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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 Thirty-ninth 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, 1930.

INTRODUCTORY LETTER

To The Honourable Chas. McCrea,
Minister of Mines.

Sir,—The undersigned has the honour to submit the Thirty-ninth 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 1929, by W. R. Rogers and A. C. Young.
Classes for Prospectors, 1929-30, by E. M. Burwash.
Mines of Ontario in 1929, by D. G. Sinclair, R. H. Cleland, E. C. Keeley, D. F. Cooper, and A. R. Webster.
Mining Accidents in 1929, by D. G. Sinclair, R. H. Cleland, E. C. Keeley, G. S. Jarrett, and A. R. Webster.

Part 2

Pickle Lake–Crow River Area, District of Kenora (Patricia Portion), by M. E. Hurst (Map No. 39*a*).
Sturgeon Lake Gold Area, District of Kenora and Thunder Bay, by A. R. Graham (Map No. 39*b*).
Obonga Lake Chromite Area, District of Thunder Bay, by A. R. Graham.

Part 3

Geology of the Shonia Lake Area, District of Kenora (Patricia Portion), by H. C. Laird (Map No. 39*d*).
Geology of the Area from Minaki to Sydney Lake, District of Kenora, by D. R. Derry (Map No. 39*g*).
Geology of the Shoal Lake (West) Area, District of Kenora, by Leonard Greer (Map No. 39*e*).
Geology of the Bigstone Bay Area, Lake of the Woods, District of Kenora, by G. G. Suffel (Map No. 39*f*).

Part 4

The Ceramic Industry of Ontario, by R. J. Montgomery (Map No. 39*c*).

Part 5

Natural Gas in 1929, by R. B. Harkness.
Petroleum in 1929, by R. B. Harkness.

Part 6

Investigations of Non-Metallic Mineral Resources of Ontario, 1929.
The Onakawana Lignite Deposit, Moose River Basin, Progress Report to May 31, 1930, by W. S. Dyer.
Testing of Fire Brick made from Mattagami Clay, by R. J. Montgomery.
Non-Metallic Minerals of Hastings County, by F. F. Osborne (Map No. 39*h*).

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, 1930.



PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

THIRTY-NINTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

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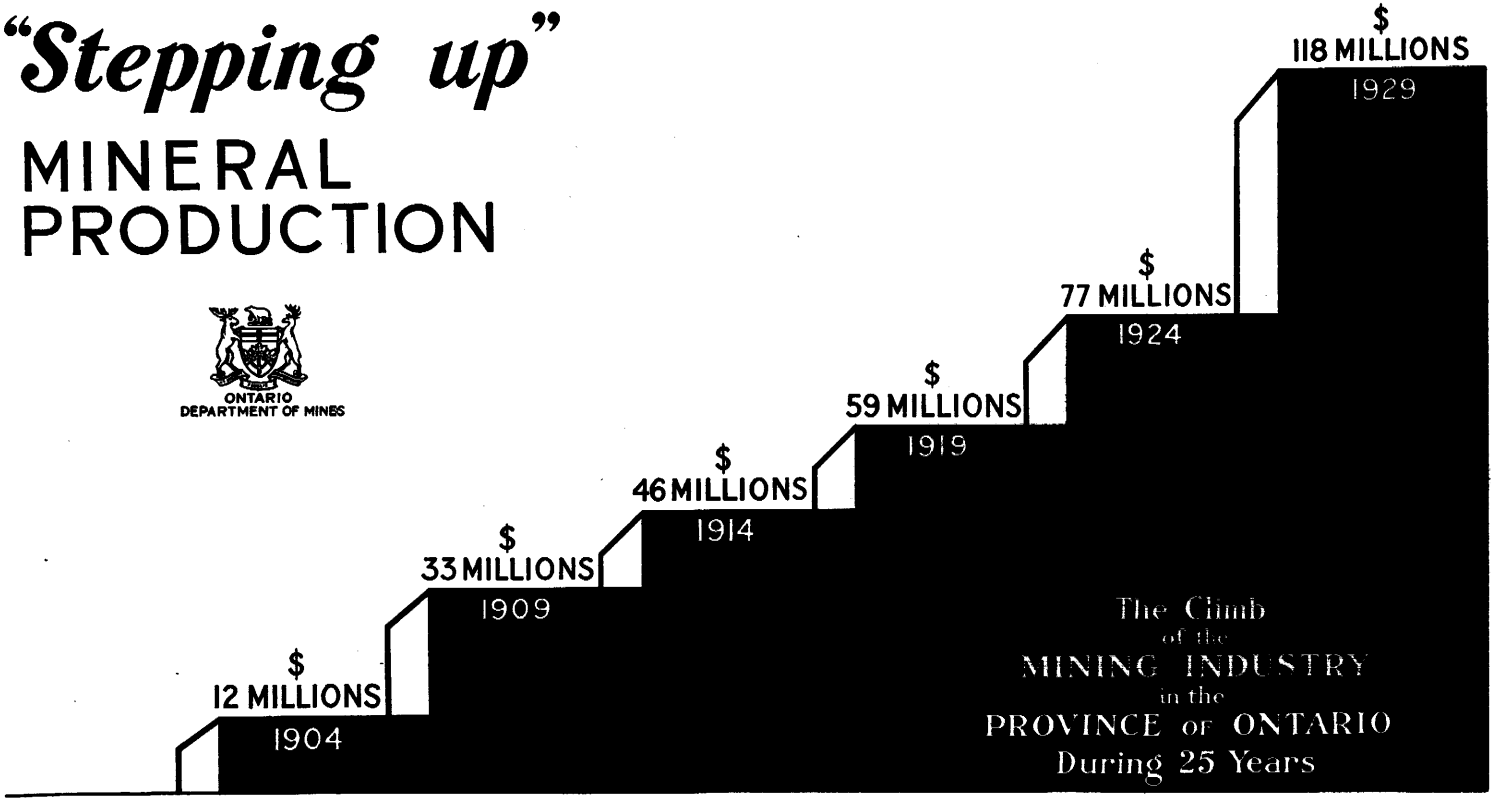
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The chart describes graphically the rapid growth of Ontario's mineral industry, more particularly during the past five years.

STATISTICAL REVIEW OF ONTARIO'S MINERAL INDUSTRY IN 1929

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

General Remarks

Since 1926 yearly advances have been reported in the value of the mineral production of Ontario, but in point of value the twelve months period of 1929 has far outstripped any previously recorded increase or total.

The total selling value of all mineral products was $117,960,722 as against $100,083,122 in 1928, or an increase of 17.86 per cent. The record of achievement as shown in Tables I and II by subdivisions was: metallics, $83,967,446, or an increase of $12,700,443, amounting to 17.7 per cent.; non-metallics, increase $798,786, or 10.2 per cent.; structural materials, a gain of $3,725,873, or 25.1 per cent.; and clay products showing a gain of $652,498, the largest increase for some years.

Several interesting features were noted during the year, the most important being the large development carried on both at Sudbury and Port Colborne by the International Nickel Company of Canada, Limited, which is commented on in the description of that section of the industry. Gold mining, despite the loss of one of the larger milling plants (Dome), may be said to have had a most satisfactory year. Silver mining as carried on at Cobalt, while handicapped by a quiet market, was enabled by the rising demand for the associated metal cobalt even to increase the output as compared with 1928. While lead production fell off considerably as compared with 1928, it was of interest to note the rising production from the new copper-lead-zinc deposits of the Sudbury area.

Among the non-metallics, gypsum, salt and natural gas all registered important increases while some 13 other items maintained their position. There was a distinct improvement in the heavy structural materials, namely, cement, lime, stone, and sand, all of which have steadily expanded their production during the past five years. Clay products, which now account for more than 6 millions of dollars per annum, have undergone a slower but steady increase in output during the past decade.

The period witnessed the culmination in October of one of the greatest booms recorded in the western hemisphere. After a period of about seven years of continued expansion, stocks of all descriptions had risen to high levels. In this period capital in large volume was available not only in the sounder mining securities but also in the more speculative issues, and the resulting crash in the latter months of the year caused drastic curtailment in many industries. While the drying up of the sources of capital halted the exploratory campaigns and prospecting, the old and well-established mining companies continued in their development and beyond a slackening in the demand for metals on the part of many trades, the productive sections of the mining industry were unshaken.

In the tables which follow complete statistics on every mineral product are presented. The first three tables view the industry in general. In Table I, quantity and value, wage-earners and wages are shown for the current year. Table II covers a five-year period, giving values only for each product, while Table III is a comprehensive historical record giving values since the beginning for metals and since 1891 for the three other groups into which the whole mineral industry is divided.

FINAL SUMMARY OF MINERAL STATISTICS OF ONTARIO FOR 1929

Product (tons of 2,000 lbs.)	Quantity	Value	Employees	Wages
METALLIC:		$		$
Gold oz.	1,622,267	33,535,226	6,462	10,442,437
Silver "	8,711,643	4,630,820	994	1,396,200
Copper in matte exported (a) lb.	16,898,515	2,534,777		
Nickel in matte exported (a) "	28,136,095	5,064,497	(b)5,981	8,843,500
Copper metallic and in concentrates, exported "	71,981,544	12,087,832		
Nickel, metallic and contained in speiss exported "	70,741,300	18,646,391		
Nickel oxide and salts "	14,916,784	3,404,573	(c)1,302	2,098,550
Platinum metals oz.	29,615	1,646,381		
Bismuth lb.	27,446	23,413		
Cobalt, metallic and in residues exported; Cobalt oxide (metal content); Cobalt in salts and unseparated oxides "	929,415	1,801,915	(d)307	297,993
Lead, pig, and in concentrates exported "	4,769,506	294,431	446	706,048
Zinc in concentrates exported "	5,516,806	297,190		
Total	.....	83,967,446	15,492	23,784,728
NON-METALLIC:				
Actinolite tons	30	375	11	1,000
Arsenic, white lb.	3,742,913	154,887	(d)	.....
Beryl "	4,456	114	.....	.....
Feldspar, crude and ground tons	21,737	206,979	85	69,629
Fluorspar "	70	1,120	2	200
Graphite, crude and refined "	1,288	90,522	35	33,948
Gypsum "	100,347	832,689	257	311,609
Iron pyrites and sulphur (e) "	4,579	51,516	.....	.....
Mica "	2,991	45,919	16	5,533
Mineral water Imp. gals.	309,700	13,651	15	6,864
Natural gas M. cu. ft.	8,583,187	4,968,137	1,323	1,529,367
Peat tons	1,000	4,500	7	6,024
Petroleum, crude bbls.	121,125	253,678	119	91,766
Quartzite and quartz tons	187,973	316,050	94	78,489
Silica brick M.	1,566	80,374	21	30,204
Salt tons	302,445	1,420,424	263	303,618
Talc and soapstone "	15,463	180,492	42	40,055
Total	.....	8,621,427	2,290	2,508,306
STRUCTURAL MATERIALS:				
Cement, Portland bbls.	4,624,712	6,608,246	867	1,061,173
Hydrated lime tons	55,916	740,127	577	398,266
Quicklime bush.	8,978,465	2,624,285		
Sand and gravel tons	8,045,213	3,156,254	620	716,500
Sand-lime brick (f) M.	55,750	641,159	190	228,576
Stone: building, trap, granite, etc tons	5,244,194	4,771,616	1,911	1,577,247
Total	.....	18,541,687	4,165	3,981,762
CLAY PRODUCTS:				
Brick, face no.	119,239,420	2,467,539		
" common "	75,060,203	1,188,688		
" fancy and ornamental "	111,337	9,012		
" sewer "	4,631,020	92,316	2,425	2,298,550
Tile, drain "	22,535,098	629,322		
" structural	.....	1,047,807		
Sewer pipe, copings, flue-linings, etc	.....	1,167,463		
Pottery	.....	96,394		
Total	.....	(g)6,830,162	.....	.....
GRAND TOTAL	.....	117,960,722	24,372	32,573,346

(a) Copper and nickel in matte valued at 15 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.
(g) Includes $131,621 worth of Haydite.

TABLE II.—COMPARATIVE VALUE OF MINERAL PRODUCTION, 1925–1929

Product	1925	1926	1927	1928	1929
METALLIC:	$	$	$	$	$
Gold	30,206,432	30,950,753	33,627,040	32,629,111	33,535,226
Silver	6,964,325	5,781,706	5,230,402	4,156,431	4,630,820
Platinum metals	1,676,446	1,559,527	1,270,843	1,309,923	1,646,381
Cobalt (*a*)	2,328,517	1,136,014	1,764,534	1,671,900	1,801,915
Nickel (*b*)	15,946,673	14,374,163	15,262,171	22,318,907	27,115,461
Copper, metallic and in matte	4,739,124	4,828,964	4,946,533	8,770,149	14,622,609
Iron ore (*c*)	.....	.....	.....	.....	.....
Pig iron (*d*)	.....	.....	.....	.....	.....
Lead (pig) and in ore	601,704	580,730	528,729	402,289	294,431
Zinc in ore and concentrates	13,685	.....	.....	3,226	297,190
Bismuth	18,566	6,440	1,003	5,067	23,413
Total	62,495,472	59,218,297	62,631,255	71,267,003	83,967,446
NON-METALLIC:					
Abrasives (*e*)	945	576	.....	.....	.....
Actinolite	500	1,000	1,075	875	375
Arsenic, white	113,325	135,549	197,668	178,149	154,887
Asbestos	901	3,935	.....	.....	.....
Beryl	.....	.....	.....	.....	114
Feldspar, crude and ground	141,059	199,102	154,533	180,153	206,979
Fluorspar	200	.....	.....	.....	1,120
Graphite, crude and refined	134,213	158,994	109,613	52,373	90,522
Gypsum	491,833	496,059	500,688	553,271	832,689
Iron pyrites and sulphur	8,799	4,912	6,077	(*f*) 54,100	(*f*) 54,056
Mica	82,661	59,085	75,183	32,945	45,919
Mineral water	25,452	27,277	12,811	27,890	13,651
Natural gas	4,083,341	4,415,918	4,331,780	4,535,312	4,968,137
Peat fuel	8,394	.....	.....	5,845	4,500
Petroleum, crude	396,154	376,822	289,391	249,981	253,678
Phosphate of lime (apatite)	.....	.....	824	.....	.....
Quartzite and quartz	(*g*) 359,691	339,304	266,204	308,608	316,050
Silica brick	.....	56,411	(*h*) 28,549	86,323	80,374
Salt	1,466,450	1,388,672	1,510,777	1,377,629	1,420,424
Talc and soapstone	174,116	178,986	181,981	179,187	180,492
Total	7,488,034	7,842,632	7,638,605	7,822,641	8,621,427
STRUCTURAL MATERIALS:					
Cement, Portland	5,253,911	4,792,857	5,144,326	5,520,897	6,608,246
Lime, hydrated and quicklime	2,044,125	2,051,446	2,198,239	2,467,843	3,364,412
Sand and gravel	1,658,700	2,117,461	2,035,793	2,056,366	3,156,254
Sand-lime brick	677,103	461,376	(*i*) 721,485	(*i*) 745,719	641,159
Stone: building, trap, granite, etc.	2,817,335	3,258,168	4,060,709	4,024,989	4,771,616
Total	12,451,174	12,681,308	14,160,552	14,815,814	18,541,687
CLAY PRODUCTS:					
Brick, face	2,403,832	2,436,848	2,287,495	2,267,268	2,467,539
" common	733,793	768,734	1,063,724	1,154,763	1,188,688
" fancy and ornamental	21,728	20,047	25,016	25,714	9,012
" sewer	37,082	111,620	202,920	49,547	92,316
Tile, drain	360,710	340,403	521,957	572,577	629,322
" structural, roofing and floor	612,138	756,011	808,436	1,035,119	1,047,807
Sewer pipe, copings, flue-linings, etc	893,443	835,206	852,187	974,157	1,167,463
Pottery	86,000	87,600	91,300	98,519	96,394
Total	5,148,626	5,356,469	5,853,035	6,177,664	(*j*) 6,830,162
GRAND TOTAL	**87,583,306**	**85,098,706**	**90,283,447**	**100,083,122**	**117,960,722**

(*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.
(*j*) Includes $131,621 worth of Haydite.

In Table III is given the aggregate value of the metals and metallic products from the time production began in Ontario down to the end of 1928. 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.

TABLE III.—TOTAL MINERAL PRODUCTION OF ONTARIO

Year	Value of Mineral Production				
	Metallic	Non-Metallic	Structural Materials	Clay Products	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		(b) 4,480,452		(b) 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
Total.....	1,100,136,597		532,428,499		1,632,565,096

(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.

(b) Estimated on basis of preceding year ($1,618,720 for stone, lime, and clay products).

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, 1928	Production, 1929	Production to December 31, 1929
	$	$	$
Gold	281,698,937	33,535,226	315,234,163
Nickel, including nickel oxide and salts	265,497,598	27,115,461	292,613,059
Silver	243,352,960	4,630,820	247,983,780
Copper (*a*)	91,365,196	14,622,609	105,987,805
Pig iron	84,775,556	.....	84,775,556
Cobalt (*b*)	21,146,459	1,801,915	22,948,374
Platinum metals	14,410,150	1,646,381	16,056,531
Iron ore (*c*)	9,463,516	.....	9,463,516
Lead	4,030,414	294,431	4,324,845
Molybdenite	209,735	.....	209,735
Zinc, in ore and concentrates	111,502	297,190	408,692
Bismuth	107,128	23,413	130,541
Total	1,016,169,151	83,967,446	1,100,136,597

(*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 to gain in favour with the mining companies of Ontario. The following table gives data covering operations in Ontario during the past four years:—

DIAMOND DRILLING OPERATIONS, 1926-1929

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

During the year under review the areas where the drilling was done were: Porcupine, 199,133 feet; Sudbury, 166,883; Kirkland Lake and Boston Creek, 82,573; Northwestern Ontario, 25,576; Gowganda area, 10,907 feet; Hastings, 317; and Abitibi coal areas, 2,767 feet.

In addition to the above the Ontario companies completed a considerable footage of diamond drilling in other provinces as follows: Quebec, 153,040 feet; Manitoba, 84,885 feet; Nova Scotia, 10,846 feet; and Saskatchewan, 2,900 feet; or a total of 251,671 lineal feet in other provinces, making a grand total of 740,827 feet in 1929.

On this work 604 men were employed by sixteen companies and $918,527 was paid in wages. For the first time the Department has collected statistics on diamonds used in drilling. During the period black diamonds totalling in weight 6,022.97 carats; borts, 7,887.83; and ballas, 293.67; or a total of 14,204.47 carats were purchased at a price of $715,166. The cost of diamonds depends on the size and grade. The average cost per carat to the operator was $50.00.

The value of imports into Canada of diamond dust, bort and black diamonds for borers during the past four years are shown below, eight countries being represented as the source of supply. As will be noted, by far the major portion comes from the United States, indicating that the diamond

supply houses of that country control the supply of industrial diamonds in Canada. The figures follow[1]:—

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

[1]Data supplied by the Dominion Bureau of Statistics.

Statistics of exports of industrial diamonds were not available, due to the fact that this classification is not specially provided for in the Canadian export statistics. It is known, however, that a considerable portion of the imports are re-exported.

DIAMOND-DRILL OPERATORS IN ONTARIO IN 1929

Name	Ontario Address	No. of drills active
Badeski, F	Timmins	9
Chisholm, D. D. (Kirkland Lake Diamond Drilling Co.)	Timmins	7
Dome Mines, Ltd	South Porcupine	2
O'Brien mine	Cobalt	1
McIntyre Porcupine Mines, Ltd	Schumacher	3
Mitchell, W. J., (Diamond-Drill Company, Ltd.)	Cobalt	22
Morissette, N	Haileybury	5
Ontario Diamond-Drilling Co., Ltd	Sudbury	11
Ryan Diamond-Drilling Co., Ltd	Timmins	12
Smith & Travers	Sudbury	20
Wright-Hargreaves Gold Mines, Ltd	Kirkland Lake	1
Sudbury Diamond-Drilling Co., Ltd	Sudbury	39
Baker, John	Buckingham, P.Q.	1
Capital Engineering Co., Ltd	New Liskeard	7
Patterson Diamond Drilling Co., Ltd	Cobalt	3
Oscar R. Smith Diamond Drilling Co., Ltd	Sudbury	1

Hydro-Electric Power.—During the year the Lake Shore mine at Kirkland Lake signed a new and more advantageous power contract with the Canada Northern Power Corporation which supplies Cobalt, Gowganda, Kirkland Lake, and Porcupine. Early in 1930 the Teck-Hughes mine did likewise, and the smaller consumers at Kirkland Lake have since come to terms with the Company.

Power is supplied by the Hydro-Electric Power Commission of Ontario, from Ear Falls on the English River at the foot of Lac Seul, at $25 per horsepower. The cost to the Howey mine at Red Lake, including a 41½ mile transmission line and sub-station costs, is only $32.50 per horsepower. Power was turned on January 28, 1930, and marks the first effort of the Commission to supply mining camps with electric power. The Ear Falls installation of 5,000 horsepower marks an epoch as regards the policy of the Commission in regard to power needs for mining areas in Northern Ontario.

In February, 1930, the Hydro-Electric Power Commission purchased the balance of the stock of the Wahnapitae Power Company. This gives entire control of the plant supplying power to Coniston smelter, Treadwell-Yukon, and Falconbridge mines. A new dam has been completed on the Wanapitei River at the outlet of Wanapitei Lake, which will permit of increased power capacity.

To meet the growing need for power at Sudbury, chiefly for the new smelter and refinery of the International Nickel Company of Canada, Ltd., the Commission contracted with the Hudson's Bay Power Company, a subsidiary of the Abitibi Power and Paper Company, for 100,000 horsepower of a new 275,000 horsepower installation at the canyon of the Abitibi below Island Falls. Power is to be delivered at a cost of $13.50 per horsepower year at Hunta, a station on the Canadian National Railway, a few miles west of Cochrane, from which point a new transmission line is being built to Sudbury. From power plant to Sudbury is over 240 miles, the longest transmission line in Ontario. In August, 1930, the power plant contract was awarded to Dominion Construction Company and it is expected this power, developed under a head of 237 feet, will be available by October, 1932.

Gold

In the following table the value of the total gold output of the Province, exclusive of premium, is given, also that from the main camps, Porcupine and Kirkland Lake, beginning in 1910 and 1913 respectively:—

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	9,942,803	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
Total to end of 1929	315,234,163	247,392,353	78.5	62,375,516	19.8

As compared with the year 1928, gold output in Ontario showed an advance of nearly one million dollars in value. The total output from all sources during the year was 1,622,267 fine ounces, valued at $33,535,226, as against 1,578,433 fine ounces worth $32,629,111 in 1928. The gain in output was due entirely to expanding production at the mines of the Kirkland Lake camp where the Lake Shore and Teck-Hughes are the most important producers. The output from Porcupine was lower in 1929 than in the previous year, due to the lower grade of ore treated at the Hollinger as well as to a decrease of 229,313 tons in quantity milled. The loss of the Dome mill, which was destroyed by fire on October 29, accounted for about 90,000 tons of the decrease in ore milled in the Porcupine area. At Kirkland Lake, ore milled showed an increase of 67,949 tons above the figure for 1928. During the period under review there was considerable development work in the northwestern portion of the Province, namely, at Michipicoten, Moss town-

ship, Red and Woman Lakes, and the new field in Patricia known as Crow River. The Howey mine at Red Lake was completing its 500-ton mill, and production commenced in April, 1930.

TABLE V.—ONTARIO'S GOLD PRODUCTION, 1929

Source	Ore milled, tons	Bullion shipped				Total Value of Bullion[1]
		Gold content		Silver content		
		Fine ounces	Value $	Fine ounces	Value $	$
PORCUPINE						
Ankerite	12,912	3,458 17	71,487	355	197	71,684
Coniaurum	103,293	30,640.66	633,399	3,978	2,086	635,485
Dome	452,900	173,041.81	3,577,091	25,568	13,446	3,590,537
Hollinger	1,549,157	455,093.96	9,407,627	91,474	47,663	9,455,290
March	48,484	12,369 90	255,708	1,165	595	256,303
McIntyre	550,100	206,627.67	4,271,373	46,727	24,118	4,295,491
Porcupine United (Rochester)	5,048	2,133.90	44,111	343	174	44,285
Vipond[2]	108,225	39,569.25	817,969	5,152	2,698	820,667
West Dome Lake	35,142	7,500.92	155,058	1,406	739	155,797
Miscellaneous	.....	2,296.02	47,463	458	238	47,701
Total	2,865,261	932,732.26	19,281,286	176,626	91,954	19,373,240
KIRKLAND LAKE						
Argonaut clean-up[2]	291	478 52	9,892	135	67	9,959
Barry-Hollinger	22,343	7,321 05	151,340	829	418	151,758
Kirkland Lake Gold	53,595	16,999 27	351,406	2,677	1,383	352,789
Lake Shore	430,170	293,586 51	6,068,971	39,902	21,218	6,090,189
Sylvanite	74,523	33,167 70	685,637	7,242	3,828	689,465
Teck-Hughes[3]	337,630	243,744 51	5,038,646	18,733	9,774	5,048,420
Wright-Hargreaves	188,238	83,631 42	1,728,815	11,323	5,913	1,734,728
Miscellaneous	.....	575 13	11,889	70	36	11,925
Total	1,106,499	679,540 11	14,046,596	80,911	42,637	14,089,233
NORTHWESTERN ONTARIO						
Bathurst (Woman Lake)	high grade	149 06	3,081	50	26	3,107
Bobjo (Woman Lake)	"	361 70	7,477	29	15	7,492
Cooper (Michipicoten)	sample tests	298 22	6,165	37	19	6,184
Parkhill (Michipictoen)	33	99 00	2,047	19	10	2,057
St. Anthony (Sturgeon Lake)[3]	684	115 00	2,377	23	11	2,388
Wabigoon-Contact Bay[2]	34	8 00	165	34	17	182
Gold Rock	300	35 00	723	5	3	726
Gold ores shipped to Noranda[4]	12	34 48	713	.....	.....	713
Big Turtle River Mining Co[2]	19	11 59	240	11	5	245
Total	1,082	1,112 05	22,988	208	106	23,094
TOTAL for Gold Mines	3,972,842	1,613,348 42	33,350,870	257,745	134,697	33,484,916
Nickel-Copper Refineries	.....	7,802 00	161,282	429,541	227,625	388,907
In copper ores shipped to Noranda	.....	11 83	244	1,030	546	790
In Treadwell-Yukon exports	.....	1,104 40	22,830	52,787	27,972	50,802
GRAND TOTAL (all sources)	.....	1,622,266 65	33,535,226	741,103	390,840	33,926,066

[1]Premium received in addition to values quoted amounted to $87,173 at Porcupine and $70,283 at Kirkland Lake.

[2]Copper was also contained in these gold ores: Vipond 402 lb.; Argonaut 10,027 lb.; Wabigoon-Contact Bay 200 lb.; and Big Turtle 251 lb., or a total of 10,886 lb. of copper.

[3]Includes 7,290 tons of tailings retreated by Teck-Hughes and 6 tons by St. Anthony.

[4]These ores were shipped via Temiskaming Testing Laboratory and included 10.92 tons from the Baldwin worth $403; Harkness Hays 0.71 tons, $71; P. Edward 0.25 tons, $14; W. B. Longworth 0.06 tons, $225.

