grey lime	125
White lime	10
Total depth	1,310

Gas at 1,171, 1,210, and 1,297 feet.
Water at 150, 615, and 760 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 178, T.R., Romney tp.

Completed May 14, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	170
Gravel and shale	10
Soap	21
Little lime	30
Soap	19
Big lime	20
Grey lime	15
Black lime	20
Grey lime	310
Grit or sharp sand	50
White lime	25
Grey lime	80
Gypsum	1
Grey lime	81
Blue lime	73
Grey lime	100
Broken lime and shale	150
Grey lime	40
Blue lime	95
Grey lime	15
White sand	24
Total depth	1,349

Gas at 1,203 feet.
Water at 180, 580, 675, 1,310, and 1,330 to 1,349 feet.

SMITH OIL AND GAS SYNDICATE, WINDSOR
S.E. pt. gore A, con. II, Romney tp.

Completed July 11, 1930.
Open flow: 150,000 cu. ft.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Surface (clay)	150
Top rock	8
Grey lime	200
Sharp sand	145
Lime	237
Gypsum and lime	20
Dark lime	415
Light brown lime	10
Grey lime	20
Brown lime	15
Grey lime	25
Brown lime	30
Grey lime	25
White lime	11
Total depth	1,311

Gas at 1,183 and 1,215 feet.
Water at 158, 260, 624, 685, and 1,311 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 185, T.R., Romney tp.

Completed October 21, 1930.
Open flow: 139,000 cu. ft.
Rock pressure: 150 lbs.

Formation	Thickness, ft.
Clay	142
Gravel	10
Big lime	158
Brown lime	115
Grey lime	50
Sharp sand	175
Grey lime	300
Dark-grey lime	340
Light water sand	5
Total depth	1,295

Gas at 1,128, 1,200, and 1,227 feet.
Water at 310, 500, and 1,295 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 187, T.R., Romney tp.

Completed December 1, 1930.
Open flow: 67,000 cu. ft.
Rock pressure: 162 lbs.

Formation	Thickness, ft.
Surface	167
Dark-grey lime	353
Sharp sand	170
Dark-grey lime	610
Light-grey lime	75
Water sand	4
Total depth	1,379

Gas at 1,175 and 1,300 feet.
Water at 240 and 690 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 177, T.R., Tilbury East tp.

Completed January 2, 1930.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Clay	179
Soap	20
Black shale	15
Soap	20
Black shale	10
Soap	16
Light-grey lime	300
Grey lime	15
Sharp sand	135
Light-grey lime	240
Brown lime	215
Dark-grey lime	201
Total depth	1,366

Gas at 1,355 feet.
Water at 560 and 715 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 173, T.R., Tilbury East tp.

Completed February 25, 1930.
Open flow: 221,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Clay	180
Quicksand and gravel	7
Soap	35
Dark lime	20
Soap and shale	21
Light-grey lime	262
Brown lime	293
Light-grey lime	87
Blue lime	50
Light-brown lime	133
Blue lime	102
Light-grey lime	15
Dark-grey lime	127
Total depth	1,332

Gas at 1,326 feet.
Water at 675 feet.

ACME GAS AND OIL CO., TORONTO
Lots 6 and 7, R.R., Zone tp.

Completed February 21, 1930.
Show of oil.

Formation	Thickness, ft.
Surface	160
Soapstone	40
Middle lime	15
Lower soapstone	24
Hard streak at 239 feet.	
Lower soapstone	9
Big lime	48
Total depth	296

Oil at 265, 280, and 295 feet.

ACME GAS AND OIL CO., TORONTO
Lot 6 A, S.L.R., Zone tp.

Completed April 2, 1930.
Show of oil.

Formation	Thickness, ft.
Clay	30
Hardpan	90
Soapstone (hard streak at 178 and at 215 to 218 feet)	108
Middle lime	14
Lower soap	25
Dark streak	8
Lower lime	70
Total depth	345

Oil at 290 and 308 feet.

OLGA GAS AND OIL CO., TORONTO
Lot 12, R.R., Zone tp.

Completed June 14, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	148
Lime and soap	90
Big lime	752
Brown lime	80
Lime	280
Brown lime	120
Shale	85
Salt	155
Lime	70
Hard brown lime	200
White lime	35
Lime and shale	190
Red Medina	355
Grey shale	420
Utica black shale	115
Trenton	725
Brown lime	45
Grey lime	35
Brown lime	98
Top of Potsdam.	
Total depth	3,998

Water at 250, 560, and 1,910 feet.

Lambton County

UNION NATURAL GAS CO., CHATHAM

Lot 18, con. I, Dawn tp.

Completed May 22, 1930.

Formation	Thickness, ft.
Surface	53
Black shale	222
Top rock	40
Upper soap	145
Middle lime	15
Lower soap	25
Onondaga and Detroit River brown lime	405
Brown and grey sharp lime	275
Brown lime	95
Lime and gypsum	5
Blue and brown lime	655
Grey lime	100
Rochester grey shale	11
Total depth	2,046

Gas at 1,783 feet.
Water at 573 feet.

UNION NATURAL GAS CO., CHATHAM

Lot 19, con. I, Dawn tp.

Completed March 26, 1930.

Formation	Thickness, ft.
Surface	68
Black shale	202
Top rock	40
Top soap	125
Middle lime	18
Lower soap	32
Onondaga and Detroit River brown lime	400
Brown and grey sharp lime	255
Brown lime	80
Brown lime and gypsum	5
Brown and blue lime	793
Rochester blue shale	7
Total depth	2,025

Gas at 1,625, 1,740, and 1,843 feet.
Oil at 1,860 to 1,865 feet.
Water at 68, 520, and 1,745 feet.

UNION NATURAL GAS CO., CHATHAM

Lot 19, con. I, Dawn tp.

Completed July 14, 1930.

Formation	Thickness, ft.
Surface	67
Black shale	198
Top rock	40
Upper soap	125
Middle lime	15
Lower soap	31
Onondaga and Detroit River brown lime	434
Brown and grey sharp lime	170
Brown lime	125
Lime and gypsum	50
Blue and brown lime	357
Brown lime	86
Grey lime	14
Total depth	1,712

Gas at 1,533, 1,612, 1,625, 1,650, 1,655, 1,659, 1,664, 1,669, 1,695, and 1,698 feet.
Water at 67, 605, and 650 feet.

UNION NATURAL GAS CO., CHATHAM

Lot 23, con. XI, Dawn tp.

Completed December 5, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	45
Upper soap	189
Middle lime	20
Lower soap	35
Onondaga and Detroit River brown lime	436
Brown and grey sharp lime	175
Brown lime	155
Lime and gypsum	100
Blue and brown lime	220
Salt and lime	215
Brown and grey lime	140
Brown and grey lime with gypsum	5
Brown and grey lime	87
Total depth	1,822

Show of oil at 1,730 feet.
Water at 380 and 1,745 feet.

UNION NATURAL GAS CO., CHATHAM

Lot 18, con. I, Dawn tp.

Completed December 27, 1930.

Formation	Thickness, ft.
Surface	60
Black shale	205
Top rock	65
Upper soap	123
Middle lime	5
Lower soap	31
Onondaga and Detroit River brown lime	416
Brown and grey sharp lime	238
Brown lime	85
Lime and gypsum	145
Blue and brown lime	592
Grey lime	58
Rochester grey shale	8
Total depth	2,031

Gas at 1,605, 1,625, 1,635, 1,658, and 1,670 feet.
Water at 60, 545, and 1,815 feet.

UNION NATURAL GAS CO., CHATHAM

Lot 20, con. I, Dawn tp.

Completed November 14, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	62
Black shale	218
Top rock	75
Upper soap	107
Middle lime	15
Lower soap	28
Onondaga and Detroit River brown lime	395
Brown and grey sharp lime	285
Blue and brown lime	740
Grey lime	115
Rochester shale	7
Total depth	2,047

Show of gas at 1,660 feet.
Water at 62 and 545 feet.

UNION NATURAL GAS CO., CHATHAM

Lot 19, con. I, Dawn tp.

Completed October 4, 1930.

Formation	Thickness, ft.
Surface	66
Black shale	194
Top rock	40
Upper soap	130
Middle lime	15
Lower soap	26
Onondaga and Detroit River brown lime	404
Brown and grey sharp lime	210
Brown lime	20
Lime and gypsum	195
Blue and brown lime	418
Total depth	1,718

Gas at 500, 1,605, 1,623, 1,633, 1,660, 1,675, 1,680, 1,700, 1,705, 1,710, 1,713, and 1,718 feet.
Water at 66, 505, and 530 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 23, con. X, Dawn tp.

Completed October 21, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	40
Top rock	34
Upper soap	155
Middle lime	20
Lower soap	33
Onondaga and Detroit River brown lime	438
Brown and grey sharp lime	180
Brown lime	103
Lime and gypsum	142
Blue and brown lime	240
Lime and salt	215
Dark-brown and grey lime	307
Grey lime	95
Rochester shale	38
Clinton	10
Cabot Head shale	80
Manitoulin lime and shale	57
Queenston red shale	14
Total depth	2,201

Gas at 287 feet.
Oil at 1,745 feet.
Water at 425 and 1,772 feet.

MILLAR, HESS SYNDICATE, DETROIT, MICH.
Lot 68, Front con., Moore tp.

Completed July 21, 1930.
Dry hole.

Formation	Thickness, ft.
Blue clay	128
Sand	5
Brown shale and rock	7
Top rock	30
Brown shale	200
Middle lime	30
Lower soap	210
Lime	193
Total depth	803

Gas at 630 feet.
Water at 128 and 735 feet.

BRITISH PETROLEUM CO., HAMILTON
Lot 19, S. ½, con. X, Plympton tp.

Completed September 5, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	81
Shale	44
Ipperwash lime	4
Soap and lime	204
Soap	50
Middle lime	5
Soap	55
Corniferous lime at 443 feet.	
Delaware and Onondaga	124
Total depth	567

Show of oil at 466 feet.

BRITISH PETROLEUM CO., HAMILTON
Lot 25, con. IX, Plympton tp.

Completed December 16, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	113
Shale with hard streaks	44
Soapstone	50
Hard limestone	2
Soapstone with streaks of lime	89
Soapstone	122
Limestone	4
Soapstone	51
Onondaga limestone	94
Total depth	569

Very small showing of gas at 555 feet.
Water at 63, 113, and 569 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 30, con. IX, Sombra tp.

Completed August 29, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	65
Black shale	225
Top rock	20
Upper soap	160
Middle lime	15
Lower soap	25
Onondaga and Detroit River brown lime	415
Brown and grey sharp lime	265
Brown lime	80
Lime and gypsum	145
Blue and brown lime	545
Grey lime	68
Rochester grey shale	32
Clinton grey dolomite	8
Cabot Head red shale	17
Blue shale	20
Total depth	2,105

Gas at 1,635 and 1,790 to 1,795 feet.
Water at 610, 645, 760, and 1,815 feet.

Lincoln County

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 8, con. II, Caistor tp.

Completed May 21, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	50
Niagara	200
Guelph lime	50
Casing shale	19
Blue shale	34
Clinton	29
Red Medina	35
Grey shale	59
White Medina	14
Red shale	12
Total depth	502

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 6, con. II and III, Caistor tp.

Completed October 10, 1929.
Open flow: 30,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	63
Niagara	200
Guelph lime	39
Blue shale	45
Clinton	30
Red Medina	37
Grey shale	60
White Medina	15
Red shale	50
Total depth	539

Gas at 489 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 7, con. III, Caistor tp.

Completed March 9, 1929.
Open flow: 35,000 cu. ft.
Rock pressure: 130 lbs.

Formation	Thickness, ft.
Surface	53
Niagara	200
Lime	50
Shale	65
Clinton	22
Red Medina	41
Grey shale	55
White Medina	15
Red shale	47
Total depth	548

Gas at 425 and 498 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 5, W. ½, con. III, Caistor tp.

Completed August 27, 1930.
Open flow: 14,000 cu. ft.
Rock pressure: 120 lbs.

Formation	Thickness, ft.
Surface	56
Niagara	200
Guelph lime	50
Shale	45
Clinton	30
Red Medina	37
Grey shale	60
White Medina	15
Red shale	50
Total depth	543

Gas at 381 and 441 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 8, con. III, Caistor tp.

Completed July 2, 1929.
Open flow: 45,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	57
Niagara	200
Guelph lime	38
Shale	39
Clinton	29
Red Medina	35
Grey shale	60
White Medina	14
Red shale	51
Total depth	523

Gas at 458 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 6, con. I, Caistor tp.

Completed July 21, 1930.
Open flow: 100,00 cu. ft.
Rock pressure: 135 lbs.

Formation	Thickness, ft.
Surface	67
Niagara	200
Guelph lime	50
Shale	50
Clinton	29
Red Medina	35
Shale	56
White Medina	13
Red shale	52
Total depth	552

Gas at 487 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 5, con. II, Caistor tp.

Completed June 24, 1930.
Open flow: 25,000 cu. ft.
Rock pressure: 129 lbs.

Formation	Thickness, ft.
Surface	70
Niagara	200
Guelph lime	53
Blue shale	34
Clinton	30
Red Medina	39
Grey shale	58
White Medina	13
Red shale	37
Total depth	534

Gas at 499 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 6, con. III, Caistor tp.

Completed February 14, 1930.
Open flow: 58,000 cu. ft.
Rock pressure: 130 lbs.

Formation	Thickness, ft.
Surface	57
Niagara	200
Guelph lime	48
Blue shale	45
Clinton	31
Red Medina	37
Grey shale	60
White Medina	15
Total depth	493

Gas at 415 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 5, con. III, Caistor tp.

Completed July 25, 1930.
Open flow: 60,000 cu. ft.
Rock pressure: 130 lbs.

Formation	Thickness, ft.
Surface	56
Niagara	190
Guelph lime	50
Casing shale	12
Shale	30
Clinton	23
Red Medina	45
Grey shale	75
White Medina	13
Red shale	45
Total depth	539

Gas at 481 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lot 6, con. I, Caistor tp.

Completed August 7, 1930.
Open flow: 15,000 cu. ft.
Rock pressure: 120 lbs.

Formation	Thickness, ft.
Surface	72
Niagara	200
Guelph lime	57
Shale	50
Clinton	28
Red Medina	35
Shale	59
White Medina	12
Red shale	25
Total depth	538

Gas at 424 and 503 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lot 4, con. III, Caistor tp.

Completed August 9, 1930.
Open flow: 80,000 cu. ft.
Rock pressure: 120 lbs.

Formation	Thickness, ft.
Surface	66
Brown lime	20
Niagara	215
Blue shale	41
Clinton	35
Red Medina	39
Grey shale	59
White Medina	15
Red shale	45
Total depth	535

Gas at 387 and 480 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lot 6, con. I, Caistor tp.

Completed August 26, 1930.
Open flow: 44,000 cu. ft.
Rock pressure: 135 lbs.

Formation	Thickness, ft.
Surface	67
Niagara	200
Guelph lime	50
Shale	50
Clinton	31
Red Medina	35
Shale	55
White Medina	15
Red shale	48
Total depth	551

Gas at 370, 408, and 511 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lot 4, E. ½, con. III, Caistor tp.

Completed August 26, 1930.
Open flow: 48,000 cu. ft.
Rock pressure: 130 lbs.

Formation	Thickness, ft.
Surface	76
Niagara	206
Lime	25
Shale	35
Clinton	38
Red Medina	30
Shale	65
White Medina	16
Red shale	46
Total depth	537

Gas at 347, 399, and 485 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lots 1 and 2, con. I, Caistor tp.

Completed September 13, 1930.
Open flow: 34,000 cu. ft.
Rock pressure: 170 lbs.

Formation	Thickness, ft.
Surface	73
Brown lime	35
Niagara	210
Guelph lime	80
Blue shale	21
Clinton	29
Red Medina	38
Grey shale	60
White Medina	13
Red shale	45
Total depth	604

Gas at 461 and 549 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lot 6, con. II, Caistor tp.

Completed September 17, 1930.
Open flow: 48,000 cu. ft.
Rock pressure: 135 lbs.

Formation	Thickness, ft.
Surface	58
Niagara	200
Guelph lime	50
Shale	53
Clinton	25
Red Medina	35
Shale	56
White Medina	14
Red shale	50
Total depth	541

Gas at 485 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 8, con. II, Caistor tp.

Completed April 19, 1930.
Open flow: 65,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	59
Niagara	210
Guelph lime	46
Grey shale	32
Blue shale	20
Clinton	30
Red Medina	35
Grey shale	46
White Medina	14
Red shale	50
Total depth	542

Gas at 420, 450, and 483 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 5, con. I, Caistor tp.

Completed June 9, 1930.
Open flow: 35,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	70
Niagara	200
Guelph lime	50
Shale	41
Clinton	27
Red Medina	40
Shale	56
White Medina	13
Red shale	48
Total depth	545

Gas at 493 feet.

GRIMSBY NATURAL GAS CO., SMITHVILLE
Lot 6, con. I, Caistor tp

Completed July 2, 1930.
Open flow: 125,000 cu. ft.
Rock pressure: 135 lbs.

Formation	Thickness, ft.
Surface	67
Niagara	200
Guelph lime	50
Shale	47
Clinton	30
Red Medina	35
Shale	58
White Medina	12
Red shale	50
Total depth	549

Gas at 499 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lot 4, con. 2, Caistor tp.

Completed October 7, 1930.
Open flow: 35,000 cu. ft.
Rock pressure: 130 lbs.

Formation	Thickness, ft.
Surface	78
Niagara	200
Lime	50
Shale	48
Clinton	26
Red Medina	38
Blue shale	56
White Medina	12
Red shale	40
Total depth	548

Gas at 412 and 501 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lots 1 and 2, con. I, Caistor tp.

Completed October 4, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	78
Brown lime	45
Shale	15
Niagara	217
Guelph lime	20
Blue shale	35
Clinton sand	33
Red Medina	38
Grey shale	60
White Medina	14
Total depth	555

GRIMSBY NATURAL GAS CO., GRIMSBY
Lot 1, con. IV, Caistor tp.

Completed October 29, 1930.
Open flow: 24,000 cu. ft.
Rock pressure: 130 lbs.

Formation	Thickness, ft.
Surface	54
Niagara	200
White lime	50
Shale	54
Clinton	26
Red Medina	37
Shale	58
White Medina	15
Red shale	54
Total depth	548

Gas at 394 and 485 feet.

GRIMSBY NATURAL GAS CO., GRIMSBY
Lots 1 and 2, con. I, Caistor tp.

Completed October 23, 1930.
Open flow: 19,000 cu. ft.
Rock pressure: 180 lbs.

Formation	Thickness, ft.
Surface	89
Brown lime	33
Niagara	209
White lime	30
Blue shale	37
Clinton	34
Red Medina	35
Grey shale	69
White Medina	14
Red shale	40
Total depth	590

Gas at 440 and 541 feet.

DOMINION NATURAL GAS CO., DUNNVILLE
Lot 9, con. I, Caistor tp.

Completed December 10, 1930.
Open flow: 71,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Surface	79
Brown shale	20
Niagara	224
Guelph	20
Blue shale	35
Clinton	40
Red Medina	35
Grey shale	58
White Medina	14
Red shale	1
Total depth	526

Gas at 383 and 400 feet.
Water at 68 and 250 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 23, con. II, Caistor tp.

Completed December 9, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	72
Niagara	163
Lime and shale	50
Shale	40
Clinton	27
Red Medina	35
Blue shale	56
White Medina	13
Red shale	5
Total depth	461

Gas at 449 feet.
Water at 118 feet.

DOMINION NATURAL GAS CO., BLACKHEATH
Lot 9, con. I, Caistor tp.

Completed January 1, 1931.
Open flow: 44,800 cu. ft.
Rock pressure: 142 lbs.

Formation	Thickness, ft.
Surface	58
Shale	40
Brown lime	15
Niagara	222
Guelph	25
Blue shale	20
Clinton	35
Red Medina	36
Grey shale	56
White Medina	13
Red shale	1
Total depth	521

Gas at 398, 430, and 433 feet.
Water at 150 and 290 feet.

Manitoulin District

MANITOWANING OIL CO., MANITOULIN ISLAND
Lot 44, con. II, Assiginack tp.

Completed November, 1928.

Formation	Thickness, ft.
Surface	10
Brown and grey dolomite	200
Dark-grey shale	170
Dark-grey bituminous shale	30
Light-grey dolomite	57
Total depth	467

MANITOWANING OIL CO., MANITOULIN ISLAND
Lot 4, con. XIV, Assiginack tp.

Completed July 24, 1928.
Total depth of well 210 feet.

Middlesex County

A. TRELEAVEN, LONDON
Lot 16, con. 12, Metcalfe tp.

Completed August 22, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	70
Sand and gravel	18
Hardpan	6
Soapstone	8
Shale	60
Top rock	25
Soapstone	140
Middle lime	32
Soapstone	5
Lime	5
Soap and lime	26
Lower lime	105
Total depth	500

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 15, con. III, Mosa tp.

Completed March 27, 1930.
Open flow: 1,048,000 cu. ft.
Rock pressure: 950 lbs.

Formation	Thickness, ft.
Surface	80
Grey shale	39
Soap and shale	136
Soap	33
Big lime	927
Salt	105
Shale break	5
Salt	55
Big lime	417
Grey shale	13
Grey lime and shale	20
Clinton	13
Pink shale	7
Clinton	13
Grey shale and lime	88
White Medina	30
Red shale	3
Total depth	1,984

Gas at 1,511 and 1,854 feet.
Water at 429, 650, and 1,630 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 14, con. III, Mosa tp.

Completed June 11, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	122
Soap and shale	190
Broken brown lime and grey shale	848
Blue lime and shale	45
Brown gypsum	5
Grey and blue gypsum	35
Broken salt and grey lime	145
Broken brown lime and grey lime	265
Dark-grey sand	30
Broken brown lime and grey lime	140
Grey shale	37
Clinton	8
Red Medina	14
Broken grey and pink shale	46
Blue shale	30
Light-grey or white Medina	28
Grey shale	12
Red shale	6
Total depth	2,006

Water at 435, 451, 1,660, 1,810 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 14, con. III, Mosa tp.

Completed August 29, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	130
Soap and shale	160
Broken brown and grey lime	140
White water sand	20
Broken brown and grey lime	405
Brown lime and gypsum	20
Broken brown and grey lime	270
Grey lime and shale	75
Salt and grey lime	165
Broken brown and grey lime	210
Grey shale	40
Broken brown and grey lime	200
Clinton	7
Red shale	5
Red Medina	13
Light sand	5
Broken pink and grey shale	60
Hard grey lime or white Medina	30
Grey lime	12
Total depth	1,967

Gas at 1,512, and 1,856 feet.
Water at 435, 1,624, 1,655 and 1,860 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 15, con. III, Mosa tp.