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
Total	22,069,219	19,002,471	12,865,734	2,909,460	2,447,648	1,857,035	787,202	592,572	52,295	14,006	13,649	10,082	7,172	62,640,470

(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; and 1929, $70,283. (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	1,059,238	549,166	73,628	Porcupine Crown: 685,135	.....	.....	.....	.....	.....	.....	.....	Rea: 125,255
1915....	4,206,015	1,530,287	750,812	246,053	Porcupine Crown: 602,436	$102,880	.....	.....	.....	$48,236	.....	.....	.....
1916....	5,073,401	2,153,820	1,218,073	176,686	Porcupine Crown: 578,322	16,814	.....	.....	.....	225,301	.....	.....	.....
1917....	4,261,938	1,480,174	1,710,204	209,738	Porcupine Crown: 377,904	44,434	.....	.....	.....	198,605	.....	.....	.....
1918....	5,752,371	82,127	1,578,444	82,868	Porcupine Crown: 124,474	103,745	.....	.....	.....	92,842	.....	.....	Newray: 1,447
1919....	6,722,266	1,290,301	1,978,014	.....	.....	23,910	.....	.....	.....	.....	.....	.....	Newray: 1,516
1920....	6,219,665	2,020,568	2,223,083	.....	Porcupine Crown: 71,529	47,169	.....	.....	.....	.....	.....	.....	.....
1921....	9,051,276	2,290,264	1,827,761	.....	Porcupine Crown: 97,301 Northcrown: 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	.....	.....
Total...	148,874,100	46,599,378	40,372,409	4,810,903	2,871,847	1,099,159	861,237	856,019	566,885	564,984	421,076	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	David-son	Porcupine United	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												9,442,41
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
Total	53,914	44,285	30,477	12,688	10,551	6,236	2,135	289	146	30	267,947	248,858,418

(*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; and 1929, $87,173. (*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, 1929

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 1928, Amount	Dividends and Bonuses paid during 1929, Amount	Rate per cent., or per share, 1929	Total of Dividends and Bonuses paid to Dec. 31, 1929	Date when last Dividend or Bonus was paid
				$	$	$		$	
Dome Mines, Ltd. (a)	Sept. 30, 1923	1,000,000	1,000,000	No par	12,405,840.75	953,334.00	$1.00	13,359,174.75	Oct. 20, 1929
Hollinger Cons. Gold Mines, Ltd. (b)	May 25, 1916	25,000,000	24,600,000	5.00	48,144,400.00	3,198,000.00	13%	51,342,400.00	Dec. 31, 1929
Lake Shore Gold Mines, Ltd	Feb. 25, 1914	2,000,000	2,000,000	1.00	6,020,000.00	2,200,000.00	110%	8,220,000.00	Dec. 16, 1929
McIntyre-Porcupine Mines, Ltd	Mar. 16. 1911	4,000,000	3,990,000	5.00	7,601,408.00	798,000.00	5%	8,399,408.00	Dec. 3, 1929
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	.....	.....	.....	.....	.....
Teck-Hughes Gold Mines, Ltd, The	Mar. 1, 1923	5,000,000	4,767,144	1.00	4,048,572.40	2,866,286.40	60%	6,914,858.80	Nov. 1, 1929
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	.....	.....	.....	.....	83,869,596.15	10,015,620.40	.....	93,885,216.55	.....

(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 GOLD MINING COMPANIES, 1912–1929

Year	Porcupine						Kirkland Lake				Total
	*Hollinger Consolidated	Porcupine Crown	†Dome Mines	Rea Consolidated	McIntyre	Vipond Consolidated	Tough-Oakes	Lake Shore	Wright-Hargreaves	Teck-Hughes	
	$	$	$	$	$	$	$	$	$	$	$
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	1,720,000	240,000	400,000.00	12,000			132,875				2,344,875.00
1916	3,126,000	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		715,000.50		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	893,750	474,714.40	10,878,732.40
1927	6,396,000		1,191,667.50		798,000.00	67,500		1,400,000	1,237,500	713,571.60	11,804,239.10
1928	5,412,000		953,334.00		798,000.00			2,000,000	825,000	2,860,286.40	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
Total	51,342,400	840,000	13,359,174.75	12,000	8,399,408.00	67,500	398,625	8,220,000	4,331,250	6,914,858.80	93,885,216.55

*Includes $160,000 paid by the Acme in 1915 before amalgamation with the Hollinger.
†Exclusive of $476,667 repayment of capital in 1922.

RECEIPTS OF CRUDE GOLD BULLION FROM ONTARIO MINES AT THE ROYAL MINT, OTTAWA, 1925–1929

Year	Crude ounces	Precious Metals			Average Premium on New York Funds, per cent.
		Gold, fine oz.	Silver, fine oz.	Total Value $	
1925	139,130	105,888	19,130	2,201,974	0.03
1926	1,610,195	1,256,570	224,106	26,112,717	0.01
1927	1,721,111	1,338,192	229,657	27.793,399	0.05
1928	1,537,295	1,217,622	199,470	25,285,865	0.008
1929	412,058	328,556	54,068	6,821,876	0.068

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, 1929

Locality	No. of Wage earners	Wages paid	Average Wage per annum
		$	$
Porcupine	4,165	6,642,361	1,597
Kirkland Lake	2,134	3,579,462	1,679
Northwestern Ontario	163	220,614	1,354
Operating but non-producing	611	791,406	1,297
Total	7,073	11,233,843	1,588

Silver-Cobalt

Several encouraging features as regards the production of silver in Ontario have offset the continued decline in the output of the metal, e.g., the steady demand for cobalt with which the silver is associated, and the consequent reopening of several idle properties by lessees. Further, important discoveries of high grade ore made at the O'Brien mine at Cross lake, and deep development carried on at the Miller Lake O'Brien at Gowganda, have added to the lives of the properties concerned. The Cobalt Contact property at Cobalt developed bodies of both high grade silver and cobalt ore. High grade cobalt ore is being shipped from the Agaunico.

At Cobalt the more important active properties during the year were Nipissing, O'Brien, Mining Corporation, and Cobalt Contact. The Keeley, Frontier Lorrain, and Lorrain Trout Lake shipped from South Lorrain; while the Miller Lake O'Brien and Castle-Trethewey produced at Gowganda. Considerable development work was carried on at the Morrison and Silverado properties, also at Gowganda. Lessees at properties as enumerated below were shippers from the Cobalt area.

Badger.....F. L. Chitty
Cobalt Comet (formerly Drummond).....H. Sequin
Coniagas.....E. H. Clemens
Crown Reserve Dump.....Geo Martin.
Foster-Cobalt.....J. H. McLeod
Hudson Bay.....W. H. Smith
Beaver (owned by C. E. Cain)....C. E. Cain
Kerr Lake.....Arthur Brocklebank
La Rose (Lawson property).T. E. Trembath
McKinley-Darragh-Savage.....Goff Smith
Silver Queen.....Newton and Herbert
Temiskaming.....Sandoe and Moyle
Trethewey, Chambers-Ferland, and Aladdin Cobalt....,J. W. Shaw et al.
Tudhope Tp.....Paramount Syndicate... (P. R. Craven)
Silver Leaf.....Roper-Dreck-Desjardins

The low price of silver is a matter of great concern to the operators of silver mines in Ontario, inasmuch as the world situation from a buying point of view has made it extremely difficult for the producers to estimate future conditions. Depletion and selective mining have curtailed production and increased costs. The average price of silver for 1929 on the New York market was 52.993 cents per fine ounce, and the monthly average dropped from 57.019 cents in January to 48.475 cents in December. On December 30 on the London market the price dropped to a lower figure than prevailed in 1903 or before the Cobalt silver camp commenced producing.

Silver coinage introduced in Great Britain in 1928 was a quaternary alloy containing 50 per cent. silver, 40 copper, and 5 each of nickel and zinc, the novelty being the introduction of zinc. The Mining Magazine of London points out that with the decline in the use of silver for currency purposes, the market in that direction has been curtailed due to the increased adoption of the gold standard. On February 28, 1930, announcement was made that the government of India had placed an import duty on silver of 9 to 10 cents per fine ounce. This caused the New York price of the metal to decline to 40 7/8 cents per ounce, a new low record, and further depressed Chinese silver currency which is still standard in that country.

The output and shipments of silver in 1928 and 1929 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 X and XI:—

SILVER PRODUCTION, 1928–1929

Source	1928		1929	
	Fine Ounces	Value	Fine Ounces	Value
		$		$
Sales of bullion by the reduction companies, smelters, and mines	5,883,583	3,419,624	7,166,459	3,823,599
Contained in silver-cobalt concentrates and residues exported	804,871	462,946	804,081	416,381
Estimated as recovered from copper-lead-zinc concentrates exported	11,589	6,742	52,787	27,972
Estimated recoveries by Noranda smelter from Ontario copper ores	111	65	1,030	546
In crude gold bullion	248,226	137,366	257,745	134,697
Recovered by nickel-copper refineries	222,924	129,688	429,541	224,272
Total	7,171,304	4,156,431	8,711,643	4,630,820

TABLE X.—TOTAL SHIPMENTS FROM SILVER MINES, SMELTERS AND REFINERIES, 1904 TO 1929

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	6,885,920
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
Total	49	118,719	775	258,579	185	21,834	5,589	1,130,781	13,940	22,772,743	63,599	5,227,049	396,248,614	244,930,445	274,460,150

(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 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 X immediately preceding. Silver shown as shipped in the following table is compiled for each mining area and is mainly the silver contents of ore or concentrates shipped to the reduction works at Cobalt or 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 X.

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 XI.—SILVER SHIPMENTS BY CAMPS, 1904-1929

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	1,101	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	.....
Total	.....	398,209,198	359,800,366	2,799,740	20,402,500	15,158,086	48,506

(a) Includes 885 ounces from Silver Islet, Lake Superior.
(b) Silver Islet, Lake Superior.

In addition to the silver content of ores, concentrates, residues, etc., producing mines are paid for the cobalt content provided the percentage is sufficiently high. Mine shippers in 1929 were paid $179,292 for 641,005 pounds of cobalt, and $3,098 for 26,731 pounds of copper. These figures for copper represent only the portion paid for by United States smelters. It was estimated that 52,118 pounds were recovered.

From monthly statements, issued by Mr. A. A. Cole, mining engineer of the Temiskaming and Northern Ontario Railway, showing railway ship-

ments of ore, concentrates, etc., from the Cobalt area, the following information has been compiled: Total shipments, 4,851.00 tons, of which 2,354.22 were consigned to Deloro and Smiths Falls, 1,440.39 to United States smelters and refineries, and 1,056.39 tons to Europe.

Shipments of silver mines by camps during 1929 were as follows:—

	Silver, oz.	Cobalt*	
		Quantity, lb.	Value, $
Cobalt	4,823,529	441,587	151,006
Gowganda	2,081,894	72,112	11,185
South Lorrain	876,006	127,306	17,101
Total	7,781,429	641,005	179,292

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

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

SILVER PRODUCERS IN 1929

Operator	Mine or Source	Location
Cobalt Camp.		
Agaunico Cobalt Mines, Ltd.	Agaunico	Bucke tp.
Cobalt Contact Mines, Ltd.	Cobalt Contact	Bucke tp.
La Rose Mines, Ltd.	La Rose	Coleman tp.
Nipissing Mining Co., Ltd.	Nipissing	Coleman tp.
Mining Corporation of Canada, Ltd.	Buffalo, Townsite, City of Cobalt, Cobalt Lake	Coleman tp.
O'Brien, M. J., Ltd.	O'Brien and Cross Lake	Coleman tp.
Cobalt Reduction Co., Ltd.	Reduction plant	Coleman tp.
16 Leases	*See* page 14	
Gowganda.		
Castle-Trethewey Mines, Ltd.	Castle	Haultain tp.
O'Brien, M. J., Ltd.	Miller Lake-O'Brien	Haultain tp.
Pioneer Prospectors Cons. Mines, Ltd.	Pioneer	Leith tp.
South Lorrain.		
Keeley Silver Mines, Ltd.	Keeley	Silver Centre, So. Lorrain
Lorrain Trout Lake Mines, Ltd.	Lorrain Trout Lake	Silver Centre, So. Lorrain
Frontier (Lorrain) Mines, Ltd.	Frontier	Silver Centre, So. Lorrain

TABLE XII.—OPERATIONS OF ONTARIO SILVER-COBALT REFINERIES IN 1929

Products marketed	Sales	
	Quantity	Value
		$
Silver bullion.....fine oz.	5,799,396	3,083,000
Arsenic, white.....lb.	3,402,592	134,392
Arsenic, other forms..... "	296,278	19,614
Cobalt products, including metals and metallic content of all oxides, mixed oxides and salts..... "	701,425	1,663,953
Nickel oxide, and salts (metal content)..... "	193,940	56,590
Base bullion (*a*)..... "	125,037	99,127
Speiss residues (*b*)..... "	361,000	73,449
Bismuth..... "	5,979	8,207
Total.....		5,138,332

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

TABLE XIII —DIVIDENDS AND BONUSES PAID BY SILVER MINING COMPANIES TO DECEMBER 31, 1929

Name of Company	Date of Incorporation	Authorized Capital	Capital Stock Issued	Par value per share	Dividends and Bonuses paid to end of 1928	Dividends and Bonuses paid during 1929	Total Dividends and Bonuses paid to 31st Dec., 1929	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.	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. (*d*)	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 Canada, Ltd.	Nov. 23, 1916	8,300,250	8,300,250	5.00	7,158,924.97	415,012.50	7,573,937.47	Dec. 19, 1929
City of Cobalt Mining Co., Ltd (*e*)	Jan 7, 1909	1,500,000	1,500,000	1.00	145,000.00	.....	145,000.00	April 15, 1920

TABLE XIII—*Continued*

Name of Company	Date of Incorporation	Authorized Capital	Capital Stock Issued	Par value per share	Dividends and Bonuses paid to end of 1928	Dividends and Bonuses paid during 1929	Total Dividends and Bonuses paid to 31st Dec., 1929	Date when last Dividend or Bonus was paid
		$	$	$	$	$	$	
Cobalt Lake Mining Co., Ltd. (*e*)	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. (*e*)	May 8, 1906	100,000	45,011	1.00	1,042,259.61	.....	1,042,259.61	Nov. 11, 1914
Nipissing Mining Co., Ltd. (*f*)	Dec. 16, 1904	250,000	250,000	100.00	30,288,297.25	390,000.00	30,678,297.25	Dec. 31, 1929
Penn-Canadian Mines, Ltd. (*g*)	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 (*h*)	.....	.....	.....	.....	96,296,268.66	805,012.50	97,101,281.16	.....

(*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*) In addition a return of capital amounting to $600,000 was made on July 3, 1919, to stockholders of the Kerr Lake Mines, Ltd.
(*e*) Mining Corporation of Canada, Limited, now owns and operates the City of Cobalt, Cobalt Lake and Cobalt Townsite mines.
(*f*) Includes $16,288,297.25 paid in dividends by the Nipissing Mines Co. (the holding company) to the end of 1916.
(*g*) Paid out of capital $40,491.15 on September 10, 1917, and an equal amount on April 24, 1918.
(*h*) Does not include dividends by private companies such as M. J. O'Brien, Ltd.

Nickel, Copper, and Platinum Metals

Expansion and development of the nickel-copper industry has been reported in every annual statement since 1925, but the increase in production in 1929 over the previous year is the greatest yet recorded. As compared with 1928 ore raised has increased 36.6 per cent., ore smelted 37.7, and matte produced 44.6 per cent. An interesting feature during the past four years, as will be noted in the table, has been the rapid increase in the quantity of matte refined in Ontario. This advance of 228 per cent. has coincided with the improved refining facilities at Port Colborne. This record of the nickel-copper industry, which is really the story of the operations of the International Nickel Company of Canada, Limited, has been the outstanding development in metal mining in the Province for the year under review. It will be recalled that the amalgamation of the International and Mond companies became effective January 1, 1929.

The table following gives the record of mining and smelting operations for the last pre-war year, for the war year of maximum output, and for the past four years:—

TABLE XIV.—NICKEL-COPPER MINING AND SMELTING, 1925–1929

Schedule	1925	1926	1927	1928	1929
Ore raised.....tons	1,264,748	1,322,050	1,305,917	1,457,910	1,991,910
Ore smelted..... "	1,258,849	1,309,782	1,350,214	1,476,704	2,033,457
Bessemer matte produced..... "	70,280	78,643	81,848	91,313	132,030
Nickel content..... "	36,596	39,038	39,623	43,393	58,095
Copper content..... "	19,636	24,159	25,969	29,704	46,315
Matte exported*..... "	32,397	34,908	33,541	39,310	28,402
Nickel content..... "	36,596	39,038	39,623	43,393	14,068
Copper content..... "	19,636	24,159	25,969	29,704	8,449
Matte refined in Canada..... "	38,567	33,489	39,253	67,866	109,818
Men employed.....No.	2,650	3,132	3,418	3,845	4,546
Wages paid.....$	3,487,051	4,359,066	4,919,445	6,005,697	7,069,995

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

Refineries.—During the year at Port Colborne, the International Nickel Company of Canada 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 1928 and 1929 is shown in the subjoined table:—

TABLE XV.—NICKEL-COPPER REFINING, 1928–1929

Schedule	1928		1929	
	Quantity	Value	Quantity	Value
		$		$
Matte, treated.....tons	67,866	.....	109,818	.....
Nickel oxide, marketed.....lb.	12,445,951	2,877,739	14,400,198	3,347,983
Metallic nickel, recovered..... "	49,142,644	12,595,814	70,704,762	18,639,814
Blister copper, recovered..... "	41,609,160	5,937,153	74,265,747	11,880,306
Gold, recovered*.....ounces	3,850	79,586	4,420	91,370
Silver, recovered*..... "	222,924	129,688	349,632	181,861
Platinum metals, recovered*..... "	23,539	1,309,923	29,615	1,646,381
Employees.....No.	797	.....	1,302	.....
Wages paid.....$	.....	1,298,778	.....	2,098,550

*Includes recoveries by the Mond division at Clydach in Wales.

As mentioned already, matte treated in Ontario has grown very rapidly following the installation of new electrolytic units at the Port Colborne refinery. The first unit was placed in operation in 1926, the second in September, 1928, the third in December of that year, and a fourth in February, 1929. These four units together have a capacity of 3,600,000 pounds of electrolytic nickel per month. Three additional units are contemplated, each with a monthly capacity of 1,200,000 pounds. One of these was put in operation in 1929, and another is now practically completed and part of it in operation. Converter copper is also produced. The gold and silver metals follow the copper, but platinum and its associated metals (palladium, rhodium, ruthenium, osmium, and iridium) are recovered as a residue in the electrolytic refining of nickel. In the future the refining and separating of these platinum metals will be done entirely at the refinery and research laboratory of the company located at North Acton, a suburb of London, England, where a process has been evolved much in advance of the former methods used for refining platinum metals on this side of the Atlantic.

TABLE XVI.—PRECIOUS METALS RECOVERED, 1925–1929

	1925	1926	1927	1928	1929	
	Ounces	Ounces	Ounces	Ounces	Ounces	Value, $
Gold*	4,016	4,447	4,866	3,850	7,802	161,282
Silver	134,390	151,429	188,180	222,924	429,541	227,625
Platinum metals:						
Platinum	8,692	9,471	11,217	10,452	12,474	843,928
Palladium	7,856	9,790	11,247	11,389	12,231	464,778
Rhodium, Ruthenium, Osmium and Iridium	432	234	298	1,689	4,910	337,675
Total.....ounces	16,980	19,495	22,762	23,539	29,615	.....
Value.....$	1,675,706	1,559,527	1,270,843	1,309,923	.....	1,646,381

*Includes small recoveries of the rhodium group by the Mond Nickel Company.

The average price obtained for platinum in 1929 was $67.655 and for palladium $38.00 per fine ounce. Prices of the rarer platinum metals fluctuate so widely that average prices are difficult to secure. Figures used for valuation purposes in 1929 were: rhodium, $50; ruthenium, $48; and iridium, $241.

Dividends.—Payments in 1929, and total dividends paid to the end of 1929 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 1928	†Paid in 1929	Total to end of 1929
Canadian Copper Company		1894-1901	$1,975,000	.....	.....
*International Nickel Co.	Preferred	1906-1928	12,299,273	$1,712,097	.....
	Common	1909-1928	65,811,694	12,375,704	.....
Total		.....	$80,085,967	$14,088,701	$94,174,668
Mond Nickel Company	Deferred	1906-1914	£264,043	.....	.....
	Preferred	1904-1928	2,381,359	£175,000	.....
	Ordinary	1905-1928	2,352,818	229,166	.....
Total		.....	£4,998,220	£404,166	.....
		or	$24,324,249	$1,966,877	$26,291,126
Grand Total		.....	$104,410,216	$16,055,578	$120,465,794

*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.

†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 percent. cumulative preferred, and 13,758,208 common shares without par value. Dividends paid by the International Nickel Company of Canada, Limited, on the common stock in 1929 were 90c. per share. Dividends paid on February 16, 1929, by the Mond company cover the 8 months period ending December 31, 1928.

Development.—The extensive programme of construction by the International company, which has been under way at Sudbury, comprising bins, concentrators, roasters, and reverberatory furnaces, also a new copper refinery under erection by the Ontario Refining Company, are expected to be completed by midsummer, 1930. The concentrator capacity has been enlarged to 8,000 tons daily. The electrolytic copper refinery will also treat custom blister copper, gold and silver concentrates, precipitates and bullion. It will have a capacity of 20,000,000 pounds of copper per month, and the plant occupies over 11 acres of ground at Copper Cliff.

Part of the present smelter equipment will be used to carry out the first stage of refining now done at Port Colborne, namely, the separation of the molten Bessemer matte into copper tops and nickel bottoms, using nitre cake. The tops will be further treated at Copper Cliff to produce blister copper, which will go to the new refinery in which the International company has a 42½ per cent. interest, while the bottoms will be shipped to Port Colborne. Thus, copper and nickel refining will be concentrated at Copper Cliff and Port Colborne, respectively. It is expected the new plant at Copper Cliff will be ready for the transfer by the autumn of 1931.

This great addition to the metallurgical plants of Ontario has been the outcome of the development of the Frood ore deposit, the lower levels of which are much higher in copper than in nickel.

During February, 1930, the combined working forces engaged in mine and smelter operations and construction at the various mines and plants of International Nickel Company of Canada, in the Sudbury district, reached

a new high level with a total of 8,839 men drawing wages. The forces represented by these figures are engaged in operation of the Frood, Creighton, and Garson mines, and in plant construction for International Nickel at Copper Cliff and Levack, and also for the Ontario Refining Company and Canadian Industries, Limited, at Copper Cliff. During 1929 these interests distributed approximately $1,000,000 per month in wages. About 2,000 men are employed at the Frood. In addition the Port Colborne refinery of the International employs nearly 1,500 men.

It should not be overlooked that the Frood is only one of a group of mines including the Creighton, Garson, and Levack, operated by the International Nickel Company, not to mention the ownership of thousands of acres of mineral lands located along the rim of the nickel belt. In addition to the copper and nickel content of the Frood ore, important values in precious metals (gold, silver, and platinum metals) are present. The Frood deposit has been opened by two shafts (International and Mond) to a depth of 3,050 and 3,350 feet, respectively, which have been connected on the 2,400-foot and 2,800-foot levels. The ore shipped from this mine goes to the Coniston and Copper Cliff smelters. The Creighton, Frood and Levack served both smelters, while the Garson ore was delivered to Coniston only. A fire which broke out at the Levack mine headframe and rockhouse on December 15 resulted in a considerable monetary loss, and caused a temporary cessation of mining operations there. Ore shipments from these properties in 1929 were as follows:—Creighton 1,177,323, Levack 367,686, Garson 246,049, and Frood 199,852 tons. Shipments from the last mentioned were largely from development. In 1929 the Coniston smelter treated 726,511 tons and Copper Cliff 1,306,946 tons of ore.

A new company, Falconbridge Nickel Mines, Ltd., has started production. The smelter was completed at the end of the year and was blown in February 5, 1930. Initial smelter capacity is 250 tons daily. The annual report of the company states that down to the 1,000-foot level there are 1,367,000 tons of ore, averaging 2.97 per cent. nickel and 0.97 copper. Refining of Falconbridge matte will be done at Kristianssands, Norway. Several other companies did development work on nickel prospects, including Sudbury Offsets, Limited, which carried on an extensive diamond-drilling campaign in Foy township with encouraging results.

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

Nickel in various forms	Quantity	Value
	lb.	$
Metallic	25,260,177	6,821,814
Electrolytic	45,444,585	11,818,000
In nickel-copper matte exported	28,136,095	5,064,496
In oxide (Port Colborne)	11,204,577	3,347,983
In speiss residues (Deloro)	36,538	6,577
In oxides, salts, etc. (Deloro)	193,940	56,590
Total	110,275,912	27,115,460

The world's nickel production was less than 5,000 tons per year prior to 1890. Commencing in 1896 the production rose rapidly until 1918, the peak war year, when 45,886 tons were produced in Ontario alone. It fell during 1921 and 1922 to about 9,000 tons, but has since risen rapidly and with the exception of the year 1925 has shown large increases every year. Ontario's output for 1925 and subsequently is shown in Table XIV. In post-war years the output of metal from New Caledonia, the next largest producer, has approximated 4,000 tons per year.

The consumption of nickel has kept pace with the growing output, and is expected to expand in the future as new uses are developed. It is significant that in pre-war times ordnance and naval armaments took 60 per cent. of the nickel production while to-day this has been reduced to about 10 per cent. Now 32 per cent. goes into nickel steels, and other industrial applications have displaced war uses. There is now wide diversification in the use of nickel: e.g., structural nickel steel, the application of nickel steel and alloys to motor cars, roller bearings which formerly used no nickel are now manufactured with nickel steel; corrosion resisting nickel-chrome alloys (so-called stainless steels), ornamental metal work, ferro-nickel alloys, nickel in iron castings where strain is expected, non-ferrous alloys such as decorative metals in railway coaches, and in nickel plating. The percentages of nickel consumption in the several fields as given in 1927 by Robt. C. Stanley, President of the International Nickel Company, follow:—

Structural nickel-steel	35	Coinage	2
Monel metal	20	Copper-nickel alloys	2
Nickel silver	15	Edison storage batteries	2
Nickel plating	5	Corrosion-resistant steels	1
Heat resisting electrical alloys	5	Nickel cast iron	1
Malleable nickel	5	Nickel catalyzers	1
Nickel-steel castings	2	Nickel-bronze	1
Ferro-nickel alloys	2	Miscellaneous alloys	1

Copper.—Heretofore this metal has been reviewed in conjunction with the nickel-copper industry of which it forms an important part. The construction of a new copper refinery at Copper Cliff to handle Canadian blister copper in a customs way, and the stimulated development of the strictly copper mines of the Province, may necessitate separation of copper from nickel for statistical purposes.

The details of copper production in 1929 follow:—

Source	Quantity	Value
	lb.	$
Metal content of Port Colborne converter copper	70,835,430	11,880,306
In nickel-copper matte exported	16,898,515	2,534,777
In Cobalt ores exported*	52,118	9,437
In Ontario ore treated at Noranda smelter	104,955	19,004
In lead-zinc-copper concentrate exported	989,041	179,085
Total	88,880,059	14,622,609

*Figures are estimated recoveries, not metals paid for.

In Ontario five copper properties made small shipments to the Noranda smelter during the period, amounting to 663.77 tons of ore containing 12 ounces of gold, 659 ounces of silver and 113,593 pounds of copper. The figures shown in the table above make allowances for losses in smelting. These properties, which are not as yet equipped with concentrators, were the Amity, Patterson, Mindoka and Potter-Doal, the latter having re-commenced shipping in December. All are served by the T. & N.O. Railway. The Tip Top mine of the Shield Development Company at Kashabowie, west of Port Arthur, shipped a test carload.