Completed November 6, 1930.
Dry hole.

Formation	Thickness, ft.
Clay	74
Shale and soap	207
Lime and shell	5
Grey lime	119
Brown and grey lime	470
Grey lime and gypsum	145
Broken grey and brown lime	195
Salt	155
Brown and grey lime	417
Blue lime	45
Grey and red shale	6
Grey lime and Clinton	6
Grey shale	35
Pink and grey lime	100
Big red shale	6
Total depth	1,986

Showing of gas at 1,515 feet.
Water at 75, 425, and 512 feet.

SOUTHERN ONTARIO GAS CO., MERLIN
Lot 15, con. III, Mosa tp.

Completed December 20, 1930.
Dry hole.

Formation	Thickness, ft.
Surface	80
Black shale	10
Brown lime	30
Soap	160
Big lime	365
Sharp sand	155
Broken brown and grey lime	420
Salt	175
Brown lime	235
Niagara lime	130
Clinton white water sand	33
Blue shale	47
Clinton Grimsby	6
Red shale or mud	18
Blue shale	115
White Medina	4
Big red shale	12
Total depth	1,995

Water at 430 and 1,620 feet.

Norfolk County

TILLSONBURG OIL AND GAS CO., TILLSONBURG
Lot 5, S.T.R., Middleton tp.

Completed December 30, 1930.
Dry hole.

Formation	Thickness, ft.
Sand and clay	15
Quick sand	175
Shale and clay	43
Onondaga	190
Flint and sharp sand	152
Big lime	388
Guelph and Niagara	265
Rochester shale	60
Clinton	32
Red Medina	28
Blue shale	62
Hard slate	12
Sharp sand and slate	4
Red shale	8
Total depth	1,434

Water at 245, 425, and 1,030 feet.
Small flow of salt water at 1,315 feet.

Welland County

WELLAND COUNTY GAS SYNDICATE, STEVENSVILLE

Lot 16, con. X, Bertie tp.

Completed May 2, 1930.
Open flow: 30,000 cu. ft.
Rock pressure: 140 lbs.

Formation	Thickness, ft.
Surface	29
Salina	221
Guelph and Niagara	232
Rochester	65
Clinton	29
Red Medina sand	59
Red Medina shale	10
Manitoulin	40
White Medina	13
Queenston	40
Total depth	738

Gas at 585, 635, and 698 feet.
Water at 32 feet.

WELLAND COUNTY GAS SYNDICATE, STEVENSVILLE

Lot 16, con. XI, Bertie tp.

Completed March 24, 1930.
Open flow: 40,000 cu. ft.
Rock pressure: 85 lbs.

Formation	Thickness, ft.
Surface	28
Salina	217
Guelph and Niagara	233
Rochester	66
Clinton	31
Red Medina sand	59
Red Medina shale	8
Manitoulin	43
White Medina	9
Queenston	56
Total depth	750

Gas at 550, 634, and 694 feet.
Water at 47 feet.

WELLAND COUNTY GAS SYNDICATE, STEVENSVILLE

Lot 16, con. XI, Bertie tp.

Completed February 26, 1930.
Open flow: 23,000 cu. ft.
Rock pressure: 55 lbs.

Formation	Thickness, ft.
Surface	26
Salina	219
Guelph and Niagara	230
Rochester shale	57
Clinton	29
Red Medina sand	60
Red Medina shale	6
Manitoulin	35
White Medina	16
Queenston	54
Total depth	732

Gas at 540 and 678 feet.
Water at 38 feet.

WELLAND COUNTY GAS SYNDICATE, STEVENSVILLE

Lot 16, con. XII, Bertie tp.

Completed September 26, 1930.
Open flow: 35,000 cu. ft.
Rock pressure: 120 lbs.

Formation	Thickness, ft.
Surface	38
Salina	210
Guelph and Niagara	228
Rochester	58
Clinton	33
Red Medina sand	67
Red Medina shale	15
Manitoulin	24
White Medina	15
Queenston	45
Total depth	733

Gas at 541, 570, and 687 feet.
Water at 61 feet.

WELLAND COUNTY GAS SYNDICATE, STEVENSVILLE

Lot 14, con. XIII, Bertie tp.

Completed August 6, 1930.
Open flow: 23,000 cu. ft.
Rock pressure: 80 lbs.

Formation	Thickness, ft.
Surface	55
Salina	215
Guelph and Niagara	210
Rochester	63
Clinton	34
Red Medina sand	50
Red Medina shale	9
Manitoulin	38
White Medina	14
Queenston	5
Total depth	693

Gas at 550 and 590 feet.
Water at 58 feet.

WELLAND COUNTY GAS SYNDICATE, STEVENSVILLE

Lot 13, con. XIII, Bertie tp.

Completed July 3, 1930.
Open flow: 35,000 cu. ft.
Rock pressure: 85 lbs.

Formation	Thickness, ft.
Surface	47
Salina	218
Guelph and Niagara	225
Rochester	54
Clinton	35
Red Medina sand	60
Red Medina shale	7
Manitoulin	49
White Medina	12
Queenston	48
Total depth	755

Gas at 553, 600, and 707 feet.
Water at 69 feet.

WELLAND COUNTY GAS SYNDICATE, STEVENSVILLE

Lot 13, con. XI, Bertie tp.

Completed June 4, 1930.
Open flow: 16,000 cu. ft.
Rock pressure: 85 lbs.

Formation	Thickness, ft.
Surface	25
Salina	231
Guelph and Niagara	229
Rochester	65
Clinton	34
Red Medina sand	44
Red Medina shale	20
Manitoulin	29
White Medina	17
Queenston	43
Total depth	737

Gas at 556, 585, and 594 feet.
Water at 33 feet.

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 16, W. ½, con. IV, Crowland tp.
Completed October 25, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	123
Lime and shale	75
Niagara	230
Shale	55
Clinton rock	33
Red Medina	56
Grey shale	28
White Medina	20
Red shale	1
Total depth	621

W. C. PATTERSON, JAMESTOWN, N.Y.
Lot 15, con. V, Crowland tp.
Completed November 29, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	117
Lime and shale	82
Niagara	230
Shale	55
Clinton rock	33
Red Medina	59
Grey shale	28
White Medina	20
Red shale	2
Total depth	626

INDUSTRIAL NATURAL GAS CO., THOROLD
Lot 9, con. VII, Crowland tp.
Completed January, 1930.
Open flow: 14,500 cu. ft.
Rock pressure: 30 lbs.

Formation	Thickness, ft.
Surface	127
Salina	120
Guelph and Niagara	233
Rochester shale	60
Clinton	28
Red Medina	71
Manitoulin	25
White Medina	21
Queenston	30
Total depth	715

Gas at 545 and 684 feet.

York County

JOHN H. C. DURHAM, BOND LAKE
Lot 64, con. I, Whitchurch tp.
Completed 1926.
Dry hole.

Formation	Thickness, ft.
Surface	570
Hard clay	15
Black clay	15
Clay	10
Shaly clay	20
Clay	30
Collingwood	40
Trenton	580
Arkose	12
Granite.	
Total depth	1,292

Water at 80, 112, and 1,145 feet.

Surface Gas

Several surface gas fields in this province have been producing gas for a number of years at Beeton, Tecumseth township; at the southern outskirts of the city of Sarnia; and in the district between the towns of Ridgetown and Blenheim, Howard and Harwich townships. Surface gas has also been observed, but not utilized extensively, north of the city of Toronto at the town of Richmond Hill; at Sherwood Park, North Toronto; in the brickyard on Greenwood Avenue, Toronto; south of Danforth Avenue at the C.N.R. crossing; in lot 30, concession II, in the northern part of Pickering township, just south of the C.N.R.–C.P.R. crossing; at St. Augustine Seminary, lot 25, concession B, Scarborough township, a few miles east of Toronto; at the city of Chatham; and in Russell county along the Ottawa river.

This surface gas is quite a different gas from that found in the sedimentary rocks. It is practically a pure methane and nitrogen, whereas the rock gases carry higher hydrocarbons than methane.[1] The surface gases carry only a trace of helium, while the rock gases carry up to 0.80 per cent. helium.[2] The surface gases run high in carbon dioxide, while the rock gases rarely have any, or, if they have, less than three-tenths of 1 per cent. The sample of gas from Caledon township is the outstanding exception to this. It is identical with the surface gas in all but the helium content in which it excels any of them in richness.[3]

[1]G. R. Mickle, "The Chemical Composition of Natural Gas Found in Ontario," Ont. Dept. Mines, Vol. XXIII, pt. 1, 1914, p. 267; R. B. Harkness, Ont. Dept. Mines, Vol. XXXII, pt. 5, 1924, p. 13.
[2]Ont. Dept. Mines, Vol. XXXV, pt. 5, 1926, pp. 11-15.
[3]A recent analysis from a well near Bronte gave 1 per cent. helium in a gas from the same horizon as the gas in the eastern part of Caledon township.

This gas horizon is, however, only a hundred feet above the top of the Utica shales and may have its origin in these bituminous shales. These surface gases are, in most instances, found where there are a hundred feet or more of heavy clays over a gravel bed, which, in turn, rests on the bed rock; in almost every case, this underlying rock is a bituminous shale. This, in Kent and Lambton, is the Huron black shale, and in the district between Beeton village and Toronto and also in Russell county is the Utica shale. The Utica shale and probably the Collingwood shale are exposed between Beeton and Toronto by the deep wide trench cut by the ancient river joining the east end of Georgian bay through the central parts of Simcoe and York counties to Lake Ontario at Toronto. Judging from the depth of the surface south of Cherrywood and from the fact that the bottom of the ancient river valley at Bond lake, Whitchurch township, is found to be deep in the Collingwood shales at about sea level and within thirty feet of the top of the Trenton limestone, it is possible that an embayment in the ancient Lake Iroquois[1] or a tributary river valley might also be in the Utica. This, of course, is at best a deduction based on the fact that the river channel at Bond lake and Richmond Hill must drain into Lake Ontario and that the course of the channel would be along the Don river; but the recent work on the waterworks tunnel on the lake front at Toronto has shown that this great channel does not enter Lake Ontario between Scarborough and the Humber, although I am informed by the engineer in charge that two channels 400 feet wide, cut to a depth of 88 feet above sea level, were noted at the Don river and at Woodbine avenue. These might be a part of the delta mouth of such a river, and its main mouth might be immediately to the east of Scarborough. These channels do not reach the Utica shales, but it is possible that the main channel may. The surface gases at and near Toronto come from the interglacial gravels (Toronto formation) a hundred feet or more below the surface, with an unknown thickness of clays and till lying below and resting on the Dundas (or Utica?) shale.

The origin of this surface gas is a matter of speculation. Mickle[2] suggests that this is a marsh gas derived from the decomposition of vegetable matter. This may easily be the case, as Coleman[3] finds in the Scarborough beds the remains of mosses and swamp plants and beetles, which are lacustrine deposits of laminated clays, including, in some places, the interglacial gravels and, in others, covering the lower boulder clay, which is, in most cases, a thin deposit resting on the bituminous Utica or Collingwood shales. The case against this is that any gas from these vegetable or animal remains must find its way down to the gravel bed and displace the water therein, while gas from these bituminous shales would, in the ordinary course of events, move upward. Of course, we have no certain knowledge that gas is generated in these black shales, but we do know that oil and gas can be and were distilled from the Collingwood shales in 1859.[4] Evidence of sufficient heat during or since the ice age is certainly lacking, as is also the evidence that marsh gas is confined and stored, or that decomposition of vegetable matter goes on after it is buried under water and silt.

The origin of the gas in the interglacial gravels at Toronto, which may be separated from the Utica shales by three hundred feet or more, would seem to be inexplicable by the bituminous shale theory. In the Toronto area the ancient river channel previously mentioned cuts the Dundas shale at the horizon

[1]A. P. Coleman, "Toronto and Vicinity," Ont. Bur. Mines, Twelfth Internat. Geol. Cong., Guide Book No. 6, 1913.
[2]G. R. Mickle, op. cit.
[3]A. P. Coleman, op. cit.
[4]W. E. Logan, Geol. Surv. Can., Rept. Prog. from Its Commencement to 1863, pp. 784, 785.

in which the gas is found in Caledon township, Peel county. This gas horizon in the Dundas shale covers the area from Georgian bay to Lake Ontario. As will be seen by reference to the table of analyses, the gases in Caledon and Scarborough are similar. Unfortunately, the helium content of the Scarborough gas was not taken, but the evidence is sufficiently strong to assign the Toronto surface gas to a seepage from the Dundas shales.

The commercial production tabulated below came from gravel beds overlying black shales. The Ridgetown field is by far the largest in the province and, so far as the writer is aware, the largest on record. The gas produced from this field is the equivalent of 12,000 tons of coal. The insert map facing page 52 shows the area underlain by black shales and indicates places where other gas fields may be found in the drift.

The following table shows the measured quantity and value of this surface gas used to date. The quantity unmeasured may easily exceed this, as it has been used in homes in these localities for thirty years and more.

GAS FROM SURFACE DRIFT SOLD IN ONTARIO

County	Field	Year	Production	Retail value at 60 cents per M cu. ft.
			M cu. ft.	
Kent	Ridgetown	1924–30	248,774	$145,611
Lambton	Sarnia[1]	1926–29	10,632	6,379
Total			259,406	$151,990

[1]The life of this small pool as a commercial producer was finished in 1929. There is still considerable gas in it, but the pressure has been reduced until no more gas will enter the pipe line.

ANALYSES OF ONTARIO NATURAL GASES[1]

Locality	H_2S	CO_2	CH_4	C_2H_6	C_3H_8	N	He(2)	Formation
Lot 7, con. I, Gosfield South tp., Essex co	0.30	.....	87.6	7.3	.....	4.8	0.15	Guelph.
Tilbury field, Kent co	.30	.....	87.3	5.5	1.4	5.5	.11	Guelph.
Tilbury field, Kent co. (purified).	trace	.....	86	10.9	(3)	3.1	(3)	Guelph.
Transmission line to Hamilton, Haldimand co	.....	0.10	83.5	7.1	1.9	7.4	.31	Clinton & Medina.
Transmission line to Niagara Falls, Welland co	.....	.....	79.8	9	1.8	9.4	.24	Clinton & Medina.
Inglewood, Caledon tp., Peel co.	.....	.....	86.7	.....	.....	13.3	.80	Dundas shales.
Beeton, Simcoe co	.....	.90	77.9	.....	.....	21.2	.01	Surface.
Scarborough tp., York co	.....	1.65	85.15	.....	.....	13.2	(3)	Surface.
Howard tp., Kent co	.....	.....	83	.....	.....	17	.03	Surface.
Sarnia, Lambton co	.....	.2	95.9	1.4	.....	2.5	.03	Surface.

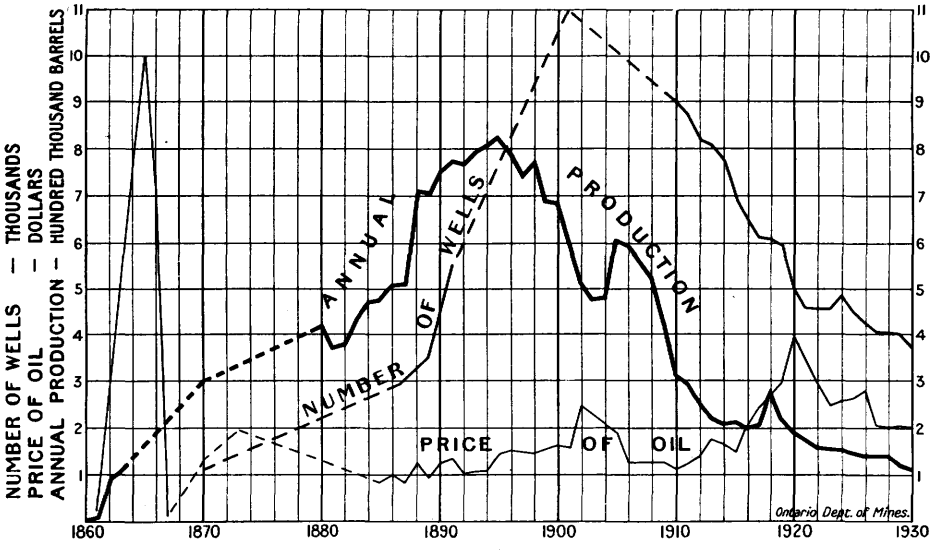
[1]These analyses are from various reports of the Ontario Department of Mines already cited.
[2]The helium analyses are by R. J. Elworthy, Mines Branch, Ottawa, Bull. No. 679.
[3]Fraction not taken.

PETROLEUM IN 1930

By R. B. Harkness

General

The production of petroleum in Ontario has shown an annual decrease since the year 1907. In the year 1917 the production from the township of Dover and the field near the village of Thamesville brought up the rate for a few years, but no new fields of any importance have been found since that date and the decline has been uninterrupted. The production in 1930 shows a decrease of 3,823 barrels from that in 1929, the production in 1930 being 117,302



Graph of the crude oil industry in Ontario for the past seventy years.

barrels and the value $235,746. The decline is just a little less than normal, in spite of the drop in the price of oil. The graph above shows that, if no new sources of petroleum are discovered, the petroleum industry will cease to exist within ten or twelve years. Most of the wells in the Petrolia, Oil Springs, and Bothwell fields are many years old; the casing and equipment are corroded, and when spring freshets put additional strains on the casing, many of them collapse. On account of the large percentage of unoperated wells, it is exceedingly difficult to find leaks. The price of oil has reached a level where the operators claim that there is no profit in operating wells; consequently, numbers of wells are abandoned that might otherwise be repaired. Unless some means of bringing oil to the surface for less money, or some means of increasing the flow of oil, is found, the old fields of Ontario will soon be a memory.

The production, value, and other information relating to the oil industry in Ontario will be found in the following tables:—

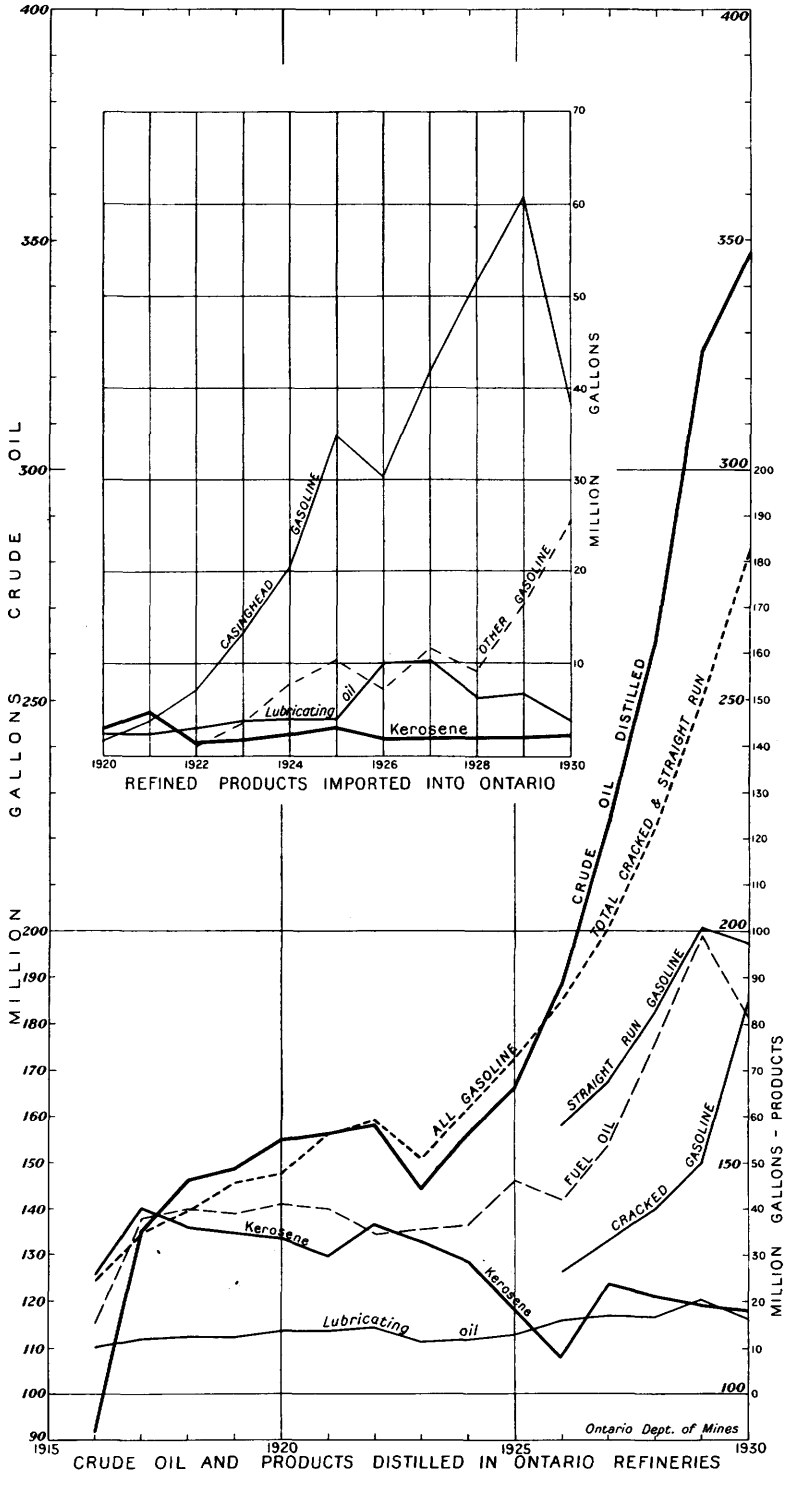
TABLE I—OIL PRODUCED IN ONTARIO BY FIELDS, 1923–1930

Field	1923	1924	1925	1926	1927	1928	1929	1930
	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	64,159	60,916	53,166	55,485	59,424	60,547	56,284	55,130
Oil Springs	39,090	41,320	39,137	38,349	37,281	35,653	30,737	29,160
Moore tp	4,790	4,483	8,195	2,438	2,112	2,148	1,230	1,576
Sarnia tp	2,387	2,068	1,905	1,890	1,590	1,221	749	1,149
Plympton tp	872	525	1,424	1,047	1,241	371	315	296
Bothwell	27,665	26,700	26,243	25,382	25,224	24,255	23,236	21,176
Tilbury East tp	1,950	.....	.....	.....	60	736	138	149
Dover West tp	5,618	3,898	2,957	959	602	773	715	457
Raleigh tp	302	783	887	676	276	.....	.....	.....
Onondaga tp	237	456	261	361	210	186	243	231
Mosa tp	10,319	8,862	8,397	7,868	7,447	7,268	6,851	7,166
Thamesville	567	.....	289	2,376	4,139	1,006	427	447
Euphemia tp	.....	.....	39	.....	.....	.....	.....	.....
Dunwich tp	594	1,351	1,001	139	.....	.....	148	365
Romney tp	849	2,955	1,235	.....	.....	.....	.....	.....
Brooke tp	.....	.....	.....	.....	.....	.....	52	.....
Total	159,399	154,317	145,136	136,971	139,606	134,164	121,125	117,302
Value	$395,300	$390,423	$369,154	$376,822	$289,391	$249,981	$253,678	$235,746
Average price	$2.47	$2.51	$2.56	$2.73	$2.11	$1.86	$2.09	$2.00