Heavy Chemicals.—Canadian Industries, Ltd., which operates a contact process sulphuric acid plant at Coniston, has built a new one at Copper Cliff costing $1,500,000. In each case, the raw products used are sulphur

fumes from blast furnace operations of the International company. The Coniston plant consists of 3 units, each with a daily capacity of 30 tons of sulphuric acid. The new Copper Cliff plant has three 50-ton units, and two of these were in operation in September, 1930. A large part of the sulphuric acid will be used for the production of nitre cake required for the separation of nickel and copper. Sodium sulphate from Saskatchewan is treated with sulphuric acid, and by a new process evolved by Canadian Industries, Limited, the action is accelerated and the resulting product is cast into moulds, an improvement on the old method by which nitre cake was available only in irregular broken fragments.

Statistical Synopsis.—The principal statistics covering the nickel-copper industry as published for the first time in Ontario reports show that the actual capital invested in Ontario in mines, smelters, refineries, etc., totalled $134,713,333, and the total selling value of products as they left the Province to have been $43,386,989. The total of salaried officials was 198, and wage earners, including those employed in building and construction by the company as well as by contractors, was nearly 8,500. Details are shown in the table on the opposite page.

Lead-Zinc-Copper

Ontario has only one lead smelter, namely, the plant near Galetta owned and operated by the Kingdon Mining, Smelting and Manufacturing Company. The ore is galena in a calcite gangue. During 1929 this smelter produced 4,201,803 pounds of lead valued at $266,596 from 102,000 tons of ore mined. In addition to the above, small quantities are recovered from base-bullion at Deloro in the smelting of silver-cobalt ores, and also from the Treadwell-Yukon concentrate exported. The total lead from all sources in 1929 was 4,769,506 pounds valued at $294,431, as against 6,814,757 pounds worth $402,289 in 1928.

Zinc was derived entirely from the Treadwell-Yukon ores. Occasionally the Kingdon smelter ships zinc-bearing concentrate, slags and drosses, but none were reported in 1929. During the year the total estimated recoverable production was 5,516,806 pounds valued at $297,190.

The lead-zinc-copper section of the industry at present is represented by the Treadwell-Yukon Mining Company only, with a well developed property at Bradley, about 17 miles west of Sudbury. The property is now served with a branch railway line 6 miles in length, which was opened for traffic on October 29. There are three classes of concentrates produced by this company, predominating in lead, zinc, and copper, respectively. At present these are exported for treatment.

PRINCIPAL STATISTICS OF THE NICKEL-COPPER INDUSTRY IN ONTARIO DURING 1929*

Number of producing companies	Number of plants	Capital invested	Dividends paid	Salaried employees		Wage-earners		Selling value of products	
				No.	Salaries	No.	Wages	Kind	$
		$	$		$		$		$
1	4 mines	90,628,544		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
								Nickel oxide	3,347,983
	1 refinery (Port Colborne)	18,091,557		86	255,923	1,302	2,098,550	Converter copper	11,880,306
								Gold	161,282
								Silver	227,625
	Construction†					2,649	3,306,061	Platinum metals	1,646,381
Total		134,713,333	16,055,578	198	653,472	8,497	12,474,606		43,502,665

*The figures do not include non-producing companies. Falconbridge Nickel Mines, Limited, did not commence smelting until February, 1930.
†Workers engaged by contractors for the International Nickel Company of Canada, Limited.

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

To stimulate mining of iron ore in the Province an Act entitled *The Iron Ore Bounty Act, 1930,* was passed in the Ontario Legislature during the 1930 session. By the terms of the Act, the government will grant as a bonus or bounty the sum of one cent per unit of metallic iron contained in each long ton of Ontario ores mined or raised in the Province for a period of 10 years, provided such ore (natural or beneficiated) is smelted or treated in Ontario. A similar Bill was passed in 1924, granting one-half cent per unit subject to an equal Federal grant being made, but this condition was not implemented and the Act was never proclaimed. The new Act will be proclaimed when the occasion arises.

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:—

TABLE XVIII.—IRON AND STEEL STATISTICS, 1925–1929

Schedule	1925	1926	1927	1928	1929
Ontario ore smelted.....short tons	6,830	.....	.....	.....	.....
Foreign ore smelted..... "	732,356	948,154	1,019,971	1,242,937	1,491,278
Limestone for flux..... "	109,198	218,996	217,748	324,550	342,776
Coke..... "	262,344	503,871	478,825	736,746	767,420
Pig iron produced..... "	412,837	545,737	515,366	822,952	861,682
Value of pig iron produced.....$	8,048,992	9,805,300	9,663,108	15,468,110	17,408,514
Steel made.....short tons	529,327	534,732	635,173	885,414	1,007,784
Value of steel made.....$	18,904,520	16,710,365	18,695,950	30,436,098	32,393,052

As shown in Table XVIII, foreign ore charged was 1,491,278 tons, from which a total of 861,682 tons of pig iron were made having a value of $17,408,514. The output consisted of 534,393 tons of basic, 228,284 tons of foundry, and 99,005 tons of malleable iron. Basic was valued at $20.75 per long ton, foundry at $25.75, malleable at $25.56, and steel at $36.00.

IRON BLAST FURNACES IN OPERATION, 1929

Name of Company	Furnaces			Location
	No.	Daily capacity, long tons	Days operated	
Algoma Steel Corporation, Ltd. (*a*).....	2	1,600	365	Sault Ste. Marie
Steel Company of Canada, Ltd.....	2	825	365	Hamilton
Canadian Furnace Company, Ltd. (*b*).....	1	300	223	Port Colborne

(*a*) In July and August, 3 furnaces. (*b*) Closed February 11 to June 10.

BLAST FURNACES IN ONTARIO FOR THE PRODUCTION OF PIG IRON

Company	Location	Furnaces		Remarks
		No.	Daily capacity gross tons	
Algoma Steel Corporation, Ltd.....	Sault Ste. Marie..	4	1,600	Active
Atikokan Iron Company.....	Port Arthur.....	1	175	Idle since 1911
Canadian Furnace Co., Ltd.....	Port Colborne....	1	300	Re-opened May 25, '28
Canadian Steel Corporation, Ltd....	Ojibway (near Windsor).....	2	1,100	Partly constructed.
Midland Iron and Steel Co., Ltd....	Midland.....	1	120	Idle since Feb., 1921
Parry Sound Iron Co., Ltd.....	Parry Sound.....	1	90	Idle since Oct. 1, 1919
Standard Iron Co., Ltd.....	Deseronto.....	1	60	Idle since June 9, 1919
Steel Company of Canada, Ltd.....	Hamilton.....	2	825	Active.

Note.—The first and last mentioned companies produce open-hearth steel as well as pig iron.

Steel and Ferro-Alloys.—Steel ingots to the amount of 889,807 long tons were made in Ontario by five companies. Of these 857,455 tons were basic open hearth for use in the manufacturing plants of the makers.

Direct steel castings derived by the open hearth basic, crucible, and electric process, totalled 23,068 long tons, of which 18,383 long tons were electric and the balance open hearth basic and converter.

Ferro-alloys were made by four companies and included ferro-manganese and ferro-silicon. The total output amounted to 80,010 long tons.

PIG IRON, STEEL AND FERRO-ALLOY PRODUCERS

Company	Location
Abrasive Company of Canada, Ltd. (*c*)	Hamilton
Algoma Steel Corporation, Ltd. (*a*), (*b*)	Sault Ste. Marie
Canadian Carborundum Co., Ltd. (*c*)	Niagara Falls
Canadian Electric Castings Co., Ltd. (*b*)	Orillia
Canadian Furnace Co., Ltd. (*a*)	Port Colborne
Carbon and Alloy Steel Co., Ltd. (*b*)	Welland
Dominion Foundries and Steel, Ltd. (*b*)	Hamilton
Electro Metallurgical Co. of Canada, Ltd. (*c*)	Welland
Exolon Co., Ltd. (*c*)	Thorold
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.

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 are shown in the subjoined table:—

THE COKING INDUSTRY IN ONTARIO, 1929

	Unit	Quantity	Value
MATERIALS USED			
Bituminous coal, foreign	tons	1,843,737	7,621,308
Coke for gas making	"	11,118	27,795
Oil for gas making	Imp. gals.	94,904	11,270
Lime	tons.	1,512	14,274
Water			15,156
Sulphuric acid, 66° Be.	lb.	33,535,020	219,879
All other materials			26,391
Total			7,936,073
PRODUCTS MADE			
Coke	tons	1,292,150	9,296,015
Coke breeze	"	88,810	160,165
Gas sold and used	M cu. ft.	14,444,375	2,957,791
Tar	Imp. gals.	13,014,003	894,754
Ammonium sulphate	lb.	39,761,539	699,926
Light oils	Imp. gals.	4,593,383	657,930
All other products			1,295
Total			14,667,876

NON-METALLIC MINERALS

During 1929 the value of the output of non-metallic minerals totalled $8,621,427 as against $7,822,641 in 1928, or an increase of 10.2 per cent. The principal items, with values in order of importance, were as follows: Natural gas, $4,968,137; salt, $1,420,424; gypsum, $832,689; quartz and quartzite, $316,050; petroleum, $253,678; feldspar, $206,979; talc, $180,492; and arsenic, $154,887. Actinolite, beryl, fluorspar, graphite, iron pyrites and sulphuric acid (i.e. sulphur content), mica, mineral water, peat, and silica brick were represented, but were all under $100,000 each in value, as may be seen in Table 1 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 where it is used as an ingredient in the manufacture of roofing material. In 1929 the output was 30 tons valued at $375 as against 70 tons worth $875 in 1928.

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 customary 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 1929 was 3,742,913 pounds valued at $154,887 as against 4,097,226 pounds worth $178,149 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, 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 the property of T. B. Caldwell, Perth, Ont., located on lot 23, concession 15, 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.

Coal (Lignite)

On the James Bay coastal plain, in the valleys of the Abitibi and Mattagami rivers, recent investigations by W. S. Dyer, geologist on the staff of the Ontario Department of Mines, have definitely established an extensive Cretaceous basin, in which formation coal measures are found in other parts of Canada. Its existence was first suggested by the late Joseph Keele in discussing the origin of the Mattagami River fire clays and china clays, and appeared in his report to the Ontario Department of Mines, published in 1920. The presence of lignite at Blacksmith rapids on the Abitibi river has been known for years, but its geological age was formerly thought to be

later than Cretaceous. To determine the extent of the deposit a diamond-drilling programme was begun in the summer of 1929 by the Provincial government under the supervision and direction of the Ontario Department of Mines, with the result that up to September, 1930, about 3 square miles of lignite, in a bed averaging about 20 feet in thickness, has been delimited. The deposit extends from the Abitibi to the Onakawana, a parallel stream, and continues to the west for an undetermined distance. The grade, from tests so far made, is similar to Southern Saskatchewan lignite which finds a ready market in Winnipeg in the raw state as domestic fuel, and is also being carbonized and briquetted successfully.

Two test shafts have now been sunk, one on the bank of the Abitibi and the other beside the Onakawana river, from which test shipments have been made. The lignite was solid and free from fines, partings or mud seams. The overburden is principally boulder clay, 50 to 100 feet in thickness. It is expected this new fuel, suited to domestic and industrial use, will prove a boon to Northern Ontario. Diamond-drilling to further delimit the extent of the field is proceeding west of the Onakawana, a euphonious Indian word which has been adopted as a trade name for the new fuel. By Order-in-Council the Ontario Government has withdrawn from staking large areas adjoining the Mattagami and Abitibi rivers.

The T. & N. O. Railway Commission has let the contract for a 45-mile extension of the Cochrane-James Bay line from the present terminus on the Abitibi river at Coral Rapids (mile 97). The extension was built during the summer of 1930, passing through the new lignite field and terminating at Murray island on the Moose river, only 45 miles from Moose Factory. Construction of a bridge across the Moose is now under way, and the remaining 45 miles of railway along the northwest bank of the river to tide water at Moose Factory will be constructed during the summer of 1931.

Feldspar

During 1929 the production of feldspar was up by 2,783 tons, accounted for by steady exports of crude to the United States, as well as to an increasing consumption of ground spar in Canadian manufactured products. The figures were 21,737 tons valued at $206,979 for 1929 as against 18,954 tons worth $180,153 in 1928. These figures include $34,121 and $22,432, respectively, as increases in value due to grinding in a domestic plant. Only one feldspar grinding plant, apart from the production of stucco, was active, namely the Frontenac Floor and Wall Tile Company at Kingston where the finely ground product is used in the manufacture of high-grade floor and wall tile as well as supplying other producers of porcelain whiteware. There were six feldspar producers during the period of which the Bathurst Feldspar Mines, Limited, and the Genesee Felsdpar Company, Incorporated, were the most important, producing around 8,000 tons each.

During 1929 some of the smaller operators were forced to discontinue mining because the United States market was cut off due to a feldspar merger in the United States. In the Bulletin of a year ago reference was made to the new Consolidated Feldspar Corporation which acquired the Dominion and New York feldspar grinding mills located at Rochester, N.Y., leaving only the Genesee mill as an independent purchaser of Canadian feldspar. In 1929 another merger was effected, known as United Feldspar Corporation. The Feldspar Grinder's Institute, formed July 15, 1929, immediately took up the question of standardization of product with the result that grinders, users, and the U.S. Bureau of Standards came to an agreement in February, 1930, at the Convention of the American Ceramic Society in Toronto, to adopt grade standards based on chemical analysis. This is expected to iron out many of the difficulties which have existed hereto-

fore between producer and consumer. Three groups of spar were established, namely, body, glaze and glass. One feature of the industry is the rapidly expanding use of spar in glass manufacture, about one-third of the U.S. output now finding a market in the glass trade. The Feldspar Glass Company at Oshawa made progress in improving its electrical furnace for bottle glass manufacture, using feldspar largely as a raw product, and hopes to be marketing its product in the near future.

Fluorspar

During 1928 and 1929, a small production of fluorspar was picked from the old ore dumps on lot 3, concession 1, of Madoc township, totalling 70 tons having a value of $1,120. The last reported production from the same area was in the year 1925.

Graphite

The only producer of this mineral in Ontario was the Black Donald Graphite Company, Limited, of Calabogie, from its property on lots 17, 18 and 19, concession III of Brougham township in Renfrew county. During 1929 sales of all grades totalled 1,288 tons valued at $90,522, as against 1,047 tons worth $52,373 in the previous year. During the year 3,734 tons of ore were mined, of which 2,948 tons received treatment. Material on hand at the end of the year was 800 tons crude and 235 tons refined.

Gypsum

During 1929, Canada Gypsum and Alabastine, Ltd., of Paris, the only producer of gypsum in Ontario, extended its operations considerably by acquiring limestone quarries and lime kilns in various parts of Canada. In this province the following were taken over in March:

1. Stone quarry and lime kilns of the Beachville Lime & Stone, Ltd. (successor to Standard White Lime Co. and Beachville White Lime Co., Ltd.).
2. Stone quarry and lime kilns in Nassagaweya township, Halton county, from D. Robertson and Son, Ltd.
3. The Limehouse plant owned by the Toronto Lime Co., Ltd.
4. The Puslinch, Kelso and Hespeler plants of the Christie-Henderson Lime Co., Ltd.

As a result of this extension of operations, the name of the organization was changed in January, 1930, to bring it more in accord with the extended business of the company, and to include lime which is now a major product. The renamed company, "Gypsum, Lime and Alabastine, Canada, Limited," is now the leading producer in Canada of high calcium lime, magnesium lime, limestone and chemical limestone. The great development of its business in the last few years has placed the company in the position of being the second largest shipper over Canadian railway lines.

Gypsum mills in Ontario are located at Lythmore and Caledonia in Haldimand county. Production for the past five years follows:—

GYPSUM SALES, 1925–1929

Grade	1925	1926	1927	1928	1929
Crushed.....tons	24,830	37,769	29,832	20,675	23,533
Fine ground..... "	548	1,110	621	1,134	497
Calcined sold..... "	8,337	3,098	856	4,133	5,269
Calcined used in products..... "	48,305	48,010	52,689	59,869	71,048
Total sold or used.....tons	82,020	89,987	83,998	85,811	100,347
Total value.....$	491,833	496,059	500,688	553,271	832,689

Iron Pyrites and Sulphuric Acid

There was only one producer of iron pyrites in Ontario during 1929, namely, Canadian Pyrites, Ltd., which shipped 156.56 tons of lump and 520.78 tons of fines from the Caldwell mine near Flower Station. This material contained 38 and 42 per cent. sulphur, respectively, and was valued at $8,506. In the main table the sulphur content of pyrites is included with the sulphur contained in the sulphuric acid recovered from sulphur dioxide fumes at the Coniston smelter of the International Nickel Company of Canada, Limited, giving a total of 4,579 tons of sulphur worth $51,516.

Canadian Industries, Ltd., which has taken over the Mond sulphuric acid plant at Coniston, constructed at Copper Cliff during 1929 an additional plant for making sulphuric acid, and also a chemical plant for the production of nitre cake. The bulk of the sulphuric acid will be used to treat sodium sulphate from Saskatchewan to produce nitre cake which the Company is under contract to supply to the International Nickel Company of Canada. Active research work is being carried on to develop the further utilization of smelter fumes.

The contact process plant at Coniston was placed in operation by the Mond Nickel Company in November, 1925. To W. H. DeBlois credit is due for adapting the contact process to treat sulphur dioxide fumes with impurities in the form of dust. Mr. DeBlois is now in charge of both plants. The Coniston plant consists of 3 units, each with a capacity of 30 tons of acid per day. The new Copper Cliff plant also consists of 3 units, but they are of 50 tons capacity each. Two of these units were in operation in September, 1930. Both vanadium and platinum catalysts are being tried out to ascertain which is the more efficient.

Mica

The production of mica in Ontario increased slightly during 1929 but the industry, due to lack of markets, is not in a flourishing condition. During the period 2,991 tons of mica, principally scrap, valued at $45,919 were shipped from the mines and by dealers as against 2,559 tons worth $32,945 in 1928. Only 250 tons of ore were reported as mined while shipments were reported by six operators. The total number of employees reported was 16 who earned $5,533, but these figures do not take into account those engaged in part time work.

By grades the shipments were as follows:—

Grade	Pounds	Value
		$
Thumb-trimmed	85,470	10,620
Scrap	5,896,640	35,299
Total	5,982,110	45,919

The thumb-trimmed, which in size varies from 1 inch by 1 inch to 5 inches by 8 inches, brought the following prices:—

Size, inches	Cents per lb.
1 by 1	7–14
1 by 2	15–20
1 by 3	18–27
2 by 2	22
2 by 3	28–55
2 by 4	50—60
3 by 5	$1.00—$1.25
4 by 6	$2.00—$2.50
5 by 8	$2.00—$2.50

MICA SHIPPERS, 1929

Name of Owner or Producer	Location or Name of Mine	P.O. Address of Manager, etc.
Bennett, H. V.	Buyer of mica	Perth
Burke, Jas.	" "	Perth
Kent Bros., and Estate of J. M. Stoness	" "	Kingston
Lee, W. W.	" "	Bedford Mills
Loughborough Mining Co.	" "	Sydenham
Martin, A. G.	" "	236 Besserer St., Ottawa
McLaren, W. L.	Lots 4, 5, 6, con. VIII, N. Burgess tp.	Box 20, Perth

Mineral Waters

The companies producing mineral waters in 1929 were as follows:—

PRODUCERS OF MINERAL WATERS, 1929

Name of Owner, Firm, or Company	Location of Spring or Well	P.O. Address of Manager, etc.
*Canada Dry Ginger Ale, Ltd.	Gloucester and Clarence tps.	6380 St. Urbain St., Montreal
Carlsbad, Ltd.	Carlsbad Springs	Carlsbad Springs, Que.
Denault, F.	Lot 22, con. IV, Clarence tp.	Bourget.
Goderich Mineral Water Co.	Goderich	Goderich.
Gurd & Co., Ltd., Charles.	Caledonia tp.	1016 Bleury St., Montreal.
Sanitaris, Ltd.	Lot 27, con. XII, Pakenham tp.	Arnprior.

*Formerly Caledonia Springs Co., Ltd.

The following table records shipments in Imperial gallons since 1921 of mineral water with valuation in bulk form at the works:—

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

Natural Gas

Production of natural gas in Ontario in 1929 was 8,583,187 thousand cubic feet, with a retail value of $4,968,133, according to the report (Vol. XXXIX, Part V) by R. B. Harkness, Natural Gas Commissioner. Production in 1928 was 7,632,740 thousand cubic feet. For fuller details the special report above mentioned should be consulted. Labour employed by the industry totalled 1,323 persons who received $1,529,367 in wages.

Peat

The output of 1,000 tons worth $4,500 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, and saleable fuel on hand at the end of the year was estimated at 2,000 tons.

Petroleum

A report on "Petroleum in 1929," by the Natural Gas Commissioner, appears in Vol. XXXIX, Part V. One statistical table, which is repeated here for convenience, taken from the above-mentioned report, is as follows:—

CRUDE PETROLEUM PRODUCTION BY FIELDS, 1925–1929

Field	1925*	1926	1927	1928	1929
	Bbls.	Bbls.	Bbls.	Bbls.	Bbls.
Petrolia, and Enniskillen township..	53,166	55,485	60,172	60,547	56,284
Oil Springs	39,137	38,350	37,281	35,653	30,737
Moore township	8,195	2,438	2,014	2,148	1,230
Sarnia township	1,905	1,890	1,679	1,221	749
Plympton township	1,424	1,047	493	371	315
Bothwell	26,243	25,382	25,224	24,255	23,236
Dover, West } Tilbury	2,957	959	602	773	715
Tilbury, East } Tilbury	.....	.....	60	736	138
Raleigh township	887	676	276	.....	.....
Onondaga township	261	361	210	186	243
Mosa township	8,397	7,868	7,456	7,268	6,851
Thamesville	289	2,376	4,139	1,006	427
Euphemia township	39	.....	.....	.....	.....
Dunwich township	1,001	139	.....	.....	148
Romney township	1,235	.....	.....	.....	.....
Brooke township	.....	.....	.....	.....	52
Total production.....Bbls.	144,249	136,971	139,606	134,164	121,125
Value.....$	369,154	376,822	289,390	249,981	253,678
Average price per bbl.....$	2.56†	2.73	2.11	1.86	2.09

*Figures to July 1, 1925, supplied by the Supervisor of Petroleum Bounties at Petrolia.

†A bounty of 26½ cents per barrel (35 Imperial gallons), or a total of $20,152, was paid in 1925 by the Federal Government under the "Petroleum Bounty Act" up to July 1, when the Act ceased to operate. This bounty was in addition to the values above quoted.

Refining of oil and the manufacture of oil refinery products were carried on during 1929 by four companies in Ontario, as follows:—

PETROLEUM REFINERIES, 1929

Company	Head Office	Plant	Days Operated
British American Oil Company, Ltd.	1312 Royal Bank Bldg., Toronto..	Toronto...	304
Canadian Oil Refineries, Ltd.	Toronto	Petrolia...	365
Imperial Oil Refineries, Ltd.	445 South Christina St., Sarnia....	Sarnia....	365
McColl Bros., Ltd.	114 Don Esplanade, Toronto.....	Toronto...	365

In 1929 only 1.35 per cent. of the crude oil distilled by these companies was of Ontario origin.

Quartz, Quartzite, and Silica Brick

The output of quartz in 1929 totalled 187,973 tons valued at $316,050 as compared with 194,503 tons worth $308,608 during the previous year, showing a slight increase in value but a decrease in quantity. Four operators were active during the period employing 94 men who received $78,489 in wages.

The largest producer is the Dominion Mines and Quarries, Limited, which operated its Killarney quarry on the north shore of Lake Huron. The East Neebish quarry, operated in former years by this company, was

idle during the period. The International Nickel Company (Mond Division) reported production, all of which was crushed to 1½-inch size and consumed at the Coniston smelter, as a flux.

Wright and Company of Sault Ste. Marie were producers, part of their output going to supply raw material required in silica brick manufacture by the Algoma Steel Corporation for consumption in their own plants. During 1928 there were 1,566,199 silica brick made having a value of $80,374.

A list of the producers follows:—

QUARTZITE, QUARTZ AND SILICA BRICK PRODUCERS, 1929

Name of Owner, Firm or Company	P.O. Address of Operator	Location of Quarry
Algoma Steel Corporation, Ltd.	Sault Ste. Marie	*
Dominion Mines and Quarries, Ltd.	Toronto, Canada Life Bldg.	Killarney.
International Nickel Company, Ltd.	Copper Cliff	Neelon tp.
Rayner, G. W.	Toronto, 151 Roxboro St. E.	Deroche tp.
Wright and Company	Sault Ste. Marie	Deroche tp., Mile 19, A.C.Ry.

*Producers of silica brick. Quartz supplied by Wright and Company.

Salt

The production of salt and brine from southwestern Ontario by six salt and two chemical plants in 1929 shows an increase over 1928. Canadian Industries, Limited, at Sandwich, and Brunner, Mond Canada, Limited, at Amherstburg, use salt brine for the manufacture of chemicals such as bleaching powder, liquid chlorine, muriatic acid, caustic soda and soda ash. The first four products mentioned are manufactured at Sandwich, the output from Amherstburg being caustic Soda and soda ash. Canadian Industries Limited, a subsidiary of Imperial Chemical Industries, Limited, of London, England, purchased the assets of the Canadian Salt Company, Limited, on November 11, 1928. The output of other alkali chemicals by the Canadian Salt Company and its successor has lately developed to an extent where it has become more important than the basic production of salt. The Windsor salt plant of this company has been dismantled.

Salt plants were operated in 1929 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.

Analysis of the figures in the table shows a slight falling off in salt sales, but an increased use of brine in chemical plants. The output 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, 1925–1929

Schedule	1925	1926	1927	1928	1929
Land.....tons	5,125	3,965	4,599	3,621	1,919
Coarse..... "	33,197	31,192	25,216	26,730	22,632
Fine..... "	43,286	47,202	47,185	51,055	49,869
Table and Dairy..... "	46,602	50,461	53,477	56,214	54,138
Pressed Blocks..... "	4,605	6,505	7,709	7,083	5,560
Brine (salt equivalent)..... "	93,500	113,020	115,995	135,138	168,327
Total sold or used..... "	226,470	252,345	254,180	279,841	302,445
Value of products sold or used.....$	1,466,450	1,388,672	1,510,777	1,377,629	1,420,424
Employees.....No.	*467	*466	290	299	263
Wages.....$	555,729	614,790	322,549	337,214	303,618

*Employees of Sandwich salt and chemical works are included.

OPERATING SALT COMPANIES, 1929

Name of Owner, Firm or Company	Location of Wells or Works	P.O. Address of Manager, etc.
Brunner, Mond Canada, Limited	Amherstburg*	Amherstburg.
†Canadian Salt Company, Limited, The	Sandwich*	Sandwich.
Dominion Salt Company, Limited, The	Sarnia	Sarnia.
Exeter Salt Works Company, Limited	Exeter	Exeter.
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.

Talc and Soapstone

Production from the two Ontario producing properties during 1929 was slightly higher than in 1927 or 1928. During the period 17,703 tons of ore were mined and 17,403 tons milled, from which 15,463 tons of different grades valued at $180,492 were marketed. The Geo. H. Gillespie Co., Ltd., at Madoc, as usual, treated ore from the Henderson mine; while the Canada Talc Company, Ltd., formerly known as the Asbestos Pulp Co., Ltd., operated its mine and mill, also at Madoc. The several grades of refined product varied in price from $9.00 to $18.00 per ton. Markets were found in Canada, United States and Great Britain. During the year the soapstone properties situated at Eagle lake in Kenora district were closed down. Following are statistics of talc and soapstone for the past five years:—

TALC AND SOAPSTONE STATISTICS, 1925–1929

Schedule	1925	1926	1927	1928	1929
Soapstone shipped.....tons	64	110	135	.....	.....
Ground talc shipped..... "	13,614	14,772	15,003	14,925	15,463
Total value shipments.....$	174,116	178,986	181,981	179,187	180,492
Employees, mine and mill.....No.	51	50	61	45	42
Wages paid.....$	47,971	47,083	51,834	44,858	40,055

STRUCTURAL MATERIALS

Construction Contracts

The value of Canadian construction contracts awarded for 1929 reported by *McLean Building Review* was $576,651,800 as compared with $472,032,600 in 1928. Ontario contracts in 1929 amounted to $215,773,100 or 37.4 per cent. of the total. Building costs have been stable for the past few years and material prices are considerably below the peak of 1920. It is expected that prices will remain stabilized at or near the present levels and, while there may be some fluctuations in the cost of building materials, no important reductions in building costs appear likely in view of higher wages.

VALUE OF ONTARIO CONSTRUCTION CONTRACTS, 1924–1929

Classification	1924	1925	1926	1927	1928	1929
	$	$	$	$	$	$
Residential	43,090,000	47,529,600	52,084,100	57,580,800	64,628,600	59,211,000
Business	27,706,000	32,579,800	38,808,200	81,328,100	58,700,200	82,949,000
Industrial	7,017,000	3,754,700	21,126,900	11,922,500	25,109,800	28,247,200
Engineering	58,228,000	37,381,000	29,910,200	45,327,600	39,913,100	45,365,900
Total	136,041,000	121,248,100	141,929,400	196,159,000	188,351,700	215,773,100

Building Permits

Building permits in 61 Canadian cities in 1929 were valued at $234,944,549. Of this total thirty Ontario cities accounted for $95,055,827 or 40.5 per cent., as noted in the following table abstracted from *Annual Review of Building Permits in Canada in 1929*, issued by the Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa.

BUILDING PERMITS IN ONTARIO, 1920-1929

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

(*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.

Cement

During 1929 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, 1913-1929

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

It should be noted that sales in 1929 were the greatest on record. In the annual statement of the Canada Cement Company, Limited, for the fiscal year ending November 30th, 1929, mention is made of the generally prosperous business conditions that prevailed throughout Canada during 1929 as responsible for a better demand for cement. A specially constructed self-discharging vessel of 3,500 tons capacity was put in operation in September to supply maritime storage and shipping points with cement and bring back gypsum from Nova Scotia for use in Eastern Canada cement plants.

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 since the raw materials entering into the manufacture of these products have all been accounted for. But readers have pointed out that, being so closely allied to the building industry, statistics of cement products should be included so that complete information covering all structural materials might be available under one cover. The following table gives the record of materials used and products made by cement products manufacturers during the past 3 years in Ontario. Monolithic construction is not included.

PRODUCTION OF CEMENT PRODUCTS IN ONTARIO, 1928–1929*

	1928		1929	
	Quantity	Cost at Works	Quantity	Cost at Works
MATERIALS USED		$		$
Portland cement ..... bbls.	195,105	401,648	275,049	472,957
Quicklime ..... bu.	641	305	7,619	3,595
Sand ..... cu. yds.	42,499	66,176	59,012	110,180
Gravel ..... "	66,572	110,545	116,509	107,641
Crushed stone ..... "	20,693	65,243	12,740	47,232
Cinders ..... tons	.....	22,818	.....	43,715
Boxes, crates, lumber, etc	.....	18,806	.....	21,326
Other materials	.....	51,100	.....	161,940
Total	.....	736,641	.....	968,586
PRODUCTS MADE				
Cement brick ..... M.	2,597	39,947	649,801	178,247
Hollow building blocks, etc	.....	779,462	.....	560,022
Drain pipe	.....	124,088	.....	51,878
Sewer and culvert pipe	.....	746,438	.....	957,325
Artificial stone	.....	379,202	.....	497,539
Cement posts, poles, etc	.....	9,319	.....	4,975
Cinder blocks (cincrete) ..... M.	950	190,158	2,209	305,893
Other products	.....	173,103	.....	234,560
	.....	2,441,717	.....	2,790,439

*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. On the other hand, wages paid and value of products have

steadily increased, indicating that the well-organized establishments have a steady and expanding business.

PRINCIPAL STATISTICS OF CEMENT PRODUCTS INDUSTRY, 1925-1929*

	1925	1926	1927	1928	1929
Plants.....No.	148	133	109	105	106
Wage-earners (average).....No.	507	474	481	590	767
Salaries and wages.....	411,836	439,487	468,371	617,503	897,481
Cost of fuel.....$	30,751	33,391	29,257	39,669	49,974
Capital invested.....$	2,068,497	2,168,758	1,888,102	2,501,018	3,031,747
Value products at works.....$	1,499,938	1,583,437	1,685,050	2,441,717	2,664,372

*Supplied by Dominion Bureau of Statistics, Ottawa.

Lime

The period under review was one marked by several changes in the ownership of lime-producing plants. Early in 1929 Canada Gypsum and Alabastine, Limited, bought a number of operating kilns. In addition to the originally owned plants, namely Teeswater and Elora (the former being dismantled early in the year), this company bought out the Beachville Lime and Stone Company, Limited, which was a consolidation of the Beachville White Lime Company and the Standard White Lime Company of Guelph; the Puslinch, Kelso and Hespeler plants of the Christie Henderson Company, the Rockwood and Limestone plants of the Toronto Lime Company (the Rockwood kilns have not been active for a number of years), and the Halton county lime plant of D. Robertson & Company, Ltd. The acquisition of the above plants, which are among the important ones of the province, has placed the company, now known as "Gypsum, Lime and Alabastine, Canada, Limited," prominently in the lime business.

During 1929 some twenty-six establishments were active, employing 577 men to whom $398,266 was paid in wages. Six of these plants are equipped for the production of hydrated lime. Total lime sales were 370,162 tons, valued at $3,364,412. Figures of production for the past five years are given in the table which follows:—

LIME STATISTICS, 1925-1929

Year	Lime Marketed or Used						Fuel Costs	Employees	Wages
	Hydrated			Quicklime					
	Tons	Value		Bush. (70 lbs.)	Value				
		Total	Per Ton		Total	Per Bush.			
		$	$		$	c.	$		$
1925..	41,610	477,585	11.47	5,115,882	1,566,540	30.6	375,220	409	436,867
1926..	39,217	457,978	11.68	5,402,261	1,593,468	29.5	396,128	414	397,988
1927..	44,749	540,687	12.08	5,668,087	1,657,552	29.2	386,284	451	458,001
1928..	49,085	597,367	12.17	6,517,170	1,870,476	28.7	388,152	414	390,611
1929..	55,916	740,127	13.24	8,978,465	2,624,285	29.2	513,741	577	398,266

For statistical purposes the information on lime is divided among the various consuming industries and for 1929 the figures were as follows:—

Consumption	Quicklime		Hydrated lime	
	Bushels	Value	Tons	Value
		$		$
Building Trades	651,460	197,173	39,617	491,796
Chemical Works	6,633,971	1,942,318	309	3,399
Metallurgical and Glass	460,975	126,698	63	725
Pulp and Paper	235,728	65,565	50	575
Sugar Refining	228,459	67,755	.....	.....
Tanneries	50,416	13,743	54	594
Agriculture	486	135	535	5,737
Dealers	505,649	155,752	15,276	237,156
Others	211,321	55,146	12	145
Total	8,978,465	2,624,285	55,916	740,127

LIME PRODUCERS, 1929

Name of Owner or Company	Location of Kilns	Head Office Address
American Cyanamid Co.[1]	Niagara Falls	Niagara Falls.
Beachville White Lime Co., Ltd.[2]	Beachville	Beachville.
Biederman, Albert G.	Wilberforce tp.	Golden Lake.
Brunner, Mond Canada, Limited[1]	Anderdon tp., near Amherstburg.	Toronto, Bank of Commerce Building.
Canada Gypsum and Alabastine, Ltd.[3]	Elora[4] and Teeswater[5]	Paris.
Canada Lime Co.	Coboconk and Sand Point.	Toronto, 465 Bay St.
Cameron, W. M.	Carleton Place	Carleton Place.
Chalmer's Lime Works	Owen Sound	Owen Sound.
Christie, Henderson & Co., Limited[2]	Hespeler,[4] Puslinch, Kelso, Galt.	Toronto, 201 Crown Office Building.
Dominion Sugar Company[1]	Chatham and Wallaceburg.	Chatham.
Dominion Rock Products, Ltd	Eganville	Montreal, 1017 New Birks Bldg.
Gallagher Lime and Stone Co., Ltd.	Barton tp.	Hamilton.
Jamieson Lime Co.	Renfrew	Renfrew.
Kinkley, Harry	Napanee	Napanee.
Robertson & Co., Ltd., D.[2]	Nassagaweya tp.	Toronto, 26 Queen St. E.
Shane Lime Co.	Grattan tp.	Eganville.
Standard White Lime Co., Limited[2]	Beachville, Guelph,[4] St. Marys and Rockwood.	Guelph, 15 Douglas St.
Toronto Brick Co., Ltd.	Coboconk	Toronto, 897 Bay St.
Toronto Lime Co., Ltd.[2]	Dolly Varden	Toronto, 26 Queen St. E.
Weppler, Henry	Glenelg tp.	Priceville, R.R. No. 2.

[1]Product from high calcium limestone used in manufacture of chemicals and sugar.

[2]Bought by Canada Gypsum and Alabastine, Ltd.

[3]Name changed to Gypsum, Lime and Alabastine, Canada, Ltd. See reference under "Gypsum."

[4]Hydrated lime plants.

[5]Dismantled in 1929.

Sand-Lime Brick

In 1929 the output of sand-lime brick was 55,750 M worth $641,159 as against 61,506 M valued at $745,719 in the previous year. These figures include the value of the lime consumed in manufacturing. The figure for value as shown in Tables I and II is the total selling price without any deduction, since the small duplication in value will in part compensate for sand produced by many part time operators from whom no reports are received.

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

SAND-LIME BRICK STATISTICS, 1925–1929

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	
			$		$	$	$	$
1925.....	8	202	213,556	66,506	820,893	12.34	677,103	15.28
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
1929.....	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

All the active plants in 1929 were located in Toronto or vicinity. The list follows:—

SAND-LIME BRICK PRODUCERS, 1929

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

*Closed down September 4, 1929.

Sand and Gravel

The sand and gravel industry of Ontario of late has developed into an important section of mineral production, accounting in 1929 for over three million dollars of the value of products. Apart from licensed operators, *i.e.*, dredging in the lakes and rivers of the province, the pits operated by municipalities, and the railway ballast pits, there were about 200 privately owned establishments active in Ontario. These pits vary in size from the small hand-operated farm or wayside pit to the up-to-date mechanically equipped washing plant capable of supplying to the trades all grades of washed sand and gravel or sized material. The largest company, which is a consolidation of several large dredging and gravel pit companies, produces approximately two million tons of sand and gravel per year. The machine operated or mechanically equipped pits total 21 in Ontario.

Two tables follow showing output by source and consumption by grade:—

OUTPUT OF SAND AND GRAVEL DURING 1928 AND 1929

Origin	1928		1929	
	Tons	Value	Tons	Value
		$		$
Private pit operators	2,193,250	973,760	2,080,280	1,138,458
Dredged from Great Lakes and Rivers	1,566,540	580,201	2,323,136	1,290,630
Department of Northern Development	805,073	71,562	1,500,814	111,171
Department of Highways	740,961	164,655	621,000	160,000
Miscellaneous counties and townships	887,293	266,188	1,519,983	455,995
Total	6,193,117	2,056,366	8,045,213	3,156,254

CONSUMPTION OF SAND AND GRAVEL IN 1928 AND 1929

Consumption	1928		1929	
	Tons	Value	Tons	Value
		$		$
Moulding Sand	41,604	44,306	61,238	47,672
Building Sand	1,121,570	417,847	1,455,523	703,442
Other Sands	12,496	12,718	13,646	13,530
*Railway Ballast				
Concrete and Road Building	4,346,405	1,181,963	5,843,234	1,946,151
†Crushed and washed	671,042	399,532	671,572	445,459
Total	6,193,117	2,056,366	8,045,213	3,156,254

*Sand and gravel produced for ballast by the railways from their own pits has not been included. In 1929 the output from railway ballast pits was 3,313,355 tons worth $306,125.

†This material is used principally in building and construction work.

Licensed Operations.—There were 30 vessels operating in the Province during the season of 1929 engaged in removing sand and gravel under Ontario license. Each boat operating in Crown waters pays to the Province a license fee of $100.00 for each area. The fee to operate on private properties is $10.00. The rate of royalty ranges from 3.6 cents to 20 cents per cubic yard. This is based on the grade of material and the location of the deposits. The license fees amounted to $5,665.00, and total removals were 1,421,533 cubic yards upon which $186,459.65 royalty was collected. These operations were in St. Clair river, St. Lawrence river, Lake Ontario, Thames river, Lake Erie, Midland bay, Lake Huron, St. Marys river and Lake Superior.

A list of sand and gravel producers follows: only pits managed by private operators and having an output of 1,000 cubic yards or over in 1929 are listed:—

PRIVATE SAND AND GRAVEL OPERATORS, 1929

Name or Company	Material G=Gravel S=Sand	Location of Deposits	Address
Adair, Dolson	S. and G.	Caledon tp., lot 24, con. V	Caledon E., R.R. 2.
Allan, James	S. and G.	Tuckersmith tp.	Seaforth.
Armstrong Supply Co., Ltd.	G.	York St., Hamilton	Hamilton.
Ashton, Thos.	S. and G.	Victoria Park Ave.	Toronto, 1354 Queen St. East.
Backus Brooks Co.	S. and G.	McIrvine tp.	Minneapolis, 1100 Builders Exchange.
Bast, Aaron	S. and G.	Waterloo tp.	Kitchener, 112 Lydia St.
Bellyou, N. E.	S. and G.	Murray tp., lot 6, con. 1.	Trenton, R.R. 4.
Benson & Patterson	S. and G.	Stamford	Stamford, 142 St. Paul Ave.
Bray, J. M.	S. and G.	Grey tp., lot 29, con. XV	Brussels, R.R. 2.
Burrows, John	S. and G.	Widdifield tp.	North Bay, 447 Klock Ave.
Cameron, Chas. M.	S. and G.	Mosa tp., lot 3, Range 1	Glencoe, R.R. 1.
Carroll Bros.	S.	Humberstone tp., lots 1, 3, 4, 5.	490 Ellicott Sq., Buffalo, N.Y.
Conlin, Herbert L.	S. and G.	Scarborough tp.	156 Front St. E., Toronto
Crosby, Wm	S. and G.	Blenheim tp., con. II	Princeton.
Cudmore, Mrs. Alice	S.	Usborne tp., lot 29, con. IV.	Hensall, R.R. 1.
Cudmore, Mrs. Bertha	S. and G.	Howard tp., lot 12	Thamesville, R.R. 6.
Cuthbert, C. E.	G.	West Oxford, lot 4, con. V	Curries, Ont.

PRIVATE SAND AND GRAVEL OPERATORS, 1929—*Continued*

Name of Company	Material G=Gravel S=Sand	Location of Deposits	Address
Dominion Concrete Co., Ltd.	S. and G.	Oxford tp., Seymour pit	Kemptville, Box 103.
Donald, Andrew	S. and G.	Dereham tp., lot 22, con. VII.	Ingersoll, R.R. 1.
Dowler Bros.	S.	Bowesville Road	Billings Bridge.
Durham Stone & Sand Co.	S. and G.	Durham	Toronto, 402 Harbour Commission Bldg.
Ellins Bros.	S. and G.	Etobicoke tp.	West Toronto, Postal Station "D."
Empire Limestone Co.	S.	Humberstone tp.	Buffalo, N.Y., 19 Hudson St.
Foster, R. R.	S.	Nepean and Gloucester tps.	Ottawa, 278 Echo Drive.
Fraser, S. A.	S. and G.	Arnprior, 1 mile E. of	Arnprior, R.R. 1.
Fuller Gravel, Ltd.	S. and G.	Fuller, Huntingdon tp.	Toronto, 402 Harbour Commission Bldg.
Goodreau, Chas.	S. and G.	Chatham tp., lot 24	Thamesville, R.R. 6.
Halliburton, J., & Sons	S.	Guelph tp.	Guelph, 101 Strange St.
Halpenny, Lewis E.	S.	Arthur tp., lot 28, con. VI.	Arthur, R.R. 4.
Higgs, Thos.	S. and G.	London tp., lot 21, con. I.	London, R.R. 7.
Hill, John D.	S. and C.	E. Zorra tp., lot 9, con. XII.	Woodstock, R.R. 6.
Hinde Bros.	S.	Mount Dennis	Toronto, 134 Northlands Ave.
Hogg, Robt.	S. and G.	Turnberry tp., lot 20, con. VII.	Wingham, R.R. 1.
Howard, N. H.	S. and G.	E. Flamborough tp., lot 7, con. I.	Aldershot.
Hydro-Electric Power Commission of Ontario.	S.	Various pits	Toronto, 190 University Avenue.
Jago Concrete Products Co.	S.	Toronto tp.	Summerville.
Johnston, G. H.	S. and G.	Westminster, lot 21, con. V.	White Oak.
Keyes, Sylvester W.	S. and G.	East Oxford tp.	Woodstock, R.R. 8.
Kilbourne & Son	S.	Westminster tp., Wharncliffe Rd.	London, 145 Wharncliffe Rd.
Kingston Penitentiary	S. and G.	Portsmouth	Portsmouth.
Kingston Sand & Gravel Co.	S.	Kingston tp., lots 33-34, con. V.	Kingston, 183 William St.
Lawson, James	S. and G.	Morris tp., lot 28, con. VIII.	Blyth, R.R. 2.
Leaside Brick and Sand Co.	S. and G.	Leaside	Leaside.
Le Viness, S.	S.	Stamford tp.	Niagara Falls, R.R. 3.
Lewis, George	S. and G.		Ailsa Craig.
Lovelace, Edwin J.	S.	Pelham tp., lots 6, 7, con. VIII, IX.	St. Catharines, 1 York St.
Lowe, G. G.	S.	Cumberland tp., lot 22, con. IV.	Leonard, R.R. 1.
MacArthur, Kenneth	S. and G.	E. Williams tp., lot 23, con. XVII.	Ailsa Craig.
McAndless, W. E.	S. and G.	London tp., lot 24, con. XI.	Ilderton.
McColl Bros.	S.	Aldborough tp., lot 3, con. VI.	Rodney, R.R. 1.
Maple Sand, Gravel & Brick Co., Ltd.	S. and G.	Vaughan tp.	Toronto, 454 King St. W.
Meriam, J. W.	S. and G.	Westminster tp., 47 & 48 "A"	London, R.R. 4.
Moore, John	S.	E. Williams tp., lot 8, con. II.	Ailsa Craig, R.R. 1.
Nagle, Jos.	S. and G.	Hibbert tp.	Dublin.
Newell, Herbert	S. and G.	Malahide tp., lot 35, con. VIII.	Aylmer, R.R. 4.
Ollman Bros.	S. and G.	Hamilton	Hamilton, 111 Macklin St.
Park, Mrs. John S.	S. and G.	Biddulph tp., lot 30, con. II.	Lucan.
Quick, Chas. R.	S. and G.	London, Manor Park	London, 101 Briscoe St.
Quigleys	S.	Saltfleet tp., Bartonville	Hamilton, 317 Main St. E.
Ratcliffe, Ltd., E. B.	G.	Barton tp., lot 1, con. III.	Bartonville, King St.
Rath, James	S. and G.	N. Dorchester tp., lot 4, con. A. & B.	Putnam, Box 33.
Regan & Blackburn	S.	Mount Dennis	Toronto, 1550 Dufferin St.

PRIVATE SAND AND GRAVEL OPERATORS, 1929—*Continued*

Name or Company	Material G=Gravel S=Sand	Location of Deposits	Address
Robinson, Wm. J.	S. and G.	Stephen tp., lots 4 and 5, con. III.	Crediton, R.R. 1.
Sand & Supplies, Ltd.	S.	N. Dumfries tp.	Toronto, 74 University Ave.
Sargeant Co., Ltd.	S. and G.	Barrie, Penetang St.	Barrie, 51 Dunlop St.
Scheerer, Conrad	S. and G.	N. Easthope, lot 31, con. II.	Stratford, R.R. 1.
Seebach, Ed.	S. and G.	Ellice tp., lot 8, con. IV.	Sebringville, R.R. 1.
Sherman & Hubbell	S. and G.	Camden tp., lot 17, con. "B",	Thamesville, R.R. 5.
Shipley, Lionel J.	S. and G.	London tp.	Wilton Grove, R.R. 2.
Skinner, R.	S.	Usborne tp.	Exeter, Box 81.
Smythe, Ltd., C.	S.	Etobicoke tp.	Toronto, 11 King St. W.
Stevens, J. H.	S.	Saltfleet tp.	Stoney Creek, Box 211.
Stover, Elmer	S. and G.	Middleton tp., lot 16, con. III	Tillsonburg, R.R. 4.
Tack, Henry J.	S.	London tp.	London, P.O., Sub. 1.
Tile, Secord.	S. and G.	Lynden	Brantford, 43 Port St.
Vallery, Frank	S. and G.	West Garafraxa tp.	Belwood, Box 107.
Waterford Sand & Gravel Co., Ltd.	S. and G.	Waterford	402 Harbour Bldg., Toronto.
Wellington, County of	S. and G.		Guelph.
White, Homer & Co.	S. and G.	Hallowell tp.	Picton.
Wilks, Geo.	S.	Woodstock	Woodstock, 26 Railway St.
Willox, Hervey	S.	Stamford tp., lots 4, 17.	Niagara Falls, 985 Bridge St.
Wilson, M.	S. and G.	Vaughan tp., lot 25, con. III.	Maple, R.R. 1.
Windsor Sand & Gravel Co.	S. and G.	S. Gosfield tp., Essex County.	Walkerville.
Wright & Co.	S.	Tarentorus tp.	960 Green St., Sault Ste. Marie.
York Sand & Gravel Co., Ltd.	S.	E. Toronto	Toronto, 1319 Bloor St. W.
Zavitz, Edgar M.	S. and G.	Lobo tp., lot 6, con. VIII.	Ilderton, R.R. 2.

The following list of sand and gravel operators covers those municipalities which produced material for their own purposes or had it done under contract. Only those with an output of 1,000 yards or over are included. Practically all the producers shown used the sand and gravel for roads.

MUNICIPAL SAND AND GRAVEL OPERATORS, 1929.

Name	Location of Deposit	Address
Albion, Township of	Albion tp.	Albion.
Allow, D.	King tp	King, R.R. 2.
Augusta, Township of		Prescott, R.R. 1.
Armstrong, Geo.	Huntley tp.	Carp.
Armstrong, James	Macaulay tp.	Stoneleigh.
Baker, W.	Westminster tp.	Lambeth, R.R. 3.
Baker, Wesley	Delaware tp.	Lambeth, R.R. 3.
Barrie, R.	Chisholm tp	
Barr, Harry	Renfrew county	Douglas.
Bauer, Otto	Logan tp	Bornholm, R.R. 1.
Beattie, David	Ellice tp.	Gadshill, R.R. 1.
Bergman, Paul	Waterloo county	Waterloo, R.R. 12.
Beverley, Township of		Rockton.
Black, R.	Westminster tp.	Lambeth, R.R. 3.
Brant, County of	Various locations	Brantford, Court House.
Brown, Fred.	Elma tp.	Atwood, R.R. 3.
Bruce, County of	Bruce county	Walkerton, c/o County Engineer.
Bruce, Mrs. John	Oxford N. tp.	Ingersoll, R.R. 3.

MUNICIPAL SAND AND GRAVEL OPERATORS, 1929—*Continued*

Name	Location of Deposit	Address
Birtch, H.	Oxford W. tp.	Woodstock, R.R. 1.
Boobocher, Geo.	Woolwich tp.	Elmira, R.R. a.
Campbell, Jos.	Caledon tp.	Caledon.
Canadian National Rys.	Pickering tp.	Toronto.
Caradoc, Township of		Muncey, R.R. 1.
Carleton county	Various locations	Ottawa.
Cassidy, M.	Greenock tp.	Chepstow.
Chaffey, Township of		Huntsville.
Clark, Geo.	Zorra W. tp.	Embro.
Clark, Wm.	Oxford E. tp.	Burford, R.R. 3.
Connell, J.	Goderich tp.	Clinton.
Cooper, A.	Neebing tp.	Fort William.
Crawford, B.	Chisholm tp.	Alderdale, c/o Township Clerk.
Crispin, Mr	Brant tp.	Hanover.
Currie, F. C.	Oxford county	Woodstock, R.R. 1.
Daniels, N.	Etobicoke tp.	Humber Bay.
Davidson, Thos.	Grey tp.	Brussels.
Delaware, Township of	Various locations	Delaware.
Devitt, C.	Cartwright tp.	Burketon.
Dixon Gravel & Sand Co.	Whitby E. tp.	Oshawa.
Dods, Andrew	Peel county	Alton, c/o G. McClelland.
Doughty, Ed.	Eramosa tp.	Guelph, R.R. 1.
Dufferin, County of	Various locations	Orangeville.
Dumfries, S., Township of	Cartwright tp.	Glenmorris.
Dysart, Township of		Haliburton.
Eastnor, Township of		Lions Head.
Elgin, County of	Various locations	St. Thomas, Court House.
Elliott, Wm.	Logan tp.	Mitchell, R.R. 3.
Enniskillen, Township of		Petrolia.
Essex, County of	Sandwich tp.	
Flamboro E., Township of		Waterdown.
Flamboro W., Township of		Dundas, R.R. 2.
Finners, S. D.	Fitzroy tp.	Kinburn, c/o Road Supt.
Fischer, John	Grey tp.	Brussels.
Fitzmaurice, Peter	Monck tp.	Bracebridge, R.R. 1.
Forwell & Sons	Waterloo tp.	Kitchener.
Francis, Jas.	Dorchester N. tp.	Dorchester, c/o Clerk.
Garbutt, W.	Maryborough tp.	Moorefield.
Giddings, Thomas	Hamilton tp.	Baltimore
Gibson, F.	Cartwright tp.	Burketon.
Godfrey, T. J.	Chapleau tp.	Chapleau.
Goodreau, Chas.	Camden tp.	Thamesville.
Gordon, J.	Cartwright tp.	Nestleton.
Gosfield N., Township of		Cottam.
Gosfield S., Township of		Ruthven, R.R. 2.
Greenburn Sand & Gravel Co., Ltd.	Pickering tp.	Greenwood.
Gregory, Lloyd	Nissouri W. tp.	Lakeside, R.R. 1.
Gregory, Lloyd	Oxford county	Medina.
Hallowell, Township of		Picton.
Hanes, Walter	Chaffey tp.	Huntsville.
Hastings, County of	Marmora and Lake tps.	
Havey, James	McNab tp.	Arnprior.
Healy, Jno.	Logan tp.	West Monkton, R.R. 2.
Hodgson, G.	McGillivray tp.	Ailsa Craig, R.R. 2.
Holshuk, E.	Waterloo county	Elmira.
Hope, Township of		Port Hope, R.R. 1.
Huron, County of	Various locations	Goderich.
Hyslop, John	Ancaster tp.	Ancaster.
Irwin, Chas.	Carleton county	Carp.
Johnston, R.	Westminster tp.	Manor Park.
Jones, J. D.	Westminster tp.	Wilton Grove, R.R. 2.
Jones, W.	Blanshard tp.	Granton.
Kent, County of	Chatham	Chatham, Harrison Hall.
Lambton, County of	Various locations	Alvinston.
Larmer, A.	Cartwright tp.	Burketon.