TABLE II—OIL WELLS AND THEIR PRODUCTION, 1930

Field	Wells			Wells drilled		Production		Gain or loss in 1930		Average production per well per year
	Operating	Not operating	Abandoned	Producing	Dry			Gain	Loss	
						bbls.	gals.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	816	898	116	.....	.....	55,130	16	.....	1,153	67.19
Oil Springs	924	136	114	.....	.....	29,159	24	.....	577	31.19
Moore tp	47	48	3	.....	.....	1,576	18	347	.....	33.19
Sarnia tp	57	66	3	.....	.....	1,148	21	399	.....	20.5
Plympton tp	13	18	2	.....	2	296	.....	.....	18	22.26
Bothwell	261	34	10	.....	.....	21,175	30	.....	2,061	81.4
Dover West tp	2	.....	.....	.....	.....	456	31	.....	258	228.15
Raleigh tp	.....	6	.....	.....	.....	.....	.....	.....	.....	.....
Onondaga tp	11	26	.....	.....	.....	230	25	.....	12	20.34
Mosa tp	74	33	1	.....	.....	7,166	10	316	.....	96.29
Thamesville	6	18	4	.....	.....	446	27	20	.....	74.16
Euphemia tp	.....	81	16	.....	.....	.....	.....	.....	.....	.....
Dunwich tp	10	89	.....	.....	.....	365	19	217	.....	36.19
Dawn tp	.....	40	.....	.....	.....	.....	.....	.....	.....	.....
Brooke tp	.....	3	.....	.....	.....	.....	.....	.....	.....	.....
Tilbury East tp	1	.....	.....	.....	.....	148	27	10	.....	148.10
Other fields	.....	1	.....	.....	6	.....	.....	.....	.....	.....
Total	2,222	1,497	269	0	8	117,302	3	1,309	4,079	.....
								Net loss, 2,770		

Exploratory drilling has been dealt with in the Natural Gas section of this report. It is impossible to separate oil and gas in exploratory work, as it is not known which product will be encountered until the well is completed.


MILLION GALLONS CRUDE OIL
MILLION GALLONS - PRODUCTS
GALLONS
MILLION
CASINGHEAD GASOLINE
OTHER GASOLINE
Lubricating oil
Kerosene
1920
1922
1924
1926
1928
1930
REFINED PRODUCTS IMPORTED INTO ONTARIO
CRUDE OIL DISTILLED
TOTAL CRACKED & STRAIGHT RUN
ALL GASOLINE
STRAIGHT RUN GASOLINE
FUEL OIL
CRACKED GASOLINE
Kerosene
Kerosene
Lubricating oil
Ontario Dept. of Mines
1915
1920
1925
1930
CRUDE OIL AND PRODUCTS DISTILLED IN ONTARIO REFINERIES

The capital invested in operating oil wells and the equipment pertaining to these is $1,546,021. The number of men employed operating the wells shown in Table II is 125 and the wages paid to them $94,952. This information has been supplied by the Dominion Bureau of Statistics, Ottawa.

Price of Crude Petroleum

The following prices are published through the kindness of the Imperial Oil Company, of Sarnia, and show the fluctuations in the market price of oil in Ontario during 1930. The prices follow those of the United States very closely, as the price of imported oil controls the market. The variation of the prices as between fields is due to the specific gravity of the oil; the lightest oil, or that containing most gasoline, commands the highest price.

January 1 to February 14	$2.20
February 15 to April 10	2.05
April 11 to June 27	2.10
June 28 to December 31	1.95

The price of crude petroleum from Oil Springs is 7 cents higher than the above prices. The price of oil from the remainder of the fields, where most of the production is secured, is the same as Petrolia crude; some of the smaller fields have a slightly lower quality, and the price paid for it is a few cents less than Petrolia crude.

Petroleum Refining

Four refineries were in operation in the year 1930 and worked at full capacity.

PETROLEUM REFINERIES, 1930

Company	Location of refinery	Head office address
British American Oil Co., Ltd.	Foot of Cherry St., Toronto	Royal Bank Bldg., Toronto.
Canadian Oil Companies, Ltd.	Petrolia	Excelsior Life Bldg., Toronto.
Imperial Oil Refineries, Ltd.	Sarnia	Sarnia.
McColl Bros	Foot of Cherry St., Toronto	114 Don Esplanade, Toronto.

The total number of employees for the year was 2,449; the salaries and wages paid amounted to $3,760,870; and the capital invested was $26,761,273.

The graph (opposite) of the refining industry shows how petroleum refiners in Ontario in the last fifteen years have met the demand for petroleum products created by the motor vehicle. The annual increase in the production of gasoline over all other products reflects this, as well as the progress made in extracting more and more gasoline from a barrel of crude petroleum, which is most noticeable in the year 1930.

A study of the imports of refined petroleum products for ten years also emphasizes the increase in the demand for motor fuel above all other products.

Refined Petroleum Products Produced and Imported

An analysis of Tables III and IV will give an indication of the consumption of refined products in Ontario.

It is to be expected that the present industrial depression will be reflected in the petroleum refining industry. It is, however, apparent only in a reduction in the rate of increase and not in a loss. The products derived from crude oil show an actual loss in all items excepting cracked gasoline, in which there is

a decided increase. This is explained by the increased use of "cracked" gasoline, which, where necessary, has anti-knock fluids added to it. There is a drop, from 1929 to 1930, in the total recovery of products from crude.

As is to be expected, there is a corresponding decrease in the refined products imported, the greatest being in casing head or blending gasoline. There was an increase in the quantity of commercial gasoline imported, but a decrease of over twelve million gallons in the total of all grades. Fuel oil shows a slight increase. The grand total shows a decrease of over 10 per cent. from 1929 to 1930.

A glance at the values will show at once the decrease in the price of crude oil and all its products, whether manufactured in Ontario or imported. At the end of the year prices were much lower than at the beginning, and as all Canadian prices follow the price of crude oil in the United States, there is every evidence that 1931 prices will be lower still. At the time of writing (July, 1931), the price of crude oil and its products in the United States is the lowest on record in fifty years.

TABLE III—PETROLEUM REFINING OPERATIONS, 1926–1930

Schedule	Unit of measure	1926	1927	1928	1929	1930
Canadian crude produced	Gallons[1]	4,693,999	4,886,199	4,695,714	4,239,383	4,105,570
	Value	$376,822	$289,391	$266,346	$253,678	$235,746
Imported crude distilled	Gallons	183,347,749	218,200,977	257,929,514	321,687,678	343,372,124
	Value	$16,940,505	$15,900,079	$17,617,756	$23,341,514	$23,273,547
Canadian crude distilled	Gallons	5,017,500	5,205,097	4,484,858	4,426,863	3,944,969
	Value	$422,159	$363,320	$283,959	$292,949	$264,008
Percentage of total		2.66	2.33	1.71	1.35	1.13
PRODUCTS						
Gasoline:						
Straight run	Gallons	58,222,949	67,976,379	83,067,789	101,276,701	97,806,121
	Selling value	$10,488,817	$9,287,286	$12,403,342	$14,521,648	$12,334,586
By cracking process	Gallons	26,659,563	32,968,207	39,724,303	49,884,248	84,496,056
	Selling value	$4,483,731	$4,354,802	$5,803,963	$7,176,654	$11,066,369
Illuminating oil	Gallons	8,088,787	23,712,369	21,304,385	19,138,614	17,973,730
	Selling value	$1,266,577	$2,828,872	$2,650,877	$2,516,618	$1,980,546
Lubricating oil	Gallons	16,025,753	17,040,724	16,822,292	20,452,106	16,451,717
	Selling value	$3,540,786	$3,237,375	$2,813,371	$3,707,592	$2,756,579
Engine distillate and naphtha	Gallons	53,869	4,045,416	3,062,787	5,845,447	4,272,751
	Selling value	$10,774	$510,960	$445,526	$811,240	$504,206
Gas and fuel oil	Gallons	41,883,125	53,767,638	76,469,354	99,035,616	80,742,218
	Selling value	$2,949,770	$3,280,343	$4,104,338	$5,016,370	$3,792,757
Tar and grease	Pounds	11,260,812	11,254,706	14,626,752	18,078,346	14,486,464
	Selling value	$221,826	$221,694	$267,563	$325,206	$276,649
Paraffin wax and candles	Pounds	9,858,490	9,526,072	17,030,064	10,784,609	10,153,924
	Selling value	$648,303	$505,133	$599,341	$538,233	$453,601
Acid and petroleum coke	Short tons	45,774	44,768	49,409	67,599	56,946
	Value	$265,481	$282,828	$314,794	$396,565	$316,180
Acid oil	Gallons	711,970	768,171	[2]	[2]	[2]
	Value	$35,823	$46,634	[2]	[2]	[2]
Still gas	M cu. ft.	630,325	811,666	823,320	1,103,142	1,551,334
	Value	$256,935	$207,370	$185,595	$270,479	$421,500
Asphalt	Gallons		1,060,761	1,276,098	2,664,199	6,029,624
	Selling value		$58,919	$65,003	$137,714	$285,460
Miscellaneous	Value	$2,978	$434,655	$387,544	$258,113	$291,404
Total value of refined products		$24,182,575	$25,256,353	$30,033,257	$35,676,432	$34,479,837
Employees	Average No.	2,241	1,871	1,853	2,313	2,449
	Wages	$2,876,150	$2,883,575	$3,013,872	$3,657,619	$3,760,870
Capital invested		$20,441,740	$19,354,638	$19,570,531	$26,784,547	$26,761,273

[1]Gallons refer to Imperial gallons.
[2]Included in acid coke.

TABLE IV—PETROLEUM AND REFINED PRODUCTS IMPORTED IN 1929 AND 1930[1]

Import	1929		1930	
	Imperial gallons	Value	Imperial gallons	Value
CRUDE PETROLEUM:				
Petroleum, 0.790 specific gravity or heavier, for refining	328,662,742	$15,857,155	323,627,779	$12,862,300
REFINED PETROLEUM:				
For use in concentrating ores	3,762	$2,406	51,132	$24,689
Gasoline lighter than 0.725 specific gravity (casing head)	60,813,222	6,083,445	38,787,934	3,451,969
Gasoline between 0.770 and 0.725 specific gravity	16,791,277	1,910,086	14,447,650	1,574,560
Gasoline higher than 0.8235 specific gravity	.....	.....	10,983,133	945,506
Gas oils, other than naphtha and gasoline, between 0.8235 and 0.775 specific gravity	11,736	1,188	91	13
Kerosene and illuminating oils	2,102,344	172,629	2,139,179	141,370
Fuel oil, 0.8235 specific gravity and heavier	7,317,164	447,084	9,556,454	496,559
Lubricating oils, consisting wholly or in part of petroleum, costing less than 25 cents a gallon	2,617,988	446,677	3,631,651	628,662
Lubricating oils, all other	4,009,183	1,706,904	3,018,605	1,290,951
All other oils	153,421	96,101	179,098	86,366
Total	93,820,097	$10,866,520	82,794,927	$8,640,645
PETROLEUM PRODUCTS:				
Axle grease.....lbs.	2,577,524	$117,144	2,268,980	$104,008
Vaseline, toilet and medicinal petroleum	.....	153,117	.....	114,973
Paraffin wax.....lbs.	1,554,440	64,444	1,428,383	50,759
Paraffin wax candles.....lbs.	305,700	54,474	327,221	65,153
Other petroleum products.....gals.	1,477,860	239,496	1,214,790	175,254
Total	.....	$628,675	.....	$510,147
Total value	.....	$27,356,350	.....	$22,013,092

[1]These statistics are furnished through the courtesy of the Department of Customs and Excise.

Total net value of petroleum and refined products imported in 1930	$22,013,092
Duty paid on the above, calculated on the existing tariff schedule	991,551
Sales tax at 1 per cent. on taxable items	225,104
Freight, approximately	11,000,000
Total value delivered in Ontario	$34,229,747

INDEX, PART V.

A

PAGE

Abandoned gas wells, number of..... 8, 9
Abbreviations for gas-well localities.... 20
Acid coke, statistics..... 58
Acme Gas and Oil Co.
  Bore-hole records.....39, 43
  Licenses.....16, 19
Acres under gas lease, number of..... 8, 9
Ajax Oil and Gas Co.
  Licenses.....16, 19
  Work by, Tuscarora Indian Reserve 10
Aldborough tp.
  Gas statistics..... 6
Alvinston.
  Gas leakage..... 13
    statistics..... 4
Amabel gas field.
  Production..... 1
  Wells..... 9
American Engineering Co.
  Gas well..... 40
  Licenses.....16, 19
Analyses of Ontario gases..... 53
Ancaster tp., gas statistics..... 7
Anderdon tp., logs of wells..... 23
Andross estate, gas well..... 29
Annett, Stan. C..... 16
Armstrong, Mrs. Sarah, gas well..... 23
Artificial gas.
  List of municipalities using. *See* map 40*g*.....*in pocket*
  Production..... 1
Asphalt, statistics..... 58
Assiginack tp., bore-hole..... 48
Axle grease, statistics..... 59
Aylmer, gas statistics..... 4

B

Baker, John.....16, 18
Barton tp., gas statistics..... 7
Bartonville, gas statistics..... 4
Basic Resources, Ltd., bore-hole records 40
Bayham gas field.
  Production..... 1
  Statistics..... 6
Bayham tp.
  Gas statistics..... 5
    wells..... 8
  Pipe lines. *See* map 40*g*.....*in pocket*
Beeton.
  Gas analysis..... 53
  Surface gas.....51, 52
Belle River.
  Gas leakage..... 13
    statistics..... 4
Belmont.
  Gas leakage..... 13
    statistics..... 4
Benner and Schafer, license..... 18
Bertie tp.
  Bore-hole record..... 50
  Gas statistics..... 7
    wells..... 9
Binbrook, gas statistics..... 4
Binbrook tp.
  Gas statistics..... 7
    wells..... 9

PAGE

Bituminous shale.
  As source of surface gas..... 52
  Outcrops. *See* insert.....*facing* 52
Blain, Dr. E. B..... 16
Blake system, Raleigh tp.
  Rural gas lines, leakage and pressure 15
Blenheim.
  Gas statistics..... 4
    leakage..... 13
    surface..... 51
Bloomfield and Culver..... 18
Bond I., Whitchurch tp..... 52
Border Cities, gas statistics..... 5
Bore-hole records..... 20-53
Bothwell.
  Gas statistics..... 4
    leakage..... 13
Bothwell oil field.
  Production (1923-1930)..... 53
Brant co.
  Gas statistics..... 1, 6
    wells..... 9
      logs..... 21-23
Brantford.
  Gas statistics..... 4
    leakage..... 13
Brantford tp., gas statistics..... 6
Brantford Gas Co.
  Gas leakage..... 13
    license..... 19
Bridgeburg, gas statistics..... 4
Brigden.
  Gas statistics..... 4
    leakage..... 13
Brighton, Percy Lawrence..... 16
British American Oil Co..... 57
British Petroleum Co., oil wells..... 44
Bronte, helium in gas..... 51
Brooke tp.
  Gas statistics..... 5
  Oil production (1923-1930)..... 55
Bruce co.
  Gas statistics..... 1
    wells..... 9
Burdick, Lyle D..... 16
Burford tp., gas statistics..... 6
Burlington, gas statistics..... 4

C

Cainsville.
  Gas statistics..... 4
    leakage..... 13
Caistor tp.
  Bore-hole records..... 45-48
  Gas statistics..... 7
    pipe lines. *See* map 40*g*.....*in pocket*
    wells..... 9
Caledon gas field.
  Gas production..... 1
    wells..... 9
  Helium in gas..... 51
Caledonia, gas statistics..... 4
Camden tp., gas statistics..... 6
Camden tp., gas statistics: population.. 6
Cameron, J. A..... 16
Canadian Oil Companies, Ltd..... 57
Canadian Salt Co., bore-hole record... 24
Canboro Gas and Oil Co..... 19

PAGE

Canborough tp.
Gas statistics ... 7
wells ... 8, 24
Candles, statistics ... 58, 59
Canfield, gas statistics ... 4
Canfield Natural Gas Co. ... 19
Capital.
Invested in gas industry ... 3
oil industry ... 57, 58
Carr, Walter, gas well ... 23
Carter, Lawrence ... 16
Cayuga, gas statistics ... 4
Cayuga tps. *See* North Cayuga tp.; South Cayuga tp.
Central Development Co. ... 16
Central Oil Co. ... 16
Central Pipe Line Co.
Pipe lines. *See* map 40g ... *in pocket*
Licenses ... 19, 20
Charlotteville tp.
Gas statistics ... 6
wells ... 8
Chatham.
Gas statistics ... 4
leakage ... 13
surface ... 51
Chatham tp.
Gas statistics ... 6
leakage and pressure, rural line ... 15
Chatham Gas Co. ... 19
Cherry, Robert ... 16, 18
Cherrywood, Ont. ... 52
Chippawa, gas statistics ... 4
Cities.
Gas statistics ... 4, 5
Cliff Gas Co. ... 19
Clive, George ... 16
Coatsworth, gas statistics ... 4
Coke, acid and petroleum, statistics ... 58
Coleman, A. P. ... 52
Coleman, J. A. ... 19
Comber.
Gas statistics ... 4
leakage ... 13
Comfort, Alex ... 16
Concentrating ore, oil for ... 59
Cooper, E. J. ... 16
Counties, gas statistics ... 6-9
Courtland, gas statistics ... 4
Courtright.
Gas statistics ... 4
leakage ... 13
Cottam, gas statistics ... 4
Cowley, E. H. ... 16
Crowland tp.
Gas statistics ... 7
wells ... 9
logs ... 51
Crude oil.
Distilled in Ontario refineries, graph 56
Crumlin gas field, production ... 1
Crystal Beach, gas statistics ... 4
Culver, Gordon ... 16
Culver, Rupert ... 16
Culver and Bloomfield ... 18
Customs duty, petroleum products ... 59

D

Davies, Jos. R. ... 16
Dawn gas field ... 2, 10
See also Lambton co.

PAGE

Dawn tp.
Bore-hole records ... 44, 45
Gas statistics ... 5
wells ... 8
Oil production (1923-1930) ... 55
De Clute gas field, extension ... 2, 10
Delhi, gas statistics ... 4
Distillate, engine, statistics ... 58
Distribution plants, leakage in ... 7, 13, 14
Dodd, J. G. ... 16
Dominion Natural Gas Co.
Bore-hole records:
Brant co. ... 21
Haldimand co. ... 24-39
Lincoln co. ... 48
Gas leakage ... 13, 14
licenses ... 16, 19
pipe lines. *See* map 40g ... *in pocket*
work by, Norfolk-Haldimand field 10
Don r., channels ... 52
Doran, Benj. ... 16
Dorchester.
Gas statistics ... 4
leakage ... 13
Dorchester N. tp.
See North Dorchester tp.
Dover gas field, production ... 1
Dover tp.
Gas lines, rural ... 15
statistics ... 6
wells ... 8
logs ... 39, 40
Oil production (1923-1930) ... 55
Dresden.
Gas statistics ... 4
leakage ... 13
Drilling for gas.
See also Gas wells.
Explanatory notes on ... 10
Dumfries S. tp. *See* South Dumfries tp.
Dundas.
Gas statistics ... 4
leakage ... 13
Dundas co., logs of wells ... 23
Dunn tp.
Bore-hole records ... 24
Gas statistics ... 7
wells ... 8
Dunn Natural Gas Co. ... 19
Dunnville.
Gas statistics ... 4
leakage ... 13
Dunwich tp.
Gas statistics ... 6
Oil production (1923-1930) ... 55
Durham, John H. C., gas well ... 51
Dutton, gas statistics ... 4
Duty on petroleum products ... 59

E

East Oxford tp., gas statistics ... 6
Echo Place, gas statistics ... 4
Eden, gas statistics ... 4
Elgin co.
Gas statistics ... 1, 6
wells ... 8
logs ... 23
Ellwood, John ... 16
Elworthy, R. J. ... 53
Employees. *See* Wages.

PAGE
Engine distillate, statistics..... 58
Enniskillen oil field
Production (1923-1930)..... 55
Enniskillen tp.
Gas, rural lines, leakage and pressure 15
statistics..... 6
wells..... 8
Enterprise Gas Co..... 19
Erie Gas and Oil Synd.....18, 19
Essex, gas statistics..... 4
Essex co.
Gas statistics..... 1, 6
wells..... 8
logs.....23, 24
Euphemia tp.
See also Dawn gas field.
Gas wells..... 8
Oil production (1923-1930)..... 55
Exploratory drilling for gas, notes.....10, 11

F

Fairground, gas statistics..... 4
Fenwick.
Gas statistics..... 4
leakage..... 13
Fingal, gas statistics..... 4
Fischer, E. F..... 16
Fisherville, gas statistics..... 4
Fisherville Gas Co..... 19
Flood, William..... 16
Florence.
Gas statistics..... 4
leakage..... 13
Flynn, E. Miles..... 16
Fonthill, gas statistics..... 4
Fort Erie, gas statistics..... 4
Free gas, consumption..... 4-7
Freeman, George..... 16
Fuel oil, statistics..... 58

G

Gainsborough tp.
Gas consumption..... 7
wells..... 9
Pipe lines. *See* map 40*g*.....*in pocket*
Galt.
Gas statistics..... 4
leakage..... 13
Gas. *See* Artificial gas; Natural gas; Surface gas.
Gas, still, statistics..... 58
Gas leakage..... 11-15
Gas oil, statistics..... 58
Gas pressure.
Distribution plants and transmission lines.....13, 14
Gas wells.
Logs..... 21-53
Statistics..... 7, 8
Gasoline, statistics..... 58
Geddes, Earl W..... 16
Gifford, Arthur, and Son..... 19
Gillies, Arthur..... 16
Glanford tp.
Gas statistics..... 7
wells..... 9
Glenn, S. J..... 16
Gosfield North tp., gas statistics..... 6
Gosfield South tp.
Boring records..... 24
Gas, analysis..... 53
statistics..... 6
wells..... 8
Grantham tp., gas statistics..... 7
Graph.
Gas industry, 40 years..... 2
Oil industry (1860-1930).....54, 56
Gray, Ira..... 16
Grease, statistics..... 58
Greenwood, J. W..... 16
Gregory, F. R..... 16
Grey. *See* St. Vincent tp.
Grierson, Andrew..... 16
Grimsby, gas statistics..... 4
Grimsby sandstone..... 10
Grimsby tp.
Pipe lines. *See* map 40*g*.....*in pocket*
Grimsby Natural Gas Co.
Bore-hole records.....45-48
License..... 19
Pipe lines. *See* map 40*g*.....*in pocket*