MUNICIPAL SAND AND GRAVEL OPERATORS, 1929—*Continued*

Name	Location of Deposit	Address
Lennox and Addington county	Various locations	Napanee.
Lorenze, Herman	Brant tp.	Chesley.
Lobo, Township of		Denfield, R.R. 1.
Love, Bird	Medora tp.	Port Sandfield, P.O.
Love, Eric	Elmira tp.	Atwood, R.R. 3.
Lisovick, T.	Neebing tp.	Cloud Bay.
Loughborough, Township of		Sydenham.
Luper, Jas.	Hullett tp.	Londesboro.
Luther E., Township of		Grand Valley, R.R. 3.
Mabee, Fred	King tp.	Lloydtown.
McArthur, Arthur	Sydenham tp.	Annan, R.R. 1.
McCallum, Dan	Peel county	Caledon East, R.R. 2.
Macdonald & Meredith, Tps. of		Echo Bay.
McGugan, D. A.	Lambton county	Alvinston.
McKee, J.	Cartwright tp.	Burketon.
McKee, M.	Cartwright tp.	Burketon.
McKenzie, F.	Blanshard tp.	St. Marys, R.R. 6.
McKillop, Township of		Seaforth, R.R. 2.
McLaws, M.	Yarmouth tp.	St. Thomas, R.R. 4.
McLean, Township of		Muskoka, Baysville.
McLeod, D. J.	Oxford county	Embro.
McMaster, Arch	Minto tp.	Palmerston, R.R. 3.
McMurray, J. F.	Oxford county	Thamesford.
McNab, John	Peel tp.	Arthur, R.R. 4.
McPhail, R.	Sombra tp.	Sombra.
McPhee, D. A.	Hawkesbury W. tp.	Vankleek Hill.
McQuade, O.	Cartwright tp.	Burketon.
McQuade, S.	Cartwright tp.	Nestleton.
Malahide, Township of		Aylmer, R.R. 3, Road Supt
Marshall, John	March tp.	Carp.
Malloy, Andrew	Blanshard tp.	St. Marys.
Martin, Enos	Woolwich tp.	St. Jacobs.
Medora, Township of		Torrance.
Middlesex, County of	Various locations	London, County Buildings.
Middleton, Township of		Tillsonburg, R.R. 4.
Morrison, Township of		Severn Bridge.
Morris, John	Zorra W. tp.	Embro.
Morton, A.	McGillivray tp.	Ailsa Craig, R.R. 2.
Mott, B.	Oxford county	Norwich.
Murphy, Walter	Whitby E. tp.	Oshawa
Nagel, George	Minto tp.	Harriston, R.R. 4.
Nairn, Township of		Nairn Centre.
Neeb, Alex	Stephen tp.	Dashwood.
Nepigon, Township of		Nipigon.
Nichol, Wm	Elma tp.	Atwood, R.R. 3.
Nissouri W., Township of		Belton, R.R. 1.
Norwich N., Township of	Oxford county	Burgessville, Clerk, C. E. Burgess.
Norton, Wm.	Brant tp.	Walkerton.
Northumberland and Durham, Counties of	Various locations	Cobourg.
Orford, Township of		Muirkirk, R.R. 1.
Ottawa Suburban Roads	Various locations	Ottawa.
Owen Sound Suburban Roads	Various locations	Owen Sound.
Owens, J. B.	Chisholm tp.	Alderdale, c/o Township Clerk.
Oxford, County of	Various locations	Woodstock, Court House.
Page Concrete Products	Etobicoke tp.	New Toronto.
Parr, John	Peel county	Brampton.
Paul, Wm.	Dysart tp.	c/o Clerk, Haliburton.
Peglo, Fred.	Brant tp.	Cargill.
Pelham, Township of		Fenwick.
Pickering, Ham	Scott tp.	Uxbridge, c/o Road Supt.
Pickering, Township of		Claremont.
Pollock, Geo.	Carleton county	Bowesville.
Prince Edward, County of		Picton, Road Supt.

MUNICIPAL SAND AND GRAVEL OPERATORS, 1929—*Continued*

Name	Location of Deposit	Address
Rae, Alec	Elma tp.	Listowel, R.R. 2.
Raleigh, Township of		Charing Cross.
Rathwell, Marshall	Carleton county	Navan.
Read, J. J.	Fitzroy tp.	Kinburn, c/o Road Supt.
Reid, Wm. J.	Stanley tp.	Varna.
Rintoul, James	Dufferin county	Laurel.
Robertson, D.	Plantagenet S. tp.	Maxville.
Rollins, John	Stephen tp.	Crediton.
Rowntree, Geo.	Vaughan tp.	Woodbridge.
Rutherford, T. J.	Sydenham tp.	Owen Sound.
Rydall, Alex.	Eastnor tp.	Lions Head.
Ryde, Township of		Housey's Rapids.
Saltfleet, Township of		Stoney Creek.
Sarnia, Township of		Mandaumin.
Scheerer, Conrad	Easthope S. tp.	Stratford.
Schweitzer, Austin	Waterloo county	Roseville.
Schwindt, Edmund	Woolwich tp.	Elmira, R.R. 1.
Sherman & Hubbell	Camden tp.	Thamesville.
Shore, John	Westminster tp.	Wilton Grove, R.R. 2.
Shugg, Wm.	Lambton county	Alvinston.
Shuniah, Municipality of		Port Arthur.
Simmonds, A.	Maryborough tp.	Moorefield.
Smith, Alfred	Dufferin county	Orangeville, R.R. 2.
Smith, Jas. D.	Renfrew county	Eganville, R.R. 1.
Smith, J. O.	Ryerson tp.	Burks Falls.
Smith, Wm.	Dufferin county	Shelburne, R.R. 1.
Snyder	Wilmot tp.	New Hamburg.
Soden, John	Pickering tp.	Brougham.
Southwold, Township of	Fingal	Fingal.
Stalkhe Bros.	Ellice tp.	Mitchell, R.R. 3.
Stephenson, Ed	Stanley tp.	Varna.
Stisted, Township of		Etwell P.O.
Sydenham, Township of		Owen Sound, R.R. 6.
Tait, W. F.	McKellar tp.	McKellar, c/o Clerk.
Tate, Drummond	Dufferin county	Grand Valley.
Taylor, Ed	Dufferin county	Waldemar, R.R. 2.
Taylor, Thos	Carleton county	Osgoode station.
Thibeault, Albert	Rayside tp.	Agilda, c/o Clerk.
Thompson, Eli	McGillivray tp	Parkhill, R.R. 8.
Thompson, Gilbert	Otonabee tp	Peterborough.
Toronto Gore, Township of		Malton, R.R. 3.
Townsend, Township of		Waterford, c/o Wm. Myerscough.
Turner, John	Stanley tp.	Clinton.
Tyendinaga, Township of		Corbyville.
Valliant, James	Renfrew county	Westmeath.
Vodden, Thos.	Grey tp.	Ethel.
Wallace, Roy	North Gower tp.	Kars P.O.
Walsingham N., Twp. of S. and G.		Clerk and Treasurer, Langton.
Waltam, Wm.	Dufferin county	Hornings Mills.
Warwick, Township of		Watford.
Waterloo, County of	Various locations	Kitchener, Court House.
Waters, W.	Waterloo county	Galt.
Westicott, Wm.	Dufferin county	Melancthon, R.R. 1.
Whitby E., Township of		Oshawa, 73 John St.
Widdifield, Township of		North Bay, Ont.
Williamsburgh, Township of		Williamsburgh.
Wilson, F.	Carleton county	Kars.
Young, John	Zorra W. tp.	Embro.
Zimmerman, R.	Macaulay tp.	Bracebridge.

Stone

The production of stone, including limestone, sandstone, trap and granite, during 1929 was 5,244,194 tons as against 4,597,764 tons during the previous year. The number of employees was 1,911 during the period, while wages paid amounted to $1,577,247.

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

VALUE OF STONE PRODUCTION, 1925–1929

Year	Limestone	Sandstone	Trap	Granite	Total
	$	$	$	$	$
1925	2,530,623	44,562	154,107	88,043	2,817,335
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

Quantities and values by grades and also for the various uses of stone during 1929 are shown in the following table. It might be pointed out that the limestone consumed in lime burning is not included here, since this is covered in the section on lime:—

STONE STATISTICS BY GRADES* AND USES, 1929

Uses	Limestone		Granite		Trap		Sandstone		Total	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
		$		$		$		$		$
Building and Ornamental	2,0664	154,816	3,397	21,676	.....	.....	10,697	69,898	34,758	246,390
Flag, curb, and paving blocks	15	150	7,581	65,863	.....	.....	.....	.....	7,596	66,013
Flux	318,910	243,867	.....	.....	.....	.....	.....	.....	318,910	243,867
Chemicals	155,068	137,947	.....	.....	.....	.....	.....	.....	155,068	137,947
Agriculture and fillers	15,999	59,305	.....	.....	.....	.....	.....	.....	15,999	59,305
Rubble and Rip Rap	146,837	123,404	.....	.....	.....	.....	.....	.....	146,837	123,404
Railways	1,574,590	1,142,648	485,199	474,417	146,318	153,634	.....	.....	2,206,107	1,770,699
Highways	2,148,623	1,897,220	73,801	12,815	136,495	213,956	.....	.....	2,358,919	2,123,991
Total	4,380,706	3,759,357	569,978	574,771	282,813	367,590	10,697	69,898	5,244,194	4,771,616
Number of producers	.....	55	.....	15	.....	5	.....	†7	.....	82
Number of wage-earners	.....	1,431	.....	275	.....	145	.....	60	.....	1,911
Wages paid	.....	$1,159,279	.....	$280,756	.....	$96,038	.....	$41,174	.....	$1,577,247

*Separate statistics covering the special grades of stone, *e.g.*, poultry grit, calcite and spar for stucco dash, and broken stone for artificial stone products have not been compiled. The figures are included in limestone and granite. In 1928 this group produced 6,617 tons valued at $46,736, and the output did not vary greatly in 1929.

†Only 4 operators reported.

Stone producers in 1929 (limestone, sandstone, trap, granite, and miscellaneous) follow:—

LIMESTONE, 1929

Name of Company	Location of Quarry	Address
Barton, Municipality of	Barton tp	Hamilton, Court House.
**Beachville White Lime Co., Ltd.	Beachville	Beachville.
Billy, Chas. V	Meath	Montreal, 510 Oxford Ave.
Bourgie, J. B	Russell tp	Embrun.
Brule & Sons, E. D	Hogsback, Gloucester tp	Billings Bridge.
Brunner, Mond Canada, Ltd	Anderdon tp	Toronto, 501 Dominion Bank Bldg.
Canada Cement Co., Ltd	Thurlow tp	Montreal, Station B, Box 290.
*Canada Crushed Stone Corp'n, Ltd	W. Flamborough tp	Hamilton, 72 Sun Life Bldg.
Carleton, County of	Gloucester tp	Ottawa, Court House.
Cartmell, John	Thorold	Thorold.
Cloutier & Grenon	Limoges	Casselman.
Cook, J. S	Amabel tp	Wiarton.
Coldwater Crushed Stone, Ltd	Medonte tp	Coldwater.
Code, W. H		Smith's Falls.
Dagg, J. G	Meaford	Kleinburg.
Doan Contracting Co., Ltd	N. of Brechin	Toronto, 384 Sorauren Ave.
Dufferin Construction Co., Ltd	Various localities	Fleet St. at Bathurst, Toronto.
Edgar Irvine Co., Ltd	Near Pembroke	Alexandria.
Foster, R. R	Merivale Rd	Ottawa, 278 Echo Drive.
Gordon Crushed Stone Co., Ltd	Haldimand county	Toronto, 239 Confederation Life Bldg.
Grenville Crushed Rock Co., Ltd	Oxford tp	Oxford Mills.
*Hagersville Contracting Co., Ltd	Walpole tp	Hamilton, 76 Sun Life Bldg.
†Hagersville Quarries, Ltd	Walpole tp	Hagersville.
Harvey, W. H., and Son		Deseronto.
Henniger, M. G	Goulbourn tp	Smiths Falls.
Highways Department, Ontario	Various townships	Toronto, Parliament Bldgs.
†Innerkip Quarries, Ltd	Innerkip	Innerkip.
Kingdon Mining, Smelting & Mfg. Co.	Galetta	Montreal, 314 Beaver Hall Hill.
Kingston Penitentiary	Portsmouth	Portsmouth.
†Kirkfield Crushed Stone, Ltd	Kirkfield	Toronto, Fleet St.
Langton, Thos	Medonte tp., lots 19, 20, con. XIII.	Coldwater.
Longford Crushed Stone, Ltd	Rama tp	Orillia, 6 Peter St.
Law Construction Company, Ltd	Sydenham tp	Toronto, 225 Sterling Rd.
Limestone Products, Ltd	Simcoe tp	Toronto, 305 Excelsior Life Bldg.
‡McKay Co., Ltd., Alex	Owen Sound	Toronto, 2 Browns Ave.
McGinnis & O'Connor	Pittsburgh tp	Kingston.
McQuigge, J. R	Ramsay tp., con. IX	Arnprior.
Noranda Mines, Ltd	Farr quarry, Haileybury	Toronto, 804 Royal Bank Bldg.
Ontario Stone Corporation, Ltd	North Orillia tp	Toronto, 611 Excelsior Life Bldg.
Ontario Reformatory	Guelph	Guelph.
Owen Sound, Municipality of	Owen Sound	Owen Sound.
Orser, S. H		Sydenham.
Pembroke, Municipality of	Markus quarry	Pembroke.
Pirson, John	Grantham tp	Stevensville.
*Puslinch Quarry, Ltd	Puslinch tp	Hamilton, 76 Sun Life Bldg.
Quinton, W. L	Kitley and Wolford tps	Jasper.
*Queenston Quarries, Ltd	Niagara tp	Hamilton, 76 Sun Life Bldg.
**Robertson & Co., Ltd., D	Nassagaweya tp	Toronto, 26 Queen E.
Robillard & Son, H	Gloucester tp	Ottawa, 195 Nicholas St.
Roddy, J. M	Kingston	Kingston, 293 Division St.

*Canada Crushed Stone Corp'n., Ltd., comprises in addition the following companies: Hagersville Contracting Co., Ltd., Queenston Quarries, Ltd., Wentworth Quarries, Ltd., and Puslinch Quarry, Ltd.

†Owned by Dufferin Construction Co., Ltd.

‡Operated by M. C. Lapierre, 1994 Ninth St. E., Owen Sound.

**Purchased by Canada Gypsum and Alabastine, Ltd.

LIMESTONE, 1929—*Continued*

Name of Company	Location of Quarry	Address
Routly, H. T.	Callander Rd., Georgetown, and Kincardine.	Toronto, 9 Richmond St. E.
*Standard White Lime Co., Ltd.	Beachville	Guelph, 15 Douglas St.
Wallace & Sons, R.	Kingston tp.	Kingston, 142 Patrick St.
Walker Bros.	Stamford tp.	Thorold, Box 586.
Wehman, John	Kingston tp.	Kingston, 251 Division St.
Welland Ship Canal	Lincoln and Welland cos.	St. Catharines.
Wilford & Co., Ltd., F. R.	Matilda and Kitley tps.	Lindsay, 24 William St. W.
Windmill Point Crushed Stone Co., Limited.	Bertie tp	Toronto, 225 Sterling Rd.
†Wentworth Quarries, Ltd.	Saltfleet tp.	Hamilton, 76 Sun Life Bldg.

*Purchased by Canada Gypsum and Alabastine, Ltd.

†Canada Crushed Stone Corp'n., Ltd., comprises in addition the following companies: Hagersville Contracting Co., Ltd., Queenston Quarries, Ltd., Wentworth Quarries, Ltd., and Puslinch Quarry, Ltd.

SANDSTONE

Name of Company	Location of Quarry	Address
Credit Valley Quarries, Ltd.	Halton and Peel counties.	Florence St., Toronto 3.
Danforth Stone Co., Ltd.	Limehouse	Toronto, 736 Danforth Ave.
Logan, Hugh	Esquesing tp.	Glen Williams.
Norrie & McHardy	Credit Valley	Limehouse.
Norton, A. W.	Credit Valley	Limehouse.
Smeaton, R. C.	Inglewood	Inglewood.
Thompson, F.	Esquesing tp.	Terra Cotta.

TRAP

Name of Company	Location of Quarry	Address
Dominion Trap Rock Co., Ltd.	Bruce Mines	Montreal, 921 New Birks Bldg.
Fort William, City of	Rifle Range	Fort William.
Hydro-Electric Power Com'n	Hydro	Toronto, 190 University Ave.
Ontario Rock Company, Ltd.	Belmont and Methuen tps.	Toronto, Crown Office Bldg.
Quinn Stone and Ore Co., Ltd.	Mission Indian Reserve	Fort William.

GRANITE

Name of Company	Location of Quarry	Address
Crystallite Stone Products, Ltd.	Birds Creek	Hamilton, 59 Hillyard St.
Gordon, D. J., Granite Co.	Gananoque	Toronto, 239 Confederation Lfe Bldg.
Grenville Crushed Rock Co., Ltd.	Hawk Lake, 25 miles E. of Kenora.	Montreal, 917 Keefer Bldg.
Hokanson, Swan	Leeds tp., lot 7, con. II.	Leeds.
Horne, Wm	Butler	Winnipeg, Man., Suite M., Ashford Blk.
Hall, R. Reece		Parry Sound, P.O. 115.
McKee, James	Escott tp.	Lansdowne, R.R. No. 3.
Peninsula Granite Quarries, Ltd.	Peninsula	Peninsula.
Robertson & Muchmore	Leeds tp.	Gananoque.
Keniston & Lowans Beresford, John Brown, Jos Hutcheon; Cook; Mills	Miscellaneous producers	Gananoque.

MISCELLANEOUS

Name of Company	Location of Quarry	Address
Dominion Stucco Co.*	Silver Mountain	St. Boniface, Man., 264 Berry St.
Bollender Bros.	Haliburton	Haliburton.
Cooper, A.	Neebing tp.	Fort William.
Kingdon Mining, Smelting and Mfg. Co., Ltd.	Galetta	Montreal, 314 Beaver Hall Hill.
Winnipeg Roofing Co., Ltd.		

*Formerly Winnipeg Roofing Co.

Clay Products

During 1929 a new survey of Ontario's ceramic industry was completed by Prof. R. J. Montgomery, Ceramic Engineer, University of Toronto. The Ontario Department of Mines is meeting the cost of this work, the results of which will be embodied in the form of a comprehensive report issued by the Department (Volume XXXIX, Part 4, 1930).

The production of heavy clay products of all classes, including sewer pipe, showed a gain of $652,498 in 1929. With the exception of the year 1922, when prices were abnormal, the production for 1929 was the greatest on record. The statistics reflect the activity in building and construction throughout the Province in general (already mentioned in the introductory remarks under "Structural Materials and Clay Products"), and more particularly in the large cities where the building industry has consumed large quantities of brick.

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, 1929

Kind	Number or Quantity	Value $
Brick—Soft-mud process—Face	25,379,063	522,191
Brick—Soft-mud process—Common	38,054,484	606,714
Stiff-mud (wire cut) process—Face	63,596,522	1,333,723
Stiff-mud (wire cut) process—Common	31,523,914	505,958
Dry-press—Face	30,290,835	611,625
Dry-press—Common	5,481,805	76,016
Fancy or ornamental brick (including special shapes, embossed and enamelled brick)	111,337	9,012
Sewer	4,631,020	92,316
Tile, structural: Hollow blocks (including fireproofing and load-bearing tile)...tons.	103,454	972,993
Roofing tile...no.	35,075	4,628
Floor tile (quarries)...sq. feet	307,400	70,186
Tile, drain...no.	22,535,098	629,322
Sewer pipe (including copings, flue linings, etc.)		1,167,463
Pottery (flower pots) from domestic clay		96,394
Haydite		131,621
Total value		6,830,162

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, 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.

During the period a gain was again noted in the output of common brick. Pressed brick, along with fancy and ornamental shapes and building tile showed a slight gain as compared with 1928. Pottery was down slightly in value while sewer pipe showed an increase.

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 1925-29

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
1925	733,693	3,074,780	86,000	360,710	893,443	.....	5,148,626
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

*Includes $400 worth of other products.

Following is a list of companies and individuals operating in 1929:—

BRICK AND TILE PLANTS, 1929

Name or Company	Address	Product
*Alvinston Brick & Tile Co., Ltd.	Alvinston, Box 26	Brick and tile.
Baird & Son, H. C.	Parkhill	Brick.
Barnhardt, W. H.	Stratford	Brick and tile.
Bartonville Pressed Brick Co., Ltd	Hamilton, 620 Lister Block	Brick.
Batchelor, Samuel	Proton Station	Brick and tile.
Bay of Quinte Brick Works (D. W. Rollins).	Belleville	Brick.
Booth Brick & Lumber Company	New Toronto	Brick.
Brampton Pressed Brick Co., Ltd	Brampton	Brick and tile.
Broadwell & Son, B	Kingsville, Box 137	Brick and tile.
Butwell, Richard	Toronto, 107 Lake Shore Rd., Humber Bay.	Brick.
Caledon Shale Brick Co., Ltd.	Toronto, 600 Bay St.	Brick.
Campbell, Neil F.	West Lorne, R.R. No. 1	Brick and tile.
Canadian Fireclay Products, Ltd.	Toronto, 60½ Adelaide St. East	Tile.
Canadian Pressed Brick Co., Ltd.	Hamilton, 63 Ottawa St. S.	Brick.
Casemore & Sons, R.	Shallow Lake	Brick and tile.
Chapman, John (Napanee Brick and Tile Works.)	Napanee, R.R. No. 3	Brick and tile.
Chapman Brick Co., Ltd.	Toronto, 104 Dawes Rd.	Brick.
Cooksville Company, Ltd	Toronto, 26 Queen St. E.	Brick, blocks and Haydite.
Cooper, W. H	Hamilton, 312 Clyde Block	Brick.
Cornhill Sons, Ltd., James	Chatham, Grand Ave	Brick.
Cowell Bros.	Tillsonburg	Brick and tile.
Curtin, Frank	Lindsay, R.R. No. 4	Brick.

*Leased to J. C. Waide, which see.

Name or Company	Address	Product
Curtis Bros.	Peterborough, Box 809	Brick and tile.
Dalton, M.	Dresden	Tile.
DeLaplante & Co., J. E.	Dawes Road, Coleman P.O.	Brick.
Dellar & Son, Albert	Brownsville	Tile.
Deller Bros.	Norwich, R.R. No. 2	Brick, blocks and tile.
Deller, Wm. H.	Thorndale, R.R. No. 4	Tile.
*Denison Tile Co., Ltd.	Windsor	Brick and tile.
Dochart Brick, Tile & Terra Cotta Works, The.	Arnprior	Brick and tile.
Dolan, John	Watford, R.R. No. 2	Tile.
Dominion Sewer Pipe & Clay Products Industries, Ltd.	Swansea, Toronto 3	Brick and tile.
Donaldson and Son, S. E.	Harriston, R.R. No. 4	Tile.
Donaldson, T. G., (Moscow Brick and Tile Works.)	Greenock, R.R. No. 1	Brick and tile.
†Don Valley Brick Works, Ltd., The	Toronto, 114 Federal Bldg.	Brick and blocks.
Douglas & Douglas	Wilkesport	Tile.
Dunn, David	New Liskeard	Brick.
Elliott, Chas.	Bluevale	Brick and tile.
Elliott, Jas., Jr.	Sault Ste. Marie	Brick.
Elliott, Wm.	Glenannan	Brick and tile.
Frid Bros.	Hamilton, Dundas Rd. and Macklin St.	Brick.
Gammage, C. R.	Dresden	Tile.
Gardiner, Wm.	Blenheim	Brick and tile.
Godfrey & Co., Thos.	Carleton Place	Brick.
Grimsby Brick & Tile Co.	Grimsby	Brick and tile.
Haist, Wellington	Crediton	Tile.
Hallatt & Son, H.	Comber	Brick and tile.
Hallatt Clay Products, Ltd.	Chatham, 4 Richards Block	Tile.
Halton Brick Co., Ltd.	Toronto, 28 Symes Rd	Brick.
Hamilton Pressed Brick Co., Ltd.	Hamilton, Kensington Ave. S.	Brick.
Hill, Aaron	Essex	Brick and tile.
Hill, A. W.	Coatsworth, R.R. No. 1	Tile.
Hircock Bros.	Bowmanville	Brick.
Hitch, D. A.	Ridgetown, Box 236	Brick and tile.
Hitch, Thos.	St. Thomas, Box 254	Brick, blocks and tile.
Hodder, Mrs. Jos. H., & Sons	Dutton	Tile.
Houston Co., Ltd., The	Tweed	Brick.
Howlett & Sons, Fred	Petrolia, Box 3	Brick, blocks and tile.
Huntsville Brick & Tile Works	Huntsville, Box 308	Brick and tile.
Hillman, Wm. (Staples Brick & Tile Co.)	Staples	Brick.
Interprovincial Brick Co., Ltd.	Toronto, 30 Toronto St.	Brick and tile.
Jackson, W. B.	Brantford, 290 Rawdon St.	Brick and tile.
Jamieson Lime Co.	Renfrew	Brick and tile.
Janes, D. A.	Mt. Brydges	Brick and tile.
Jasperson, B.	Kingsville	Brick and tile.
Jervis, W. J.	Dorchester, R.R. No. 3	Brick.
Johnson, James, Sr.	Pembroke, R. R. No. 3	Brick and tile.
Koebel Bros.	St. Clements, Box 54	Tile.
Kruse Bros.	Seaforth, R.R. No. 3	Brick and tile.
Kerr, Fred	Crediton	Tile.
Lindsay, Earl	Wallaceburg, R.R. No. 2	Tile.
Martin, Thos. E.	Thamesville, R.R. No. 4	Tile.
Maw, Wm. T.	Minesing	Brick and tile.
McCoomb, Chester	Denfield, R.R. No. 2	Brick and tile.
McCormick Bros.	Watford, R.R. No. 5	Tile.
McEachran, M., & Sons	Highgate	Brick and tile.
McFarlane, W. J.	Forest	Tile.
‡McFarren, Ltd., F. B.	Toronto, 18 Toronto St.	Brick.
McIvor Bros.	Cobourg, Box 636	Brick.
McMahon, Robert	Kerwood, R.R. No. 2	Tile.
Middleton, Chas.	Wyoming	Tile.

*Plants at Tilbury, Fletcher, and Belle River, sold to Fred Howlett and Sons.

†Sold to Toronto Brick Co.

‡Formerly Streetsville Brick Co., Ltd.