H

Hagersville.
Gas statistics..... 4
leakage..... 13
Haldimand co.
Gas statistics..... 1, 7
wells..... 8
logs.....24-39
private..... 9
Haldimand gas field reserves..... 2
See also Dominion Natural Gas Co.
Haldimand Gas Fields Syndicate..... 19
Hamilton.
Analysis of gas transmitted to..... 53
Harkness, R. B.
Report by, on Natural gas (1930)... 1-53
Petroleum (1930).....54-59
Harwich tp.
Gas lines, rural, leakage and pressure 15
statistics..... 6
surface..... 51
wells..... 9
Helium in natural gas..... 51
Hepworth, gas statistics..... 4
Highbank Oil Co..... 10
Highgate, gas statistics..... 4
Hints to gas prospectors..... 11
Hoover, A. E.....16, 18
Hottinger, E. C..... 16
Houghton tp., gas wells..... 8
Howard, W. C..... 16
Howard gas field, production..... 1
Howard tp.
Gas analysis..... 53
rural lines, leakage and pressure... 15
statistics..... 6
surface..... 51
wells..... 9
Humberstone, gas statistics..... 5
Humberstone tp.
Gas statistics..... 7
wells..... 9
Huron black shale..... 52
Hurst, Clifford..... 16
Hussey, W. J.....16, 18

I

PAGE

Illuminating oil, statistics..... 58
Imperial Oil Refineries, Ltd..... 57
Imported gas..... 1
  Refined products..... 56-59
Industrial gas, consumption..... 6
Industrial Natural Gas Co.
  Bore-hole records.....40, 51
  Licenses..... 16-19
Ingersoll.
  Gas statistics..... 4
    leakage..... 13
Inglewood, analysis of gas..... 53
Interglacial gravels, Toronto, origin... 52
Inwood.
  Gas statistics..... 4
    leakage..... 13
Ironside, E. H..... 16

J

Jackson, Percy L..... 18
James, Francis Leigh..... 16
Jarvis, gas statistics..... 4
Jasperson, Bon.....16, 18, 19
Josh, Thomas..... 18
Joyce, Joseph..... 16

K

Kent co.
  See also Ridgetown gas field.
  Gas statistics..... 1, 6
    wells..... 8
      logs..... 39-43
  Huron black shale..... 52
Kent gas field, core-drilling..... 2
Kerosene statistics..... 59
Kervin and Dawson..... 18
Kingsville.
  Gas statistics..... 4
    leakage..... 13
Kingsville gas field, production..... 1
Kiser Bros..... 18
Kohler, Jacob..... 16

L

Labour. *See* Wages.
Lake Shore, gas statistics..... 4
Lake Shore Natural Gas Co..... 19
Lambeth, gas statistics..... 4
Lambier, Chas. Nelson..... 16
Lambton co.
  See also Sarnia gas field.
  Gas statistics..... 1, 6
    wells..... 8
      logs.....44, 45
    new discoveries..... 1
  Huron black shale..... 52
Lauer, D. G..... 18
Leamington.
  Gas statistics..... 4
    leakage..... 13
    license..... 19
Lentz and Miller..... 18
Lewis, James R..... 16
Lewis, Wm. J..... 16
Licenses, operators listed..... 16-19
Lincoln co.
  Gas statistics..... 1, 7
    wells..... 9
      logs..... 45-48

PAGE

Lincoln Gas Co..... 19
Logan, W. E..... 52
Logs of wells..... 20-53
Louth tp., gas statistics..... 7
Lymburner and Webber..... 18
Lynch, Jas. B..... 16
Lynedoch, gas statistics..... 4

M

Mabee, gas statistics..... 4
McChesney, Jas. G..... 16
McColl Bros..... 57
McCrimmon, J. E..... 16
McCutcheon, Thos. J.....16, 18
McGill, Joseph..... 17
McKechnie, Sam..... 18
McKillop, Wm..... 18
McLister, J. J..... 18
McMillan, R. R..... 17
McNinch, S. E..... 17
MacPherson, G. A..... 16
Mahaffy, A. M..... 17
Maidstone tp., gas consumption..... 6
Malahide tp.
  Gas pipe lines. *See* map 40*g*.....*in pocket*
    statistics..... 6
    wells..... 8
      log..... 23
Manitoulin isld., well log..... 48
Manitowaning Oil Co..... 48
Manufactured gas. *See* Artificial gas.
Manufacturers Natural Gas Co..... 19
Maps.
  Natural gas pipe lines in S. Ont...*in pocket*
  Surface gas in S. Ont....*insert facing* 52
Mason, Chester F..... 18
Medicinal petroleum, statistics..... 59
Mehlenbacher, L. B..... 17
Merlin.
  Gas statistics..... 4
    leakage..... 13
Merritton, gas statistics..... 4
Mersea tp.
  Gas statistics..... 6
    wells..... 8
Messer, Julius..... 17
Metcalfe tp., boring record..... 48
Mickle, G. R.....51, 52
Middlesex co.
  Gas statistics..... 1, 6
    wells..... 8
      logs.....48, 49
Middleton tp.
  Gas field enlarged..... 2, 10
    statistics..... 6
    wells..... 8
      logs..... 49
  Pipe lines. *See* map 40*g*.....*in pocket*
Midfield Natural Gas Co..... 19
Millar, Hess Synd., bore-hole record... 45
Miller, R. F..... 17
Miller and Lentz..... 18
Moore tp.
  Bore-hole record..... 44
  Gas lines, rural, leakage and pressure 15
    statistics..... 6
  Oil production (1923-1930)..... 55
Mosa gas field, discovered..... 2

PAGE

Mosa tp.
See also Southern Ontario Gas. Co.
Boring records ... 49
Gas wells ... 8
Oil production (1923-1930) ... 55
Moulton tp.
Gas statistics ... 7
wells ... 8
log ... 25
Mount Hamilton, gas leakage ... 13
Murdock, J. T. ... 17

N

Naphtha, statistics ... 58
Natural gas.
Report by R. B. Harkness on industry:
Consumption ... 3-7
Leakage ... 11-15
Licenses ... 16-20
Logs of wells ... 20-54
Price ... 4, 5
Production ... 1, 2, 7-9
Natural Gas Conservation Act ... 16
Naylor, A. G. ... 17
Neath, Charles ... 17
Nelles Corners, gas statistics ... 4
Newberry gas field. *See* Mosa gas field.
Newton, Roy ... 17
Niagara Falls.
Analysis of gas transmitted to ... 53
Gas statistics ... 4
Niece, Hosea and Son ... 19
Norfolk co.
Gas statistics ... 1, 6
wells, logs ... 49
private ... 9
Norfolk gas field.
See also Dominion Natural Gas Co.
Gas prospecting ... 2
Norfolk tp., gas wells ... 8
Norrington, R. W. ... 17
North Cayuga tp.
Gas statistics ... 7
wells ... 8
logs ... 25-29
North Dorchester tp.
Gas statistics ... 6
wells ... 8
North Newberry. *See* Mosa tp.
North Toronto, surface gas ... 51
North Walsingham tp.
Gas statistics ... 6
wells ... 8

O

O'Brien, W. L. ... 17
Oil.
Illuminating, statistics ... 58
Lubricating, statistics ... 58
Mineral. *See* Petroleum.
Oil Springs, gas statistics ... 4
Oil Springs gas field. *See* Lambton co.
Oil Springs oil field.
Production (1923-1930) ... 55
Oil Springs Oil and Gas Co.
Licenses ... 19
Production increased ... 10
Olga Gas and Oil Co.
Bore-hole records ... 24, 39, 40, 43

PAGE

Oneida tp.
Gas statistics ... 7
wells ... 8
logs ... 29, 30
Onondaga gas field, production ... 1
Onondaga tp.
Gas statistics ... 6
wells ... 9
Oil production (1923-1930) ... 55
Pipe lines. *See* map 40g ... *in pocket*
Ontario Salt Co.
Gas leakage ... 13
License ... 19
Open flows, study of, advisable ... 11
Ore concentration, oil for ... 59
Orford tp.
Bore-hole records ... 40
Gas statistics ... 5
Ottawa valley, surface gas ... 51
Oxford co., gas statistics ... 6
Oxford tps. *See* East Oxford tp.; West Oxford tp.

P

Paleozoic rocks.
Division between, and Pre-Cambrian, S. Ont. *See* insert ... *facing* 52
Paraffin wax and candles, statistics ... 58, 59
Paris.
Gas statistics ... 4
leakage ... 13
Patterson, W. C.
Gas wells ... 24-26, 51
Licenses ... 17, 19
Pattinson, R. L. ... 17, 18
Pay gas, consumption ... 5, 6
Peel co.
Gas statistics ... 1
wells ... 1
Pelham tp., gas statistics ... 7
Penfold, A. G. ... 17
Penn-Ryan Oil and Gas, Ltd. ... 18
Perkins, J. E. ... 18
Petrol Oil and Gas Co.
Bore-hole records ... 21-23
Licenses ... 19
Work by, Tuscarora Indian Reserve 10
Petroleum.
Report on industry (1930) by R. B. Harkness ... 54-59
Petroleum coke, statistics ... 58
Petrolia.
Gas statistics ... 4
leakage ... 13
Oil refinery ... 57
Petrolia oil field, production (1923-1930) 55
Pipe lines (gas), S. Ont.
See map 40g ... *in pocket*
Pickering tp., surface gas ... 51
Plympton tp.
Bore-hole records ... 45
Gas statistics ... 6
Oil production (1923-1930) ... 55
Port Burwell.
Gas statistics ... 5
leakage ... 13
Port Colborne, gas statistics ... 5
Port Colborne–Welland Natural Gas and Oil Co. ... 17-19
Pipe lines. *See* map 40g ... *in pocket*

PAGE

Port Dover, gas statistics 5
Port Lambton, leakage 13
Port Rowan, gas statistics 5
Pre-Cambrian.
  Division between, and Paleozoic, S. Ont. *See* insert ..... *facing* 52
Pressure. *See* Gas pressure; Rock pressure.
Price of oil 54, 57, 58
Private gas wells, production 1, 9
Production.
  Natural gas 1, 2, 7-9
  Oil (1860-1930) 54
Prospecting for gas, hints *re* 10
Provincial Natural Gas Co.
  Licenses 19, 20
  Pipe lines. *See* map 40*g* ..... *in pocket*
Pure Gas and Oil Co 17

R

Rahn, Clayton 17
Rainham tp.
  Gas statistics 7
    wells 8
      logs 30-32
Rainham Gas and Oil Syndicate
  License 19
  Logs of wells 30, 31
Raleigh tp.
  See also Union Natural Gas Co.
  Gas lines, rural, leakage and pressure 15
    statistics 6
    wells 8
      logs 40-42
  Oil production (1923-1930) 55
Randall, A. E. 18
Raven, Christopher 17
Red Medina. *See* Grimsby sandstone.
Refining operations (petroleum).
  Graph and notes 56, 57
Rental paid for gas area 8, 9
Richmond Hill, surface gas 51
Ridgetown.
  Gas statistics 5, 9
    leakage 13
    surface 51
Ridgetown gas field.
  Gas from, calculated in coal tons 53
Ridgeway, gas statistics 5
Robinson, Henry 7
Rochester tp.
  Gas statistics 6
  Gas statistics: population 6
    leakage, rural lines 15
Rock pressure, gas wells 8, 9
  Study of, advisable 11
Rodgers, Alex 17
Rodney, gas statistics 5
Romney tp.
  Gas statistics 6
    wells 8
      logs 42, 43
Rural lines, gas leakage on 7, 12, 15
Russell co.
  Surface gas 51
  Utica shale 52
Ruthven, gas statistics 5