Name or Company	Address	Product
Milton Pressed Brick, Ltd.	Milton	Brick.
Miner, M. F.	Kingsville	Brick and tile.
Morley Walker Brick Co.	Toronto, 114 Greenwood Ave.	Brick.
Moulton, John	Holyrood, R.R. No. 2	Brick and tile.
Napanee Brick and Tile Works	*See* Chapman, John	
National Fire Proofing Co. of Canada, Ltd.	Toronto, 601 Dominion Bank Bldg.	Blocks and tile.
National Sewer Pipe Co., Ltd.	Aldershot	Brick and structural tile.
Ollman Bros.	Hamilton, 111 Macklin St.	Brick.
Ontario Government (Dept. of Provincial Secretary).	Toronto (Mimico plant)	Brick, blocks and tile.
O'Reilly, T. E.	Ottawa, 320 Bay St.	Brick.
Ottawa Brick Mfg. Co., Ltd., The	Ottawa, 53 Queen St.	Brick and tile.
Ott Brick & Tile Mfg. Co., The	Kitchener, 33 King St. E.	Brick and tile.
Owen Sound Brick Co., Ltd., The	Owen Sound	Brick.
Parks, H. W.	Dresden, R.R. No. 2	Tile.
Paxton, Fred R.	St. Catharines, 242 Queenston St.	Brick.
Pembroke Brick Co., The	Pembroke	Brick.
Phinn, Geo. E. (Strathroy Plant)	London, 238 Briscoe St.	Tile.
Phinn Brick Co.	London, Pipeline Rd.	Brick and tile.
Phippen & Son, H. W.	Toronto, 150 Dawes Rd.	Brick.
Piggot & Co., Geo.	Toronto, 72 Guestville Ave.	Brick.
*Piper, Murphy and Piper	Fort William, 509 Victoria Ave.	Brick.
Port Rowan Brick & Tile Co.	Port Rowan	Brick, blocks and tile.
Price & Cumming	Toronto, 58 Wellington St. E.	Brick.
Price & Smith	Toronto, 458 Greenwood Ave.	Brick.
Richardson & Son, J.	Kerwood	Brick and tile.
Rollins, D. W.	*See* Bay of Quinte Brick Works	
Russell Brick Company	Toronto, 40 Blake St.	Brick.
†Sadler, Frederick L.	Dublin	Brick and tile.
Sherman Clay Products	Kingsville	Brick and tile.
Smith, Alex., & Son	Dutton, R.R. No. 2	Brick and tile.
Snelgrove, Andrew	Beaverton	Brick and tile.
Sproat, William M.	Seaforth, R.R. No. 4	Tile.
Standard Brick Company, Ltd.	Toronto, 500 Greenwood Ave.	Brick.
Staples Brick and Tile Co.	Staples	Tile.
Steele, Edwin	Vankleek Hill	Brick.
Stroh, M. C.	Conestogo	Brick and tile.
Sun Brick Co., Ltd.	Toronto, 1104 Bay St.	Tile and blocks.
Superior Brick & Tile Co., Ltd.	Fort William	Brick and tile.
Sutherland, W. A.	Parkhill, Box 293	Brick and tile.
Tope, Richard, Estate of	Hamilton, 171 Queen St. S.	Brick.
Toronto Brick Company, Ltd.	Toronto, 60 Victoria St.	Brick.
Thompson, Ralph	Henfryn	Brick.
Telford, J. C.	Southwold Station	Tile.
Tweed Brick & Tile Works	Tweed	Brick and tile.
Voakes & Son, D.	Ruscom, Box 20	Tile.
Wagstaff, Albert H.	Toronto, 348 Greenwood Ave.	Brick.
Wagstaff, Charles	Lindsay, R.R. No. 4	Brick and tile.
Waide, J. C.	London, 1010 Adelaide St.	Brick and tile.
Waite, John E.	Forester Falls	Tile.
Wallace & Son, R.	North Bay, 66 First Ave. E.	Brick.
Watson, W. S.	Thedford	Brick.
Weetzel, J. C.	Tavistock	Tile.
Wein, Aaron	Crediton	Brick and tile.
Winch, Stuart A.	Paisley	Tile.
Windsor Brick & Tile Co.	Windsor, Exchange Bldg.	Brick, blocks and tile.
Wright & Sons, Geo.	Comber, Box 46	Tile.
Woodslee Brick & Tile Co.	Woodslee	Brick and tile.

*Same as Fort William Brick Co.

†Same as Dublin Brick and Tile Works.

SEWER PIPE AND POTTERY WORKS, 1929

Name of Company	Location of Plant and P.O. Address of Manager, etc.
SEWER PIPE	
*Dominion Sewer Pipe and Clay Industries, Ltd.	Swansea and Aldershot.
*Hamilton & Toronto Sewer Pipe Co., Ltd.	Hamilton.
*Ontario Sewer Pipe & Clay Products, Ltd.	Mimico.
POTTERY	
Canada Potteries, Ltd.‡	Hamilton, Locke St.
Davis & Son, John	Toronto, 601 Merton St.
Foster Pottery Company	Hamilton, Main St. West.
†Smith Potteries, The	Oshawa, Box 111.

*These companies were absorbed early in 1929 by the National Sewer Pipe Company, Limited, with executive offices in the Metropolitan Building, Toronto.

†Imported clay used for making glazed ware and art pottery.

‡Formerly R. Campbell Sons.

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, 1913–1929

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

Of the 97 companies incorporated in 1929, 71 had specified capital and 26 were companies without nominal or par value, while 5 companies had shares of both kinds. The corresponding figures for 1928 were 211, 183, 33 and 5.

MINING COMPANIES WITH SPECIFIED CAPITAL INCORPORATED IN ONTARIO IN 1929

Name of Company	Head Office	Date of Incorporation	Capital
			$
Acme Gas & Oil Co., Ltd.	Toronto	July 12	1,000,000
Animikie Iron Ore Co., Ltd.	Fort William	April 17	500,000
Barrie-Frontenac Mines, Ltd.	Toronto	Nov. 28	500,000
Big Turtle River Mining Co., Ltd.	Fort Frances	Sept. 9	500,000
*Bracton, Limited	Toronto	Jan. 14	1,000,000
Brookbank Mines, Ltd.	Toronto	Mar. 25	3,000,000
Canadian Aerial Exploration, Ltd.	Haileybury	Feb. 26	200,000
Canadian Diatomite and Silica, Ltd.	Toronto	Mar. 20	600,000
Canadian Mineral Lands Development Co., Ltd.	Toronto	Sept. 20	4,000,000
Central Gold Mines, Ltd.	Picton	May 1	3,000,000
Cheney Mines, Ltd.	Toronto	Dec. 26	2,000,000
Cibuck Copper Mines, Ltd.	Chapleau	Mar. 14	1,500,000
*Clay Industries, Limited	Aldershot	Nov. 9	2,000,000
Condor Consolidated Mines, Ltd.	Toronto	Aug. 9	5,000,000
Conroyal Gold Mines, Ltd.	Toronto	Feb. 25	5,000,000
Copper-Chief Mines, Ltd.	Toronto	Aug. 9	3,000,000
Crater Copper Mines, Ltd.	Toronto	Mar. 16	1,000,000
Crow River Mines, Ltd.	Toronto	Jan. 25	4,000,000
Dominion Stone Co., Ltd.	St. Catharines	Jan. 9	100,000
Farmlime Company, Ltd.	Sarnia	Mar. 5	250,000
Four Nations Gold Mines, Ltd.	Kirkland Lake	April 23	3,000,000
Horse Shoe Mines, Ltd.	Toronto	Feb. 5	4,500,000
Hutchinson, Ltd., A. G.	Sandwich	Feb. 11	40,000
Interlake Quarries, Ltd.	Toronto	July 25	1,000,000
International Copper Co., Ltd.	Toronto	Nov. 9	250,000
Iris Gold Mines, Ltd.	Kirkland Lake	Mar. 7	2,000,000
Kaladar Gold Mines, Ltd.	Toronto	Feb. 26	4,000,000
Kashouillette Syndicate, Ltd.	Toronto	Feb. 6	40,000
Kingston Ontario Mines, Ltd.	Toronto	Aug. 1	40,000
Kirkland Mile Strip Mining Co., Ltd.	Toronto	July 9	3,000,000
Kishkap Mines, Ltd.	Haileybury	Mar. 20	3,000,000
Kukuku Mines, Ltd.	Haileybury	Mar. 20	3,000,000
Laird Mining & Exploration Co., Ltd.	Sault Ste. Marie	Feb. 1	500,000
Lakeland Gold Mines, Ltd.	Hamilton	Sept. 4	4,000,000
Limestone Products, Ltd.	Toronto	June 7	250,000
MacKay, Ltd., D.	Toronto	Feb. 8	40,000
Mallard Lake Gold Mines, Ltd.	Toronto	Mar. 15	3,000,000
Malone Lake Mining Co., Ltd.	Toronto	July 8	3,000,000
Maple Leaf Mines, Ltd.	Toronto	Mar. 25	3,000,000
Mineral Areas Syndicate, Ltd.	Toronto	April 25	3,000,000
Mississauga Mines, Ltd.	Toronto	April 12	2,000,000
National Gravel & Fuel, Ltd.	Windsor	Mar. 27	100,000
National Pavers, Limited	Windsor	Mar. 27	500,000
Navarre Gold Mines, Ltd.	Toronto	Jan. 15	3,000,000
Newfoundland Gull Lake Mines, Ltd.	Toronto	Aug. 22	6,000,000
New Havilah Mines, Ltd.	Toronto	Feb. 25	5,000,000
Northern Lead Zinc, Ltd.	Ottawa	Mar. 8	1,000,000
Ontario Oil and Gas Co., Ltd.	Toronto	Sept. 13	1,000,000
Pacaud Copper Mines, Ltd.	Toronto	Feb. 9	1,000,000
Parkhill Gold Mines, Ltd.	Sault Ste. Marie	April 3	3,000,000
Penn-Ryan Oil and Gas, Ltd.	Toronto	Dec. 2	3,000,000
Rabbit Mountain Silver Mines, Ltd.	Fort William	Feb. 2	40,000
Realty Securities, Ltd.	Toronto	Feb. 20	200,000
Rouillard Gold Mines, Ltd.	Haileybury	Feb. 25	3,000,000
Round Lake Copper Mines, Ltd.	Toronto	Feb. 23	1,000,000
Seynuck Valley Oil Co., Ltd.	Acton	Aug. 8	500,000

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

MINING COMPANIES WITH SPECIFIED CAPITAL INCORPORATED IN ONTARIO IN 1929—*Continued*

Name of Company	Head Office	Date of Incorporation	Capital
			$
South Kirkland Mines, Ltd.	Cobalt	May 11	3,000,000
Spence Development Co., Ltd.	Toronto	Mar. 6	3,000,000
*Standard Paving & Materials, Ltd.	Toronto	Jan. 25	1,500,000
*Standard White Lime Co., Ltd.	Guelph	Oct. 25	200,000
Stewart Cadillac Syndicate, Ltd.	Toronto	Feb. 8	40,000
Stratton Oil Company, Ltd., The	Stratton	April 17	100,000
Sulphides Mining & Development, Ltd.	Toronto	July 15	5,000,000
*Sun Brick and Tile Co., Ltd.	Toronto	Nov. 22	300,000
Teddy Bear Valley Mines, Ltd.	Toronto	July 6	10,000,000
Upper Canada Mines, Ltd.	Toronto	April 4	2,500,000
Victoria Summerville Lead Mines, Ltd.	Toronto	May 2	1,200,000
Walsh-Aguino Mines, Ltd.	Sudbury	Feb. 2	3,000,000
Wawa Lead Syndicate, Ltd.	Sault Ste. Marie	Feb. 14	100,000
West River Mining Co., Ltd.	Toronto	Jan. 3	300,000
Young Munro Gold Mines, Ltd.	Toronto	Mar. 8	3,000,000
Total (71 companies)			142,390,000

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

MINING COMPANIES INCORPORATED IN ONTARIO IN 1929 HAVING SHARES WITHOUT NOMINAL OR PAR VALUE

Name of Company	Head Office	Date of Incorporation	No. of Shares
Argo Gas and Oil Co., Ltd.	Chatham	July 15	1,000,000
Associated International Mines, Ltd.	Toronto	May 14	5,000,000
Basic Resources, Ltd.	Toronto	Nov. 13	200
Beachville Lime & Stone, Ltd.	Beachville	Feb. 7	90,000
Ben Nevis Smelting & Refining Co., Ltd.	Toronto	April 15	1,000,000
Big Dipper Exploration & Developing Co., Ltd., The	Toronto	Jan. 25	1,000,000
*Bracton, Limited	Toronto	Jan. 14	50,000
Brown-Munro Gold Mines, Ltd.	Toronto	Mar. 21	2,000,000
Burgor Prospectors, Limited	Toronto	Nov. 7	100,000
*Clay Industries, Ltd.	Aldershot	Nov 9	10,000
Coniaurum Mines, Ltd.	Toronto	July 4	6,000,000
Diatomite Products, Ltd.	Toronto	June 14	500,000
Duport Mining Co., Ltd.	Port Arthur	Jan. 14	2,000,000
Ebonridge Quarries, Ltd.	Toronto	Mar. 28	20,000
Humber Gravel Co., Ltd.	Toronto	Jan. 11	1,000
Huronian Mining and Finance Co., Ltd.	Toronto	Oct. 25	5,000,000
Melzer Mines, Ltd.	Toronto	June 11	2,500,000
Mount Roble Company, Ltd.	Toronto	April 17	25,000
Nellie Lake Mines, Ltd.	Welland	Feb. 1	1,000,000
Niagara Falls Sand & Gravel, Ltd.	Niagara Falls	Jan. 9	100,000
Nickel Hill Syndicate, Ltd.	Toronto	July 4	100,000
Northern Gravel Co., Ltd.	Sault Ste. Marie	Jan. 28	4,000
Northern Properties, Ltd.	Toronto	Oct. 30	1,000,000
Olga Gas and Oil Co., Ltd.	Toronto	Aug. 8	1,000,000
Patricia Industries, Ltd.	Toronto	Dec. 20	100,000
Phoenix Molybdenite Holding Co., Ltd.	Toronto	July 31	250,000
Rideau Smelting & Refining Co., Ltd.	Smiths Falls	Sept. 7	500,000
Smelters Corporation of Canada, Limited	Toronto	May 16	2,000,000
*Standard Paving & Materials, Ltd.	Toronto	Jan. 25	200,000
*Standard White Lime Co., Ltd.	Guelph	Oct. 25	5,000
*Sun Brick & Tile Co., Ltd.	Toronto	Nov. 22	2,000
Total (31 companies)			32,557,200

*Also see list with specified capital. Five 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 1929 BY ORDER-IN-COUNCIL

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

Name of Company	Date of Incorporation	Date of License (O.C.)	Capital for use in Ontario
			$
Aluminium (VI), Ltd.	Canada*	Jan. 18	40,000
Barbara-Marshay Mines, Ltd.	Arizona	Feb. 8	40,000
Canadian Homestake Exploration Co.	South Dakota	May 8	50,000
Eureka Flint & Spar Co., Inc.	New Jersey	May 8	40,000
International Minerals, Ltd.	Canada**	Jan. 4	250,000
Kamiskotia Copper Mines, Ltd.	Canada**	Jan. 25	100,000
Mormac Development Co., Ltd.	Canada**	Aug. 14	40,000
Northern Metals, Limited	Canada**	Sept. 26	50,000
Porcupine Mining & Milling Co., Ltd.	Delaware	Mar. 12	250,000
Tonawanda Mines, Ltd.	Quebec	Sept. 7	40,000
Towagmac Exploration Co., Ltd.	Quebec	Jan. 18	500,000
United Verde Extension Mining Co.	Delaware	April 9	40,000
Ventures Claims, Limited	Canada**	Oct. 25	100,000
Total (13 companies)			1,540,000

*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, 1929, was $882,026.05 as compared with $968,243.84 in the previous year. Details follow:—

ORDINARY:

MAIN OFFICE

Sand and Gravel—			
Royalties	$134,884.74		
Licenses	5,780.00		
		$140,664.74	
Casual Fees		960.29	
Boring Permits		1,608.30	
Sale of Record Books—Unwrought Metal Sales Act		86.00	
Gas Leases		3,750.00	
Dredging		74.50	
Refunds		669.08	
			$147,812.91

BRANCHES

Inspection—Cable Testing Fees			2,111.70
Assessment—Taxes			
Acreage		$33,541.24	
Profit		397,004.41	
Gas		13,602.62	
			444,148.27
Chemical and Assay—Fees			3,586.02

BRANCHES—*Continued*

Mine Rentals—		
Mining Leases	$7,151.19	
Licenses of Occupation	1,948.02	
Miners—		
Licenses	81,571.07	
Permits	1,840.00	
Fees—Recording	83,344.80	
Miscellaneous	4,929.30	
Maps—Sales	2,055.55	
		$185,839.93
Natural Gas Commissioner—Permits		970.69
Temiskaming Testing Laboratories—Fees		17,037.67
Sulphur Fumes Arbitrator—Damages collected		4,006.56
		$805,513.75
CAPITAL:		
Mining Recorders—Mining Land Sales		76,512.30
Total Revenue		$882,026.05

Expenditures of the Department were $364,686.86 ordinary and $5,376.61 capital or a total of $370,063.47.

MINING LANDS SOLD AND LEASED IN YEAR ENDING OCTOBER 31, 1929*

District	Sales			Leases			Total		
	No.	Acres	Amount $	No.	Acres	Amount $	No.	Acres	Amount $
Timiskaming	335	13,037.71	34,979.63	53	2,190.45	1,213.49	388	15,228.16	36,193.12
Cochrane	141	5,545.97	14,848.44	....	.....	.....	141	5,545.97	14,848.44
Thunder Bay	15	508.30	1,292.00	....	.....	.....	15	508.30	1,292.00
Sudbury	131	5,532.52	14,841.76	10	480.04	133.65	141	6,012.56	14,975.41
Algoma	49	1,979.56	5,355.65	....	.....	.....	49	1,979.56	5,355 65
Kenora	5	169.07	429.68	....	.....	.....	5	169.07	429.68
Patricia	17	421.18	1,052.95	....	.....	.....	17	421.18	1,052.95
Rainy River	8	295.64	739.10	2	46.40	4.64	10	342.04	743.74
Nipissing	1	50.00	150.00	9	383.60	38.36	10	433.60	188.36
Elsewhere	3	173.00	436.00	....	.....	.....	3	173.00	436.00
Total	705	27,712.95	74,125.21	74	3,100.49	1,390.14	779	30,813.44	75,515.35

*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, 1929

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	356	5,245	2,603	6,799	1,301	3,868	722	1,838	309	393	1,196	2,636	27,266
2. Letters written	450	5,274	2,025	6,653	716	3,190	726	1,586	382	414	1,093	2,394	24,903
3. Miners' Licenses issued	14	711	315	305	227	281	168	340	.....	27	242	205	2,835
4. Miners' Licenses renewed	2	1,644	1,060	946	432	757	162	1,018	93	119	177	359	6,769
5. Mining Applications recorded†	70	2,164	650	891	487	691	319	346	34	48	348	973	7,021
6. Mining Applications cancelled	46	2,970	948	855	50	97	15	633	52	70	70	2,284	8,090
7. Agreements, Transfers, etc., recorded	35	1,907	303	811	130	503	123	144	3	19	130	685	4,793
8. Receipts for Miners' Licenses, Permits, Recording Fees, etc. $	809.50	34,603.95	13,888.75	16,734.10	7,573.75	12,313.00	4,561.75	10,259.50	973.25	1,269.50	5,201.45	14,418.25	122,606.75
9. Receipts as Purchase Money or Rental $	1,060.50	7,947.59	8,120.54	26,169.47	4,993.50	875.25	363.00	6,452.83	.....	1,201.70	1,029.43	1,300.05	59,513.86
10. Claims of which surveyors' plans were filed	8	24	69	166	22	29	8	17	.....	.....	47	237	627
11. Disputes entered	.....	39	6	8	7	.....	.....	5	.....	.....	.....	1	66
12. Disputed cases decided by Recorders	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13. Appeals to Mining Court	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
14. Extensions of time granted	50	1,383	405	1,003	124	356	44	39	5	64	156	1,625	5,254
15. Certificates of Record granted	11	147	86	230	63	42	3	77	.....	11	10	17	697
16. Certificates of Performance of Work granted	11	85	101	231	74	5	3	63	.....	11	46	43	673
17. Claims for which papers were forwarded to the Department for issue of title	12	87	93	253	56	4	3	72	.....	11	10	13	614
18. Forest Reserve Permits issued	.....	44	50	1	22	12	8	36	22	.....	.....	.....	195
19. Substitute Miners' Licenses issued	.....	15	13	10	1	9	3	23	.....	.....	1	.....	75
20. Abstracts issued	92	6,423	1,332	1,108	153	674	283	155	43	64	346	1,670	12,343
21. Blue prints sold	20	1,622	761	1,426	272	212	68	279	113	166	53	356	5,369

*Report covers the last half of 1929 only. The office was opened July 1, 1929.
†There were 1,186 claims recorded at Toronto, making a total of 8,207 for the entire Province as compared with 15,046 in 1928.

MINING CLAIMS RECORDED IN THE SEVERAL MINING DIVISIONS, 1907 AND 1910-1929

Mining Division	1907	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
Timiskaming	7,860	1,021	922	516	1,326	215	222	156	269	184	244	329	159	328	971	735	634	438	875	499	346
Coleman*	291	40	*																		
Sudbury	456	1,131	2,309	776	483	237	233	464	262	168	673	267	319	701	436	559	546	1,367	3,351	6,424	2,164
Sault Ste. Marie	291	818	119	137	127	23	92	44	135	199	90	90	216	541	498	284	451	395	735	702	487
Port Arthur	317	207	183	180	182	353	641	172	180	66	171	108	120	296	222	300	494	1,278	982	1,269	691
Kenora		95	89	91		25	23	45	32	48	31	25	53	168	150	77	229	935	140	520	348
Parry Sound†	102	26	15	5		2		10	25	12	39	33									
Larder Lake	3,813	84	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
Montreal River	866	344	98	126	63	28	2	56	294	293	134	81	143	174	400	471	471	290	126	156	48
Gowganda		513	258	194	68	23	14	51	113	52	145	215	101	55	33	444	220	96	24	40	34
Porcupine		2,150	3,756	538	496	240	262	401	236	48	136	192	273	760	1,424	556	620	1,297	3,127	611	650
Kowkash								160	135	2	9	21	3	148	206	438	150	28	250	368	319
Red Lake																		5,827	2,018	1,100	973
Fort Frances‡																					70
At Toronto						49	92	128	95	39	231	87	145	171	116	139	226	203	795	1,576	1,186
Total	13,996	5,792	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

*Joined with Timiskaming since 1911. †Office at Parry Sound closed in 1921. Records are now kept at the Department of Mines, Toronto.
‡Fort Frances office established July 1, 1929. Claims (8) recorded at Toronto during first half of year.

STATEMENT OF MONEYS REMITTED BY MINING RECORDERS FOR THE FISCAL YEAR ENDING OCTOBER 31, 1929

Mining Division	Name of Recorder	Address	Purchase Price	Forest Reserve Permits	Miners' Licenses	Recording Fees	Maps	Miscellaneous Fees	Total
Sudbury	McArthur, T. A.	Sudbury	$13,605 73	$340.00	$10,891.00	$23,639.00	$423.75	$1,713.75	$50,613.23
Porcupine	Dixon, Redvers	S. Porcupine	9,117.34	500.00	7,062.00	5,774.75	205.25	651.50	23,310.84
Larder Lake	Ginn, H. G.	Swastika	33,265.84	10.00	6,510.00	10,593.50	399.50	889.00	51,667.84
Red Lake	Holland, H. E.	Goldpines	1,192.25		2,979.00	13,134.25	136.00	638.00	18,079.50
Kenora	Smith, J. D. C.	Kenora	439.43		2,065.00	2,491.00	45.54	140.80	5,181.73
Timiskaming	McAulay, N. J.	Haileybury	6,560.06	340.00	6,914.00	2,835.00	71.25	215.75	16,936.06
Port Arthur	McGregor, C. F.	Port Arthur	963.25	100.00	5,583.00	7,112.75	66.25	217.75	14,043.00
Gowganda	Coghill, J. M.	Elk Lake		200.00	521.00	220.00	30.75	8.75	980.50
Montreal River	Coghill, J. M.	Elk Lake	1,358.85		742.00	506.50	44.00	45.00	2,696.35
Kowkash	O'Rourke, M. F.	Tashota	414.00	80.00	1,574.00	2,137.00	18.25	100.00	4,323.25
Sault Ste. Marie	Miller, W. N.	Sault Ste. Marie	5,755.95	220.00	3,347.00	4,520.00	80.25	275.25	14,198.45
Fort Frances	Alexander, J. A.	Fort Frances	946.50		78.00	458.00	15.00	33.75	1,531.25
Total			$73,619.20	$1,790.00	$48,266.00	$73,421.75	$1,535.75	$4,929.30	$203,562.00

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. 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, 1929:—

DETAILS OF PROFIT TAX

GOLD:—		
Dome Mines, Ltd.	$18,356.83	
Hollinger Consolidated Gold Mines, Ltd.	19,806.60	
Lake Shore Mines, Ltd.	47,081.85	
McIntyre Porcupine Mines, Ltd.	17,877.47	
Sylvanite Gold Mines, Ltd.	899.17	
Teck-Hughes Gold Mines, Ltd.	78,463.00	
Wright-Hargreaves Mines, Ltd.	3,609 86	
*Vipond Consolidated Mines, Ltd.	1,474.35	
		$187,569.13
SILVER:—		
*Keeley Silver Mines, Ltd.	$241.03	
Nipissing Mining Co., Ltd.	3,578.62	
		3,819.65
NICKEL-COPPER:—		
International Nickel Co. of Canada, Ltd.	$184,495.76	
Mond Nickel Co., Ltd.	21,119.87	
		205,615.63
Total		$397,004.41

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 1929, inclusive:—

COMPARATIVE FINANCIAL STATEMENT OF THE TEMISKAMING TESTING LABORATORIES, 1922–1929

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	.....

Following is a brief statement of the work of the year 1929:—

Assaying.—Gold, 3,930 samples; silver, 1,869; copper, 1,526; silver bullion, 92; cobalt, 309; nickel, 130; zinc, 151; lead, 60; silica, 88; chromium, 16; arsenic, 13; iron, 12; platinum, 11; tin, 7; miscellaneous, 5.

Ore Testing.—Three concentration tests.

Silver-Cobalt Ore Milled and Sampled.—Lots, 78; weight, 703.62 tons; silver content, 1,302,838 ounces.

Base Bullion Melted.—90 bars containing 75,315 gross ounces of silver.

Gold Ore Purchased.—Two lots or 11 tons, for which $482.03 was paid.

Gold Ore Shipped.—One lot to Noranda smelter, 18.14 tons; value, $1,143.37.

*Through a clerical error items of $1,071.84 for Vipond and $9,019.99 for Keeley were included with Acerage Tax instead of Profit Tax for the fiscal year ending October 31, 1929.

Draughting Office, North Bay

In order to cope with the demand from prospectors and others for blue prints 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 blue prints 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 blue prints were prepared at Toronto. The office is equipped with an electric blueprinting machine.

During the fiscal year ending October 31, 1929, there were 1,772 blue prints distributed from the North Bay office, and total receipts from this source were $513.30. In addition maps were supplied by this office to Mining Recorders, who sold 5,369 blue prints during the calendar year 1929.

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 1929:—

FREE ASSAYS UNDER THE PROVISIONS OF THE MINING ACT OF ONTARIO

Mining Division	Number of Samples received for Free Assays during 1929											
	Gold	Silver	Copper	Lead	Zinc	Tin	Nickel	Iron	Sulphur	Silica	Cobalt	Total
Eastern Ontario*	5	3	6	.....	.....	2	2	2	.....	.....	.....	20
Fort Frances*	14	9	1	1	.....	.....	.....	.....	.....	.....	.....	25
Kenora	4	3	1	.....	1	.....	.....	1	.....	.....	.....	10
Patricia portion	36	5	4	2	2	2	.....	1	.....	.....	2	54
Kowkash	9	4	1	.....	.....	.....	.....	.....	.....	.....	.....	14
Larder Lake	57	9	20	1	3	3	.....	.....	.....	.....	.....	93
Mississagi Reserve*	9	10	5	.....	1	.....	.....	.....	.....	.....	.....	45
Montreal River	7	5	1	.....	.....	1	1	.....	.....	.....	.....	13
Porcupine	18	7	7	.....	5	.....	.....	1	.....	.....	.....	38
Gowganda	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Port Arthur	31	11	10	.....	.....	.....	.....	4	.....	.....	.....	56
Red Lake	32	.....	.....	1	1	.....	.....	.....	.....	.....	.....	34
Sault Ste. Marie	31	7	11	3	.....	.....	1	3	1	.....	.....	57
Sudbury	43	14	28	10	10	2	2	14	.....	1	1	125
Timagami Reserve*	2	2	3	1	.....	1	2	.....	.....	.....	.....	11
Timiskaming	23	14	11	3	1	.....	.....	.....	.....	.....	.....	52
Total†	332	104	119	22	24	10	7	26	1	1	3	649

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

†Total free assays in 1928 numbered 1,316.

The Assay Office has been in operation without interruption 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 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	Number of samples
Gold	650
Silver	185
Copper	309
Lead	34
Zinc	68
Nickel	140
Iron	9
Platinum	10
Tin	7
Sulphur	2
Limestone	17
Phosphorus	4
Cobalt	19
Titanium	4
Coal	71
Carbon	4
Radium	3
Alumina	3
Insoluble	2
Graphite	2
Chromium	2
Vanadium	2
Clay	2
Miscellaneous	10 others were tested. These included 1 each of palladium, uranium, antimony, manganese, arsenic, gypsum, phosphorus, silica, potash, and marl.
Identification	134 samples were received by mail and reports issued. A large number were brought directly to the Laboratory; of these no record was kept.
Rocks	20 samples were submitted by geologists of the Department of Mines for complete analysis.
Total	1,612 as compared with 4,112 in 1928.

The schedule of charges, effective Jan. 1, 1930, for the Provincial Assay Office and Chemical Laboratory is as follows:—

TARIFF OF FEES FOR ANALYSES AND ASSAYS

1. Assays:	Fee
Gold	$1.50
Silver	1.50
Gold and silver in one sample	2.50
Platinum metals	Prices on application
2. Iron Ores:	
Iron (metallic)	$1.50
Silica	1.50
Iron and insoluble residue	2.50
Ferrous oxide	2.00
Phosphorus	3.00
Sulphur	2.50
Manganese	3.00
Titanium	4.00
Complete analysis	Prices on application

TARIFF OF FEES FOR ANALYSES AND ASSAYS—*Continued*

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

Determination of:

Insolubiles	$1.50
Silica	3.50
Ferric iron	3.00
Ferrous iron	2.00
Alumina	3.00
Lime	2.50
Magnesia	3.50
Potash	6.00
Soda	6.00
Alkalies (in one sample)	8.00
Water (combined)	2.00
Moisture	1.00
Carbon dioxide	4.00
Sulphur	2.50
Phosphorus anhydride	3.00

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

Determination of:

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

5. Coke, Coal, Peat, etc.:

Determination of:

Moisture	$1.00
Volatile combustible	1.50
Fixed carbon	1.50
Ash	1.50
Sulphur	2.50
Phosphorus	3.00
Calorific value (B.t.u.)	5.00
Ultimate analysis	Price on application

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

7. Ores and Minerals:

Determination of:

Alumina	$3.00
Antimony	4.00
Arsenic	3.00
Bismuth	4.00
Cadmium	4.00
Chromium	6.00
Cobalt	5.00
Nickel	3.00
Cobalt and Nickel in same sample	6.00
Copper	1.50
Fluorine	4.00
Lead	1.50
Molybdenum	4.00
Manganese	3.00
Tin	5.00
Zinc	3.00
Mercury	5.00

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

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

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

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

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

The pulp of each sample is retained for future reference.

DIRECTIONS

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

TERMS

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.

Departmental Correspondence

The volume of correspondence necessary for the work of the Department of Mines at Toronto is considerable. Figures supplied by the Files Branch show that for the fiscal year ending October 31, 1929, communications received numbered 29,483.

Correspondence in connection with the office of the Minister of Mines is not included, nor is that pertaining to applications for patent or lease of mining lands,—the latter files being kept in the Department of Lands and Forests.

In addition, Branches of the Department, including offices of the Mine Assessor, Mining Court, Mines Inspection, Publications and Statistics, Assay Office, and Gas Commissioner, carry on correspondence independently.

CLASSES FOR PROSPECTORS, 1929-30

By E. M. Burwash

Introduction

During the past winter the usual classes for prospectors were carried on by the writer, who held sessions at fourteen points in or adjacent to the mineral areas of the province. The places visited this winter were, with two exceptions, the same as a year earlier. Fort William and Fort Frances were substituted for Chapleau and Iroquois Falls.

The work was conducted on lines similar to those which have been in use for several years past. Eight daytime classes were held for the study of minerals and rocks. Eight specimens on the average were examined each day and identified by the class by means of Dr. Goodwin's tables for determination of minerals and rocks by easily applied field tests. This method gives two valuable results: first, an acquaintance gained by close observation of the properties of the different mineral and rock species, which is the necessary training for accurate identification or spotting in the field; and second, a development of facility in the use of the tables themselves. This is the only way by which the user of the tables can be sure of reliable results in the determination of unfamiliar species.

Short discussions were held on the composition, determinative points, and economic uses of each mineral; and a scheme of rocks was worked out with the object of training the students on the meaning of the textures and mineral composition of the igneous rocks and the origin and depositional conditions of the sediments. An idea of the causes and successive steps in metamorphism was also roughly outlined. The mineral tables depend on the properties of lustre, colour, streak, hardness, and cleavage for the principal divisions and subdivisions in about the order named, and subordinately on specific gravity, crystal form, reaction to acid (for carbonates), odour, feel, elasticity, etc. In the rock tables, structure, texture, and hardness are the leading heads; and mineral composition, colour, odour, and weathering are subordinate.

Attendance

Following the curve of recent years the attendance this year shows a continued decline, though not as great either absolutely or relatively as that of last year. The collapse of the stock markets in November, 1929, appears to have caused a considerable shortage of funds available for advances to prospectors, with the result that a large number of claims have been allowed to lapse, and men have turned their attention to other work that does not allow of time for attendance at classes. It is noticeable that the attendance before Christmas showed a marked decrease, and afterwards the attendance in places where the courses were given last year showed in most cases a decline or only a slight gain. The most notable exception to this rule is Haileybury, the last place visited, where the classes during the last three winters have shown a steady increase, numbering 48, 60, and 66 in successive years. In the two cases where classes have not been held for two years, the attendance has also increased slightly. It would appear that at least in the small places it is better to avoid holding classes in successive years.

The average attendance during 1929-30 was 45.8 per cent. of the registration.

The subjoined table furnishes the data on which the above conclusions are based.

TABLE OF ATTENDANCE

Analysis of results for 1929-30 (with comparative figures for last visit at the same point)

Place	Dates	Mineralogy			Geology, (evening lectures), average attendance		Total study and lecture periods		Increase	Decrease
		Registration		Average attendance						
		1929-30	1928-29	1929-30	1929-30	1928-29	1929-30	1928-29		
	1929								per cent.	per cent.
Ottawa	Nov. 7-15	10	8	5	12	11	100	85	17.6	.....
North Bay	Nov. 18-26	5	4	3	44	18	245	180	36.1	.....
Sudbury	Nov. 28–Dec. 6	5	16	2½	8	12	59	117	.....	49.5
Sault Ste. Marie	Dec. 9-17	24	28	15½	14	9	193	184	4.9	.....
	1930									
Port Arthur	Jan. 6-14	17	21[1]	10	15.5	23[1]	153	183[1]	.....	16.4
Fort William	Jan. 16-24	29	24	19	32	30	311	232	34	.....
Fort Frances	Feb. 6-14	19	18[2]	10.5	14.4	16[2]	156	157[2]	.....	.6
Mine Centre	Jan. 27–Feb. 3	16	28	10	29	37	215	286	.....	24.8
Kenora	Feb. 17-25	15	27	9	12	22.4	136	244	.....	44.2
Sioux Lookout	Feb. 27–Mar. 7	21	26	10	21	25	188	247	.....	23.88
Timmins	Mar. 10-18	21	17	11	20	21	191	189	1.06	.....
Matheson	Mar. 20-28	11	47	6.6	21	54	158	453	.....	65.12
Kirkland Lake	Mar. 31–Apr. 8	22	29	14.6	38	30	286	266	7.5	.....
Haileybury	Apr. 9-17	66	60	22	20	23	349	277	25.99	.....
Total	Nov. 7–Apr. 17	281	353	128.7	301	331.4	2,740	3,100	.....	11.61
Average		20.7	25.2	9.2	21.5	23.7	195.7	221.4	.....	.....

[1] 1928.
[2] 1929.

Acknowledgments

Grateful acknowledgements for interest and assistance are due to the following gentlemen, who in many cases have devoted a portion of their time and influence to the support of the classes during a series of years.

W. H. Collins, Director, and E. Poitevin, Geological Survey, Ottawa.

A. C. Casselman, Principal of the Normal School, and G. W. Lee, Chairman of the Temiskaming and Northern Ontario Railway, North Bay.

T. A. McArthur, Mining Recorder, C. A. Campbell, and the Principal of the Technical School, Sudbury.

W. N. Miller, Mining Recorder, Mr. Hone, Principal of the Technical High School, and the *Sault Star* at Sault Ste. Marie.

S. W. Ray, C. F. McGregor, Mining Recorder, Mr. Hewitson, and C. King, Secretary of the Chamber of Commerce at Port Arthur. Mr. McWilliams, Principal of the Technical School, Port Arthur, suggests a special afternoon class next year for his students. The City Council very courteously allowed us the use of the Council Chamber for our work.

The City Clerk and Council, Fort William.

John Prideau and J. M. Egan, Mine Centre.

Mr. Ross and others at Fort Frances.

J. D. C. Smith, Mining Recorder, and the Town Council, Kenora, who as usual allowed us the use of the Council Chamber.

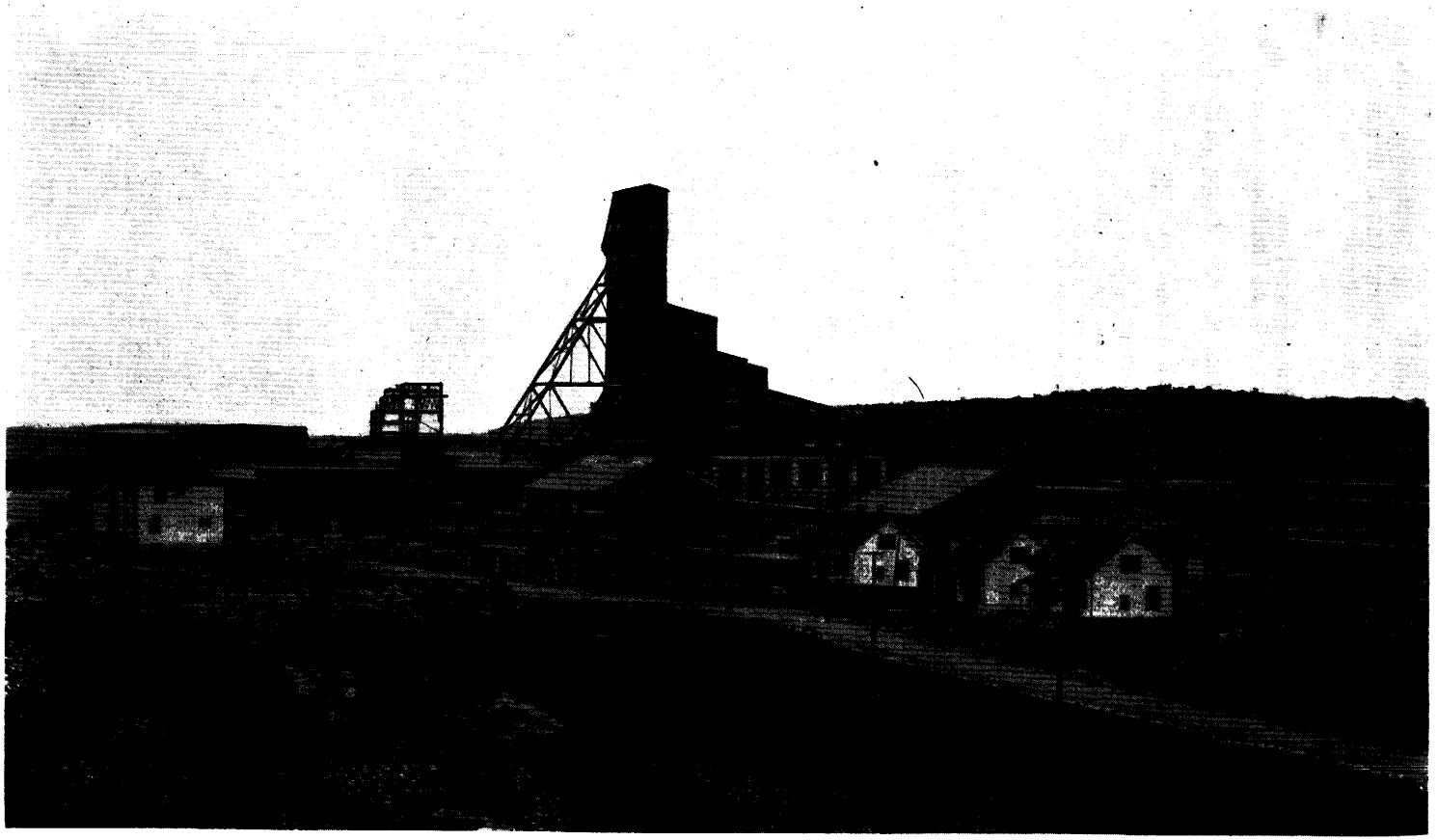
R. Alpine McGregor and the Railway Y.M.C.A., Sioux Lookout.

Mr. Richardson, the School Board, and the Oddfellows Order, Timmins.

T. Morrow, A. Child, and others, Matheson.

H. Geo. Ginn, Swastika, and the authorities of the township of Teck, who furnished us with very comfortable quarters at Kirkland Lake.

N. J. McAulay, Mining Recorder, Haileybury.



No. 3 shaft of the Frood mine, looking west, June, 1929. Office and change-house in foreground, power-house on left, rock-house and 147-foot headframe in rear.

MINES OF ONTARIO IN 1929

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.

As an introduction to the descriptions of the mines and metallurgical plants of the province, the following list, alphabetically arranged for metals or minerals extracted and also for the names of the companies concerned, may be of use for reference purposes. The inclusion of a property in this list does not necessarily imply that it is a producing one or that it is being worked at the present time. The table contains the names of all operating properties and works inspected in 1929.

MINES AND METALLURGICAL WORKS

Operator	Mine	Manager	Address
AERIAL PROSPECTING			
Brett-Trethewey Mines, Ltd.	.....	.....	43 Toronto St., Toronto.
Consolidated Mining and Smelting Co. of Canada, Ltd.	.....	.....	Drummond Bldg., Montreal.
Dominion Explorers, Ltd.	.....	.....	914 Excelsior Life Bldg., Toronto.
Northern Aerial Minerals Exploration, Ltd.	.....	J. E. Hammell...	100 Adelaide St. W., Toronto.
Prospectors, Limited	.....	.....	Haileybury.
CHROME			
Consolidated Chromium Corporation...	.....	A. R. Globe.....	Allanwater, via Collins.
COPPER			
Amity Copper and Gold Mines, Ltd....	Amity.....	Sidney A. Pain...	Boston Creek.
Patterson Copper Mines, Ltd.	Patterson.....	James Houston...	Boston Creek.
Shield Development Co., Ltd.	Tip Top.....	J. G. Harkness...	Kashabowie.
Sudbury Basin Mines, Ltd.	Cheney.....	.....	914 Excelsior Life Bldg., Toronto.
White Lake Mines, Ltd.	White Lake.....	O. G. Carstens...	Blind River.
COPPER-ZINC-LEAD			
Treadwell Yukon Co., Ltd.	Errington.....	V. C. Clauson....	Bradley.
FELDSPAR			
Bathurst Feldspar Mines, Ltd.	Bathurst.....	J. E. Sullivan....	R.R. 7, Perth.
Craig, T. H.	Craig.....	T. H. Craig.....	P.O. Box 300, Perth.
Feldspar Quarries, Ltd.	Bowes, Furlong, and Foster	Stanton G. Smith	Perth.
Genesee Feldspar Co., Inc.	Richardson and Genesee	P. MacDonald...	Hybla.
National Feldspar Co., Ltd.	National.....	W. J. McCallum.	R.R. 7, Perth.
Verona Quarries, Ltd.	Verona.....	C. A. McMahon..	Desert Lake.
Wanup Feldspar Mines, Ltd.	Wanup.....	J. G. Anderson...	Perth.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
		GOLD	
Ankerite Gold Mines, Ltd.	Ankerite	W. H. Seamon	South Porcupine
Baldwin Kirkland Gold Mines, Ltd.	Baldwin Kirkland	S. L. Macdonald	690 Danforth Ave., Toronto
Barry-Hollinger Gold Mines, Ltd.	Barry-Hollinger	James Houston	Boston Creek.
Bathurst Mines, Ltd.	Bathurst	Frank Carnegie	Narrow Lake.
Beardmore Gold Mines, Ltd.	Beardmore	W. A. Roberts	Beardmore.
Bobjo Mines, Ltd.	Bobjo	G. A. Howes	Sioux Lookout
British Canadian Mines, Ltd.	Foley	J. M. Aitken	8 Bloor St. E. Toronto.
Buckingham Mines, Ltd.	Buckingham		116 Federal Bldg., Toronto.
Canadian Champion Reef Mining Co., Ltd.	Champion Reef		1302 Canada Permanent Bldg., Toronto.
Central Patricia Mines, Ltd.	Central Patricia	A. J. Keast	c/o Western Canada Airways, Allanwater.
Coniaurum Mines, Limited	Coniaurum	John Redington	Schumacher.
Cooper Gold Mines, Ltd.	Jubilee	John Knox, Jr.	Wawa, via Hawk Junction.
De Santis Gold Mining Company, Ltd. (under option)	De Santis	Peter De Santis	Timmins.
Dome Mines, Ltd.	Dome	H. P. De Pencier	South Porcupine.
Dunkin Gold Mines, Ltd.	Dunkin		Northern Ontario Bldg., Toronto.
Golden Summit Mines, Ltd.	Golden Summit	Wm. J. Simpson	Sesekinika.
Gold Rock Mines, Limited	Haycock	Miles Walker	Wabigoon.
Haslat-Duck Lake Mines, Ltd.	Haslat-Duck Lake	M. L. Bouzan	202 Hamilton Trust Bldg., Toronto.
Hayden Gold Mines, Ltd.	Hayden	Seymour Stevens	Timmins.
Hollinger Cons. Gold Mines, Ltd.	Hollinger	A. F. Brigham	Timmins.
Horse shoe Mines, Ltd.	Regina	C. W. Dalby	801 Excelsior Life Bldg., Toronto.
Howey Gold Mines, Ltd.	Howey	H. G. Young	Red Lake, via Sioux Lookout.
Jackson-Manion Mines, Ltd.	Jackson-Manion		1507 Bank of Hamilton Bldg, Toronto.
Jones Porter Mines, Ltd.	Jones Porter	John Jones	Box 1330, Timmins.
Kirkland Lake Gold Mining Co., Ltd.	Kirkland Lake Gold	W. M. Sixt	Kirkland Lake.
Lake Shore Mines, Ltd.	Lake Shore	E. B. Knapp	Kirkland Lake.
McIntyre-Porcupine Mines, Ltd.	McIntyre	R. J. Ennis	Schumacher.
McMillan Gold Mines, Ltd.	McMillan	E. J. McMillan	Sudbury.
March Gold, Ltd.	March	M. Knutson	Box 533, South Porcupine
Metals Development, Ltd.	Metals Development.	J. C. Nelson	Jackson-Manion.
Mineral Research Corporation	Davidson-Carr	A. R. Globe	Savant Lake.
Moss Mines, Ltd.	Huronian	J. G. Harkness	Kashabowie.
Patricia Dent Gold Mines, Ltd.	Patricia Dent	J. C. Dodd	Jackson-Manion.
Polaris Gold Mines of Canada, Ltd.	Polaris	W. C. Churchill	Box1691,Timmins.
Porcupine United Gold Mines, Ltd.	Rochester	Jos. T. Baldwin	Timmins.
Power and Mines Corporation, Ltd.	Grace	C. A. Chisholm	1254 St. Catherine St. W., Montreal.
Ridgedome Mines, Ltd.	Ridgedome	C. J. B. Armstrong	Timmins.
Ritchie Gold Mines, Ltd.	Ritchie		11 King St. W., Toronto.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
	GOLD—*Continued*		
St. Anthony Gold Mines, Ltd.	St. Anthony	H. A. Swart	Savant Lake.
Sylvanite Gold Mines, Ltd.	Sylvanite	C. E. Rodgers	Kirkland Lake.
Tashota Gold Mines, Ltd.	Tashota		1111 Beaver Hall Hill, Montreal.
Teck-Hughes Gold Mines, Ltd.	Teck-Hughes	D. L. H. Forbes	Kirkland Lake.
Telluride Gold Mines of Canada, Ltd.	Telluride	H. Hollands-Hurst	Englehart.
Trethewey-Ossian Mines, Ltd.	Trethewey-Ossian	Sidney A. Pain	Boston Creek.
United Mineral Lands Corp.	Paymaster	M. Donovan	South Porcupine.
Vipond Consolidated Mines, Ltd.	Vipond	Robert E. Dye	Timmins.
West Dome Lake Gold Mines, Ltd.	West Dome	D. M. McPhail	South Porcupine.
Wright-Hargreaves Mines, Ltd.	Wright-Hargreaves	M. W. Summerhayes	Kirkland Lake.
	GRAPHITE		
Black Donald Graphite Co., Ltd.	Black Donald	R. F. Bunting	Calabogie.
	GYPSUM		
Canada Gypsum and Alabastine, Ltd.	Caledonia	L. V. Robinson	Caledonia.
Canada Gypsum and Alabastine, Ltd.	Lythmore	L. V. Robinson	Caledonia.
	LEAD		
Kingdon Mining, Smelting and Manufacturing Co., Ltd.	Kingdon	R. R. Rose	Galetta.
	LEAD AND ZINC		
Lake Geneva Mining Co., Ltd.	Lake Geneva	W. E. Bawden	Sudbury.
North American Metals Corp., Ltd.	Dorion	H. E. Knobel	Loon.
North American Metals Corp., Ltd.	Ogema	H. E. Knobel	Loon.
	NICKEL AND COPPER		
Falconbridge Nickel Mines, Ltd.	Falconbridge	Ernest Craig	Garson.
International Nickel Co. of Canada, Ltd.	Creighton	R. D. Parker	Creighton Mine.
International Nickel Co. of Canada, Ltd.	Frood	G. L. Helmrich	Frood Mine.
International Nickel Co. of Canada, Ltd.	Garson	W. J. Mumford	Garson.
International Nickel Co. of Canada, Ltd.	Levack	A. L. Sharp	Levack.
McVittie-Graham Mines, Ltd.	Moose Lake	W. E. Segsworth	67 Yonge St., Toronto.
Sudbury Offsets, Limited	Sudbury Offsets		1004 Bank of Hamilton Bldg., Toronto.
	SILVER		
Agaunico Cobalt Mines, Ltd.	Agaunico	J. M. C. Dunlop.	North Cobalt.
Blair Gowganda Silver Mines, Ltd.	Blair Gowganda	M. D. Kennedy	Gowganda.
Brocklebank, Arthur (under lease)	Kerr Lake	Arthur Brocklebank	Cobalt.
Cain, C. E., and Associates	Beaver	C. E. Cain	Cobalt.

MINES AND METALLURGICAL WORKS—*Continued*

Operator	Mine	Manager	Address
SILVER—*Continued*			
Castle-Trethewey Mines, Ltd.	Castle	Angus D. Campbell	Bestel.
Chitty, F. L. (under lease)	Badger	F. L. Chitty	Cobalt.
Clemens, E. H. (under lease)	Coniagas	E. H. Clements	Cobalt.
Cobalt Contact Mines, Ltd.	Green-Meehan	J. M. C. Dunlop	North Cobalt.
Cobalt Contact Mines, Ltd.	Red Rock	J. M. C. Dunlop	North Cobalt.
Cobalt Contact Mines, Ltd. (under option)	Ruby	J. M. C. Dunlop	North Cobalt.
Cobalt Kittson Mines, Ltd.	Cobalt Kittson	A. J. Pidgeon	Cobalt.
Friday Mines, Ltd.	Friday	J. R. Sproat	Timagami.
Keeley Silver Mines, Ltd.	Keeley	W. J. Dobbins	Silver Centre.
McLeod, J. H., and Price, C. W. (under lease)	Foster	J. H. McLeod	Cobalt.
Martin, George (under lease)	Crown Reserve	George Martin	Cobalt.
Mining Corporation of Canada, Ltd.	Buffalo	Arnold Smith	Cobalt.
Mining Corporation of Canada, Ltd.	City	Arnold Smith	Cobalt.
Mining Corporation of Canada, Ltd.	Crompton	Arnold Smith	Cobalt.
Mining Corporation of Canada, Ltd.	Frontier	Arnold Smith	Cobalt.
Mining Corporation of Canada, Ltd.	H. R. 64	Arnold Smith	Cobalt.
Mining Corporation of Canada, Ltd.	McKinley-Darragh	Arnold Smith	Cobalt.
Mining Corporation of Canada, Ltd.	Nancy Helen	Arnold Smith	Cobalt.
Mining Corporation of Canada, Ltd.	Townsite	Arnold Smith	Cobalt.
Morrison Mines, Ltd.	Morrison	Horace F. Strong	Gowganda.
Nipissing Mining Co., Ltd.	Nipissing	Hugh Park	Cobalt.
O'Brien, M. J., Ltd.	Cross Lake	W. A. O'Flynn	Cobalt.
O'Brien, M. J., Ltd.	Miller Lake O'Brien	H. G. Kennedy	Bestel.
O'Brien, M. J., Ltd.	O'Brien	W. A. O'Flynn	Cobalt.
Peterson Cobalt Mines, Ltd.	Peterson Cobalt	D. J. Russell	Cobalt.
Sandoe, Richard, and Moyle, H. (under lease)	Temiskaming	Richard Sandoe	Cobalt.
Sequin, H. (under lease)	Cobalt Comet	H. Seguin	Cobalt.
Shaw, John W., and Associates (under lease)	Aladdin	John W. Shaw	Cobalt.
Shaw, John W., and Associates (under lease)	Chambers-Ferland	John W. Shaw	Cobalt.
Shaw, John W., and Associates (under lease)	Trethewey	John W. Shaw	Cobalt.
Smith, W. H. (under lease)	Hudson Bay	W. H. Smith	Cobalt.
Trembath, Thomas E., and partner (under lease)	La Rose	Thomas E. Trembath	Cobalt.
TALC			
Canada Talc Co., Ltd.	Asbestos Pulp	Roy Taylor	Madoc.
Geo. H. Gillespie Co., Ltd.	Henderson	Geo. H. Gillespie	Madoc.
METALLURGICAL WORKS			
Algoma Steel Corporation, Ltd.	Blast furnace	Jas. H. Bell	Sault Ste. Marie.
Cobalt Reduction Co., operated by Mining Corporation of Canada, Ltd.	Silver refinery	M. F. Fairlie	Cobalt.
Deloro Smelting and Refining Co., Ltd.	Silver refinery	S. B. Wright	Deloro.
International Nickel Co. of Canada, Ltd.	Blast furnace	Peter Macdonald	Copper Cliff.
International Nickel Co. of Canada, Ltd.	Blast furnace	John F. Robertson	Coniston.
International Nickel Co. of Canada, Ltd.	Nickel refinery	H. W. Walter	Port Colborne.
Steel Company of Canada, Ltd.	Blast furnace	R. A. Gillies	Hamilton.

AERIAL PROSPECTING

Northern Aerial Minerals Exploration, Limited

This company operates under a Dominion charter with a capitalization of 100,000 preferred shares of $50 each and 250,000 common shares without nominal or par value. The officers and directors of the company are as follows: J. E. Hammell, Toronto, president; Robert Fennell, Toronto, secretary; A. L. Smith, James A. Richardson, E. H. Rose, directors. The head office is at 1402 Concourse Building, 100 Adelaide Street West, Toronto.