S

St. Anns, gas statistics 5

PAGE

St. Catharines.
  Gas statistics 5
    leakage 13
St. George.
  Gas statistics 15
    leakage 13
St. Vincent tp., gas well closed down ... 10
St. Williams, gas statistics 5
Sales tax, petroleum products 59
Saltfleet tp., gas statistics 7
Sandwich, bore-hole records 24
Sandwich East, South, and West tps.
  Gas statistics 6
    leakage, rural lines 15
    wells, logs 24
Sarnia.
  Gas analysis 53
    leakage 13
    statistics 5
  Oil refinery 57
Sarnia gas field, production 1
Sarnia tp.
  Gas statistics 6
    wells 8, 9
  Oil production (1923-1930) 55
Scarborough 52
Scarborough tp.
  Gas, analysis 53
    surface 51
Schafer and Benner 18
Schier, Frank 17
Selkirk, gas statistics 5
Seneca tp.
  Gas pipe lines. *See* map 40*g* ..... *in pocket*
    statistics 7
    wells 8
      logs 32-34
Seneca Gas Syndicate 19
Seynuck, Tony 18
Shanahan, M. J. 17
Shedden, gas statistics 5
Shedden-Fingal, gas leakage 13
Sherbrooke tp.
  Gas statistics 7
    wells 9
      logs 34
Sherwood Park, surface gas 51
Simcoe.
  Gas statistics 5
    leakage 14
Simpson, Charles 17
Smiley, Thomas 17
Smith, Harry B. 16, 18
Smith, Luke 17
Smith, Robt. H. 17, 19
Smith Oil and Gas Synd.
  Bore-hole records 42, 43
  License 19
Smithville, gas statistics 5
Snell, R. U. 17
Sombra.
  Gas statistics 5
    leakage 14
Sombra tp.
  Gas statistics 6
    leakage 15
    wells, logs 45
South Cayuga tp.
  Gas statistics 7
    wells 9
South Cayuga Gas Synd 19

PAGE

South Dumfries tp., gas statistics..... 6
South London, gas leakage..... 14
South Walsingham tp.
Gas statistics..... 6
wells..... 8
Southern Ontario Gas Co.
Gas consumers; leakage.....13, 14
licenses.....16-20
pipe lines. *See* map 40g.....*in pocket*
wells, logs.....42, 43, 49
Work by, Mosa tp..... 10
Southwold tp., gas statistics..... 6
Springvale Gas and Oil Co.....19, 20
Stamford tp., gas statistics..... 7
Stephens, Hugh..... 17
Stevensville, gas statistics..... 5
Stevensville Natural Gas and Fuel Co.. 19
Still gas, statistics..... 58
Stony Creek Gas and Oil Synd..... 19
Stover, F. C..... 17
Stover, F. H., and Son 18
Straffordville.
Gas statistics..... 5
leakage..... 14
Sullivan, Geo. F..... 17
Sundy, Basil K..... 18
Surface gas.
In drift. *See* insert.....*facing* 52
notes on.....51, 52
wells in, production..... 1

T

Tar, statistics..... 58
Tecumseth tp.
Surface gas..... 51
Thamesville.
Gas statistics..... 5
leakage..... 14
Thamesville oil field.
Production (1923-1930)..... 55
Thomson, W. Grant..... 17
Thorold.
Gas statistics..... 5
leakage..... 14
Thorold tp., gas statistics..... 7
Tilbury, gas statistics..... 5
Tilbury gas field.
Gas, analysis..... 53
Production..... 1
Reserves..... 2
Tilbury East tp.
Gas statistics..... 6
leakage, rural lines..... 15
wells..... 8
logs..... 43
Oil production..... 55
Tilbury North and West tps.
Gas statistics..... 6
Tillsonburg.
Gas statistics..... 5
leakage..... 14
Tillsonburg Oil and Gas Co.
Bore-hole record..... 49
Toilet petroleum, statistics..... 59
Topp, Nathan..... 17
Toronto.
Oil refineries..... 57
Surface gas.....52, 53
Towns.
Gas statistics..... 4, 5

PAGE

Townsend tp.
Gas statistics..... 6
wells..... 8
Townships.
See also Rural lines.
Gas statistics..... 6
wells..... 8, 9
Transmission lines, gas leakage.....7, 12, 14
Treleaven, A., gas wells..... 48
Tupperville, gas statistics..... 4
Tuscarora tp.
Bore-hole records.....21, 23
Gas statistics..... 6
wells..... 9
logs..... 21-23
Tuscarora Indian Reserve.
Gas possibilities..... 10

U

Union Natural Gas Co.
Bore-hole records.....41-45
Dawn and De Clute fields extended by 10
Gas from private wells bought by... 9
Leakage.....13, 14
Licenses to.....19, 20
Pipe lines. *See* map 40g.....*in pocket*
United Development Co..... 17
Utica Shale, Russell co..... 52

V

Vacuum Gas and Oil Co.
Boring in Middleton tp..... 10
License..... 19
Vanderlip, W. J..... 17
Vaseline, statistics..... 59
Vidler, Walter R..... 17
Vienna.
Gas statistics..... 5
leakage..... 14
Villages, gas leakage.....13, 14
Vittoria, gas statistics..... 5

W

Wages.
Gas industry..... 3
Oil industry.....57, 58
Wainfleet tp.
Gas statistics..... 7
wells..... 9
Wallaceburg.
Gas statistics..... 5
leakage..... 14
Wallacetown, gas statistics..... 5
Wallis, E. C..... 17
Walpole tp.
Gas statistics..... 7
wells..... 9
logs..... 35-39
Walsingham tps.
See North Walsingham tp.; South Walsingham tp.
Walter, H. A..... 7
Waterford, gas statistics..... 5
Welland, gas statistics..... 5
Welland co.
Gas statistics..... 1, 7
wells..... 9
Pipe lines. *See* map 40g.....*in pocket*

PAGE

Welland County Gas Synd.
Gas wells, logs 50
Licenses 70
Wellandport, gas statistics 5
Well Drillers' Act 16
Wells, gas.
Increase of those drilled 1
Logs. *See* Logs of wells.
Statistics 8, 9
Wentworth co.
Gas statistics 1, 7
wells 9
West Hamilton, gas leakage 14
West Lorne, gas statistics 5
West Oxford tp., gas statistics 6
Western Peninsula Oil and Gas Co.
Bore-hole records 23
Westman, E. H. 17
Westminister tp., gas statistics 6
Wheatley.
Gas statistics 5
leakage 14
Whitchurch tp.
See also Bond l.
Well, log 51
Whittaker, John 17
Wicks, Frank 18
Williamsburgh tp., bore-hole record 23
Willits, G. E. 17, 18
Willoughby tp.
Gas statistics 7
wells 9

PAGE

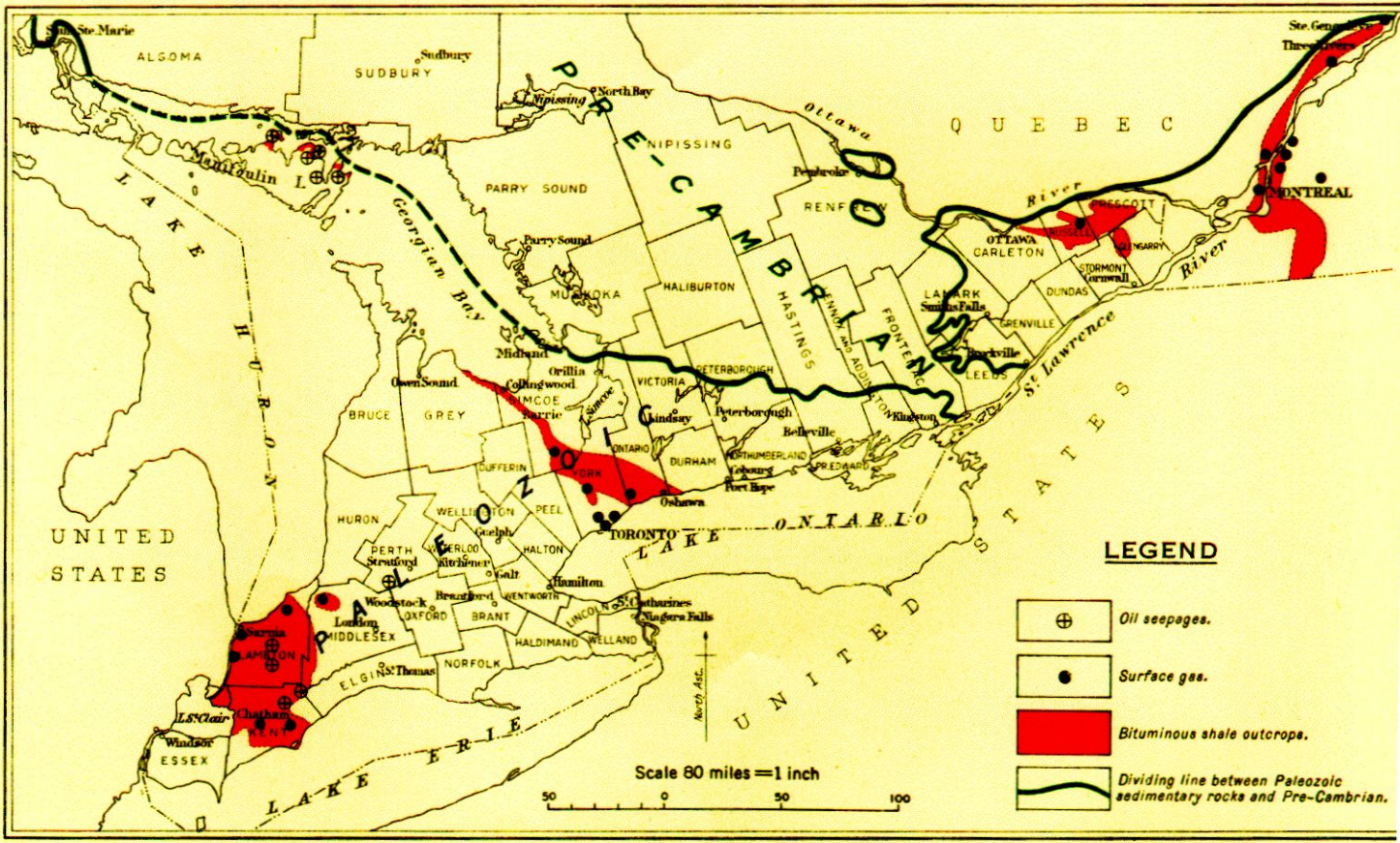
Wilson, Anthony 18
Wilson, Leo 17
Windham tp.
Gas statistics 6
wells 8
Windsor.
Gas leakage 14
statistics 5
Windsor Gas Co. 20
Winger, S. W. 17
Wood, J. George 17
Woodhouse.
Gas statistics 6
wells 8
Woodstock.
Gas statistics 5
leakage 14
Wyer, Samuel S. 11
Wyoming.
Gas statistics 5
leakage 14

Y

Yager, J. J. 19
York co., bore-hole records 51

Z

Zone tp.
Bore-hole records 43
Gas statistics 6



OCCURRENCES OF SURFACE GAS IN SOUTHERN ONTARIO