The aerial base and field headquarters are at Sioux Lookout on the main line of the Canadian National railway. From here prospecting parties are sent by aeroplane to favourable areas previously located by field engineers on reconnaissance flights.

The most favourable ground prospected and staked in the province last year by this company was in the Crow River area. Fifty-two claims, in two groups, were staked on a very promising showing. During the summer and winter of 1929-30, stripping and trenching disclosed a break of 900 feet, of which 250 feet showed values of $12.50 over 10-foot widths. Diamond-drilling has proved that these values are maintained to a depth of 150 feet.

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 the 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 $3\frac{3}{4}$ 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 started in the late fall of 1929, when camps for the accommodation of 40 men were erected. Since that time

10 diamond-drill holes have been put down from surface, a shaft has been sunk 100 feet, and some cross-cutting has been done.

Concentrating tests made on the ore from the deposit have shown that it will be possible to market a product in the neighbourhood of 55 per cent. Cr_2O_3.

COPPER

Amity Copper and Gold Mines, Limited

Amity Copper and Gold Mines, Limited, operated during 1929 at Boston Creek, Pacaud township, district of Timiskaming, with a force of 20 men. The capital is 3,000,000 shares of $1 par value. D. O. Johnson is president; J. E. Russell, vice-president; Gideon Grant, secretary-treasurer; Samuel Squires, F. L. McLean, and R. Jackson are directors. Sidney A. Pain is manager. The head office of the company is at 501 Lumsden Building, Toronto.

The development work for 1929 is as follows: The shaft was sunk from the 475-foot level to the 965-foot level, and stations were cut on the 475-, 600-, 735-, and 866-foot levels; 1,188 feet of crosscutting and drifting was done on the 475- and 600-foot levels. Three cars of ore were shipped to Noranda.

Patterson Copper Mines, Limited

Patterson Copper Mines, Limited, operated their property in the township of Pacaud, district of Timiskaming, with a force of 30 men, from January till October, 1929, when the mine closed down. The officers and directors of the company are: Dana H. Porter, president; R. A. Whitely, treasurer; James Houston, manager. The head office of the company is at 504 General Assurance Building, Toronto.

The three-compartment shaft was sunk 390 feet, and the following development work done:—

Level	Station	Crosscuts	Drifts	Total
	feet	feet	feet	feet
125-foot	17.60	70.60	568.80	656.00
250-foot	37.20	303.95	660.80	1,000.95
375-foot	21.33	8.83	.....	30.16
500-foot	34.75	361.70	569.90	966.35
Total	110.88	745.08	1,799.50	2,655.46

Shield Development Company, Limited

This company has an authorized capitalization of 2,000,000 shares of no par value, of which 1,059,350 shares have been issued.

The officers and directors are: N. R. Fisher, president and managing director; Alistair Fraser, vice-president; James Cooper, secretary-treasurer; C. Z. Gzowski, C. N. Monsarrat, and J. D. Paterson.

The head office is at 75 Sparks Street, Ottawa, and the executive office at 132 St. James Street, Montreal.

The property held by this company includes a group of claims in the Thunder Bay district about 9 miles south of Kashabowie, known as the Tip Top mine. There is a narrow-gauge light railway from Kashabowie to the mine.

A total of 345 feet of drifting and crosscutting and 50 feet of raising was done during 1929. A shipment of 38.28 tons of ore with a copper content of 6.89 per cent. was made to the Noranda smelter. This ore was obtained from development headings on the 100-, 150-, and 200-foot levels.

A new power-house was installed to replace the one destroyed by fire in April, 1929.

Underground operations were suspended on October 31, 1929. The company employed an average of 6 men underground and 25 men on surface. J. G. Harkness was mine superintendent.

Sudbury Basin Mines, Limited

Operations of the Sudbury Basin Mines, Limited, at the Cheney mine, a copper prospect in Gould township, district of Algoma, were suspended on March 4, 1929. To this date approximately 1,625 feet of drifting and 860 feet of crosscutting had been done on the 150-foot level.

Jos. H. Travers was mine superintendent and employed a force of about 40 men.

White Lake Mines, Limited

The authorized capital of this company is 2,000,000 shares of $1 par value. The officers and directors of the company are: W. A. Lamport, president; J. C. Allan, secretary; W. J. McCallum and D. G. Miller, directors.

The head office is at 301 Royal Bank Building, Toronto.

The property held by this company consists of 10 claims in township 1 A in the Mississagi Forest Reserve, about 45 miles northeast of the town of Iron Bridge.

On February 10, 1929, work was started on the erection of buildings and the transportation of the plant. The plant was put in operation and drilling commenced on May 2, 1929, and work was continuous for the balance of the year.

Underground work consisted of driving two adits under the surface showings and drifting on the vein. The total development footage in adits and drifts for the year was about 2,050 feet.

The mining plant consisted of a 600 cubic foot Sullivan compressor, direct-connected to a 120 h.p. Fairbanks Morse Diesel-type engine, a Sullivan drill-sharpener, and a hand forge.

An average of 31 men was employed, 12 underground and 19 on the surface. O. G. Carstens was in charge of operations.

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 the Sudbury Basin area, were continuous throughout 1929.

Development work consisted of 10,068 feet of drifts and crosscuts, 2,690 feet of raises, and 16,937 feet of diamond-drilling.

Ore hoisted totalled 89,221 tons, of which 27,705 tons was from the 300-foot level and 61,516 tons from the 500-foot level. The total amount of rock hoisted was 40,506 tons.

The average number of men employed during 1929 was 244, of whom 155 were underground workers.

Joseph Errington is manager, and V. C. Clauson is general superintendent.

The following information is extracted from the company's annual report:—

Surface Improvements

There were no material additions made to plant or equipment during the year. The Canadian Pacific Railway built a six mile branch line from Chelmsford, a station on their main line, to and across the property. From this branch line a spur track was built to the mill by the Treadwell Yukon Company. All inbound and outbound freight is now handled by direct railroad service. The branch line and spur tracks will enable connections to be made between No. 1, No. 2, and No. 3 shafts with the mill and thus take the place of the electric railroad system mentioned in last year's annual report.

Mill

The mill operated continuously throughout the year. Additional flotation cells were added, bringing the total up to 74. Progress made in treating the ore has increased the recovery of zinc to 80 per cent., of copper to 70 per cent., of lead to 60 per cent., and of gold and silver to 50 per cent. each. Additional recoveries can and will be made by regrinding and retreating certain middling products that now go to waste; but the amount of additional recovery to be made can be determined only by actual results from large-scale milling such as we have been conducting to achieve the present overall recovery of 73 per cent. of the assay value. The mill, in addition to its demonstration of recoveries, has also proved the value of ore taken out of the mine in cutting out and preparing stopes for large scale mining.

There was milled during the year 89,221 tons of ore, having an average assay of 0.028 ounces gold, 1.64 ounces silver, 1.04 per cent. copper, 0.986 per cent. lead, and 4.49 per cent. zinc. A statement of concentrates produced, and concentrates shipped, together with the amount on hand at the end of the year, is as follows:—

	Tons	Assay content				
		Gold	Silver	Copper	Lead	Zinc
		ounces	ounces	per cent.	per cent.	per cent.
COPPER CONCENTRATE:						
On hand Jan. 1, 1929	26.72	0.170	9.82	13.92	5.36	5.78
Produced in 1929	3,312.46	.208	11.49	14.89	4.46	5.50
Total	3,339.18	.207	11.48	14.88	4.47	5.50
Shipped in 1929	3,314.01	.262	12.11	15.21	4.41	5.46
On hand Dec. 31, 1929	25.17	.210	11.01	15.22	4.43	5.49
LEAD CONCENTRATE:						
On hand Jan. 1, 1929	25.50	0.300	16.85	2.19	32.11	5.65
Produced in 1929	751.73	.300	19.44	3.07	34.00	5.75
Total	777.23	.300	19.36	3.04	33.94	5.58
Shipped in 1929	777.23	.318	19.98	3.17	32.64	5.62
On hand Dec. 31, 1929	None					
ZINC CONCENTRATE:						
On hand Jan. 1, 1929	2,452.43	0.040	2.92	1.26	1.06	45.27
Produced in 1929	5,648.22	.037	2.90	.78	1.27	45.48
Total	8,100.65	.038	2.90	.93	1.21	45.42
Shipped in 1929	7,448.65	.032	2.87	.77	1.02	45.01
On hand Dec. 31, 1929	652.00	.025	1.83	.67	.85	45.00

The net receipts from all concentrates sold during the year, which included concentrates produced during 1928, were $213,487.93, which amount has been applied against development costs.

In addition to zinc, copper, and lead concentrates, an iron pyrite concentrate is now being produced, which has an estimated value of $1 per ton of ore for sulphur content alone. This iron pyrite concentrate is now being stored on the ground while negotiations for its sale are under way. Copper concentrates are being shipped to Laurel Hill, Long Island, lead concentrates to East Helena, Montana, and zinc concentrates to European zinc plants via Montreal during the season of open navigation on the St. Lawrence river. The concentrates being produced are free from smelter penalties for objectionable contents, but under the smelter schedules now in force there is no payment for gold, silver, lead, and copper in the zinc concentrates; no payment for the lead and zinc in the copper concentrates; and no payment for the zinc in the lead concentrates. The loss of these overlaps, and much of the accumulative freight charges on all three classes of concentrates can be saved by local treatment. In this connection, F. M. Smith, metallurgist for the company, has made an extensive study of our metallurgical problems and has submitted a report covering his studies.

Mine

No. 1 Shaft Area.—No exploratory work or preparatory mining was done on this area on either the 300- or 500-foot level. The No. 512 drift, 500-foot level, was advanced easterly to connect with a westerly heading from No. 2 shaft area, to give a connection between shafts on the 500-foot level for safety, for ore haulage, and to conform with legal requirements.

No. 2 Shaft Area.—Work on the Christie, Rheaume, and the North vein constituted the important work done in the mine during the year. This work was all confined to the 500-foot level, and the results have been satisfactory. At present the westerly faces are in waste, but the easterly faces are in ore.

From the westerly limit to the easterly faces is 1,640 feet, and in this lateral extent there has been developed in three of the four veins so far found in this area eight ore bodies having a total length of 2,030 feet, with an average width of 36 feet, or a total horizontal cross-section of 73,000 square feet of commercial ore. There is a large area of known veins yet to be explored on this level, but without taking any further possibilities into account the stoping work for milling ore has proven the occurrence of 7,300 tons of ore per vertical foot.

No. 3 Shaft Area.—All work in this area was discontinued. The rapid development of ore in the No. 2 shaft area made it unnecessary to continue the expense of the separate organization and camp required for No. 3 shaft work.

Summary.—In the three shaft areas the development and preparatory mining work consisted of 7,735 feet of drifts, 2,333 feet of crosscuts, 2,690 feet of raises, 2,431 feet of prospect drill-holes, and 14,506 feet of diamond-drilling.

Future Development Work

The sinking of No. 2 shaft is now in progress and will continue until the 1,500-foot level has been reached. Stations are being cut at 250-foot intervals below the 500-foot level, so intermediate levels can be driven as necessary. When the 1,500-foot level has been reached a crosscut will be driven northerly to reach the four veins that have been explored by the 500-foot level of No. 2 shaft. If the stopeable areas on the 1,500-foot level are of the same size as so far developed on the 500-foot level, then there would be indicated a 15-year life at the rate of 2,000 tons per day from one small portion of the mine.

Assay Values, Estimated Operating Costs, and Profits

The average assay of all ore bodies developed to date is: gold, 0.03 ounces; silver, 1.65 ounces; copper, 1.05 per cent.; lead, 1 per cent.; and zinc, 4.55 per cent.

On an operating basis of 2,000 tons per day and treating the resulting zinc, copper, and lead concentrates at the mine, there should result an operating profit of $2.20 per ton. This estimate is based on copper at 15 cents, lead and zinc at 5½ cents, and figuring $1.00 per ton of ore for the sulphur content of the iron pyrite concentrate.

GOLD

Ankerite Gold Mines, Limited

This company is capitalized at $2,000,000, divided into shares of $1 par value each, of which $1,500,000 has been issued. Together with these shares there is a bond issue of $500,000. The company owns three claims in the township of Deloro, district of Cochrane, known as M.E. 60, 61, and 62.

Early in 1926, the Ankerite Gold Mines, Limited, was formed to acquire the assets of the North American Gold Corporation. In the new company the Porcupine Goldfields Development and Finance Company, Limited, holds an 86⅓ per cent. interest, and the balance belongs to the North American Gold Corporation.

The officers of the Ankerite Gold Mines, Limited, are as follows: F. C. Baker, president; J. P. Ronaghan, secretary; F. Marsic, treasurer, all of New York. Additional directors are: C. E. C. Smith, National Club, Toronto, and W. S. Walton, Royal Bank Building, Toronto. The head office address is 233 Broadway, New York.

W. H. Seamon is manager at the property. During the year 1928 the following development work was completed: drifting and crosscutting, 1,436 feet; raising and winzing, 178 feet. Total development on the property to January 1, 1929, is as follows: sinking, 1,302 feet; drifting and crosscutting, 12,696 feet; raising and winzing, 986 feet.

During 1928, some 66,606 tons of ore was milled with a bullion production of $289,960. During the year the average number of men employed was 101, distributed as follows: mill, 12; surface, 19; mine, 70. Work was curtailed in the summer of 1929, and ceased on September 30.

Baldwin Kirkland Gold Mines, Limited

Baldwin Kirkland Gold Mines, Limited, has a capital of 5,000,000 shares of $1 par value. Wm. Schumacher is president, and S. Christopherson and Leon Ulman are directors. Operations were started in March, 1929, and continued until November, 1929, with a force of 14 men. S. L. Macdonald was manager.

The total amount of drifting and crosscutting done was as follows:—

Level	Feet
100-foot	200
200-foot	1,500
300-foot	900
400-foot	160

The property is situated in the township of Teck, district of Timiskaming, and the head office is at 690 Danforth Avenue, Toronto.

Barry-Hollinger Gold Mines, Limited

Barry-Hollinger Gold Mines, Limited, operated their property at Boston Creek, Pacaud township, district of Timiskaming, during 1929 with a force of 65 men. The capital is 4,000,000 shares, of $1 par value. H. C. Crow is president; R. Fennell is secretary-treasurer; Dr. E. H. Greene, James A. Dunn, and P. A. Barry are directors. James Houston is manager.

The manager's report for the year 1929 is as follows:—

Development

During the year, the three-compartment shaft was sunk 356 feet with stations cut at 1,375-, 1,500-, and 1,625-foot horizons. No. 7 vein was opened up on the 1,375- and 1,500-foot levels, and a crosscut is at present being driven on the 1,625-foot level to pick up the downward extension of No. 7 vein ore shoot.

500-foot Level.—A development drift was put out to prospect the west and northwest sections of the property. Altogether 1,021.5 feet of crosscutting and drifting was completed. In this work a body of red porphyry was intercepted. Where encountered, this dike was 27 feet wide with a northwesterly strike and with a dip of 70 degrees to the southwest. A small tongue from this porphyry paralleled the vein for about 100 feet, but no ore was located along the contact. This is the first body of porphyry so far encountered in our underground work and may have some genetic relation to the ore which lies farther to the east.

A crosscut was driven north which encountered No. 1 vein; 178 feet of drifting was completed on this vein. While values were encountered in sections along this drift, they were not consistent enough to make mill-grade ore. However, this vein shows a very strong shearing and may possibly make ore at another horizon.

750-foot Level.—A short crosscut was driven on this level which located a 50-foot shoot of ore. A stope was opened up on this shoot which produced 2,800 tons of ore.

1,000-foot Level.—In 1,007A stope, work was resumed and ore located in the hanging wall. This stope was mined through to the level above and produced approximately 4,000 tons of ore.

1,125-foot Level.—A raise was put up 35 feet in faulted ground and ore located. This stope (No. 1,107) was mined through to the 1,000-foot level and produced 3,100 tons of ore.

1,250-foot Level.—A stope was opened up on this level and a raise completed through to the 1,125-foot level. Over 2,400 tons was sent to the mill from this stope with approximately 700 tons of broken ore remaining in the stope. This stope is not completed, and work will be resumed at a later date.

1,375-foot Level.—Approximately 450 feet of drifting was completed on No. 7 vein on this level during the year and two shoots of ore located, one 50 feet long and the other 80 feet long. As work in the No. 1,507 stope below progresses, it becomes more evident that this 80-foot shoot will lengthen to the east as the ore goes into the hanging wall of the drift to the east on the 1,375-foot level. Mining of No. 1,307 stope will start at once, and a raise will be put through the ore to the level above. Some very good grade ore was encountered in opening up this stope.

1,500-foot Level.—Ore was opened up for a distance of 180 feet on this level with ore widths averaging from 6 to 20 feet. To date 7,150 tons of ore has been broken in this development; 3,070 tons of this ore still remains in the stope. Approximately 18,000 tons of ore remains unbroken between the back of the stope and the 1,375-foot level. This ore shoot is the most important so far developed on the property both as to length, width, and grade of ore.

To the west of this ore shoot we expect to locate the downward extension of the ore in No. 1,307A stope. We expect to start crosscutting to this ore about the middle of February.

Summary of Underground Operations.—During the year ending December 31, 1929, the following development work was done:—

	Feet
Drifting and crosscutting	2,502.5
Raising	509.5
Sinking	356
	Cubic feet
Station work	10,532

Some 22,350 tons of ore was hoisted, of which 20,800 tons was taken from the stopes, the balance being taken from the development drifts.

Mill

During the first five months of the year the mill averaged from 45 to 50 tons per day. This was gradually stepped up to a tonnage of 90 to 100 tons per day for the last three months of the year. The following is a summary of mill returns based on the Government quarterly returns for the year:—

	Production	Dry tons milled	Recovery per ton milled
January, February, March	$21,835.11	4,223	$5.17
April, May, June	27,102.15	4,652	5.83
July, August, September	40,363.95	5,717	7.06
October, November, December	62,310.41	7,751	8.04

Production

Total bullion produced for the year 1929 amounted to $151,611.62 from 22,343 dry tons milled, making an average recovery of $6.79 per ton. This compares with a recovery of $111,-767.21 for the year 1928 from 23,060 dry tons milled, an average recovery of $4.85 per ton.

The increase in production over the previous year of 35 per cent. was due entirely to better grade ore drawn from the 1,500-foot level.

Future Development

During the coming year we expect to be in a position to complete the sinking of the three-compartment winze to the 2,000-foot level, with stations at 1,750-, 1,875-, and 2,000-foot levels.

We plan on keeping one machine entirely on exploratory work, and in the near future this machine will start on the 500-foot level to check up the western extensions of Nos. 8 and 9 veins and to explore the continuation of the porphyry dike located in No. 502 drift and its relation to veins Nos. 8 and 9.

This is a most promising section of ground and can be opened up at small cost by back-filling one of the old stopes on the 500-foot level instead of hoisting the development rock to surface. At a later date we plan to crosscut to No. 1 vein on the 1,000-foot level.

Ore Reserves

No accurate estimate of ore reserves can be made as both Nos. 1,307 and 1,507 raises have not been completed to the level above. On November 1, we roughly estimated 18,000 tons of broken and unbroken ore in the mine above the 1,500-foot level. Since that time we have drawn off 5,400 tons of ore, yet we are reasonably assured at the present time of developing at least 18,000 tons with the possibility of a still greater tonnage. This is due to opening up of wider ore in No. 1,507 stope than we originally figured.

Bathurst Mines, Limited

The authorized capital of this company is 4,000,000 shares of no par value, of which 2,225,006 were issued at the end of 1927. Of these shares, 950,000 were held by T. H. Bathurst, Limited, and 500,000 by the Price-Logan Gold Mines, Limited.

The officers of the company are: T. W. Bathurst, president; E. P. Gleeson, vice-president. T. H. Rea, R. H. New, and Dr. F. Quin are directors. The head office is at 51 Sparks Street, Ottawa, and the mine office address is Narrow Lake, Ont.

The company's holdings include 30 claims of the Price-Logan, Daimpre, Bathurst, and Colburn groups, located about Car and Bathurst lakes, Skinner township, district of Kenora (Patricia portion).

The following buildings have been constructed of logs: two sleep camps, 20 by 20 feet; cookery, 36 by 36 feet; office, 24 by 18 feet; power-house, 40 by 37 feet; dry-house, 18 by 12 feet; blacksmith shop, 18 by 12 feet; residence, 18 by 12 feet; headframe, 43 feet in height; and staff-house, 16 by 16 feet.

The following plant was installed and placed in operation during the year: two 60 h.p. locomotive-type boilers; one Canadian Ingersoll-Rand air compressor, straight-line type FR-2, with a capacity of 528 cubic feet per minute; one Canadian Ingersoll-Rand hoist, 7 by 6 inches, type SSR. This hoist was replaced by an 11- by 8-inch of the same type in the new year.

The blacksmith shop is equipped with a Rand sharpener and furnace.

During the year the shaft was sunk 225 feet and one level broken off at the 200-foot horizon. When inspected in July, 1929, drifting on this level amounted to 1,741 feet, with 1,291 feet of crosscutting.

On June 15, 1929, a small mill was placed in operation from which $2,500 had been recovered, being production from a rich pocket on the surface and some underground ore. Mill equipment and practice is as follows: A 9- by 7-inch jaw crusher feeds direct to two steam stamps discharging to two copper plates, 7 by 3 feet, which overflow to a canvas table, 8 by 12 feet, where some fine gold and concentrates are caught.

When inspected, operations had been curtailed somewhat, and only 12 men were employed on the property. Frank Carnegie is manager.

Beardmore Gold Mines, Limited

The authorized capitalization is 5,000,000 shares of $1 par value.

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

The head office is at 207 Metropolitan Life Building, Toronto.

The property consists of 32 claims on the north shore of Lake Superior in the Nipigon Forest Reserve, about 132 miles northeast of Port Arthur and a mile and a half distant from the town of Beardmore on the Canadian National railway.

Operations were carried on continuously during 1929, and the development footages were as follows: drifts, 150 feet; crosscuts, 200 feet; shaft-sinking, 100 feet.

A prospectus issued March, 1930, includes a report by P. H. Crawshaw, which says in part:—

> The main development at the mine to date has been the sinking of No. 2 shaft to a depth of over 200 feet, with stations and workings cut at both the 100- and 200-foot levels. This shaft has been efficiently timbered to the lower levels and is at present being served by a small steam hoist operating a bucket only.
>
> The ore bodies consist of mineralized quartz veins in carbonate rock, heavily mineralized in places with arsenopyrite and the sulphides of iron, with which the gold values are mainly, if not wholly, associated. At the 100-foot level, 61 feet of drifting and crosscutting has been accomplished, and channel sampling across the vein at this level has given an average value of $22.30 over drift widths. On the 200-foot level lateral work consists of 220 feet of crosscutting to the south, 71 feet of drifting on the vein to the west, and 33 feet of drifting on the vein to the east. The crosscut to the south has disclosed two other veins which with further development may prove good sources of ore of commercial grade, a roof sample across 6 feet on the No. 2

vein assaying $11.40. Channel sampling on the 200-foot level on the No. 1 vein proved very erratic, with values running between a few cents and $116, and with selected high grade samples assaying an average of $444. Owing to the irregular fracturing and deposition of the sulphides, channel sampling does not give a true indication of average values, and bulk sampling should be resorted to in lots of 5 to 10 tons, when I feel that I shall be quite safe in stating that average values across the vein material now exposed would exceed $30 per ton, as, in places, the vein is extremely rich with values running into some hundreds of dollars.

The average number of men employed during the year was: underground, 5; on the surface, 6.

W. A. Roberts was in charge of the property.

Bobjo Mines, Limited

This company is capitalized at $5,000,000, in shares of $1 par; 2,948,005 shares have been issued.

The officers of the company are: R. J. Josey, president; L. K. Fletcher, L. Erenhous, F. D. Reid, and J. Parker, directors. The head office of the company is at 372 Bay Street, Toronto. The mine office address is, c/o Western Canada Airways, Limited, Sioux Lookout.

The property consists of 43 claims in Dent township, East Clearwater lake section of Kenora district (Patricia portion), and was formerly part of the Laidley claims optioned to the Coniagas Mines, Limited.

The following notes on the property are taken from the report of E. L. Bruce on the Gold Deposits of Woman, Narrow and Confederation Lakes:[1]—

The largest deposit of quartz yet opened up occurs west of the porphyry dike on Claim K.R.L. 6,631. It consists of an irregular mass, with its greater length north and south. From the eastern margin a large number of small quartz veins, ranging from stringers to veins two or three inches wide, curve away to the east towards the porphyry dike, which, at the north end of the quartz dome, is 60 feet distant from it.

The wall rock is greenstone, part of which is spherulitic. Northwest of the quartz mass a small regular quartz vein strikes slightly west of north, cutting diorite. A small lamprophyric dike cuts through it without displacing it.

The quartz is a white to bluish variety in which pyrite is sparingly disseminated. Native gold has been recognized at several places. Microscopic examination shows that the quartz has been fractured and cemented by later quartz, which forms a fine-grained mosaic around the fragments.

In the above-mentioned area a high-grade pocket was found on surface. The company then diamond-drilled the area with a view to picking up the formation and determining a shaft site.

A complete mining plant was taken to the property early in 1929. This plant consists of two 70 h.p. boilers, one Canadian Ingersoll-Rand PRL compressor, 14 by 9 by 12 inches, 600 cubic feet per minute capacity, a Walker Bros. double-drum hoist, capable of sinking 500 feet, and a small generator for camp lighting. The blacksmith shop is equipped with a steel sharpener. Camp buildings for the accommodation of forty men have been erected.

At the time of inspection in July, 1929, a two-compartment shaft had been sunk 270 feet, with levels at the 125- and 250-foot horizons, on each of which considerable drifting and crosscutting had been done.

A small mill, consisting of a 3- by 2½-foot ball mill of the clean-up barrel type and a 6- by 8-inch jaw crusher driven by a small steam engine is in operation on the property. This is treating high-grade ore from the surface pocket. The bullion is recovered in the assay plant just recently put up.

When the property was inspected, 28 men were employed. G. A. Howes is superintendent.

[1]Ont. Dept. Mines, Vol. XXXVII, pt. 4, 1928, p. 46.

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 of the company is at 8 Bloor Street East, Toronto.

British Canadian Mines, Limited, are the owners and operators of the Foley gold mine at Shoal lake, Rainy River district. The company owns outright 778 acres and has a controlling interest in 249 acres.

During 1929, operations at the Foley were very curtailed, owing to lack of finances, and the total underground work consisted of completing a winze from the 200-foot level to connect with a raise previously driven some 160 feet from the 420-foot level. This gives a vertical shaft from the 850-foot level to the 200-foot level, and the intention is to complete this shaft through to surface.

New pumps were installed underground to handle mine water, and also at the lake to supply the mill and power plant. A new 12,000-gallon steel tank was installed in the mill for the purpose of supplying mill requirements.

The financial statement issued by the company as at July 31, 1929, is as follows:—

ASSETS

CURRENT ASSETS:		
Cash on hand and in bank	$28,786.89	
Accounts receivable	2,973.40	
Inventory of supplies, machinery parts, and explosives	2,020.73	
		$33,781.02
DONATED STOCK, HELD IN TRUST:		
200,000 shares of capital stock of British Canadian Mines (no personal liability) at 50 cents per share		100,000.00
PROPERTIES, PLANT, DEVELOPMENT:		
Mining properties at book values	$1,180,250.00	
Buildings, machinery, and equipment	250,013.16	
Direct development	400,232.39	
Exploration and preliminary work	34,351.16	
General expense, including administration at the mine	253,257.27	
Head office expense	49,070.81	
		2,167,174.79
INTEREST ON BONDS		9,479.66
INCORPORATION AND PRELIMINARY EXPENSES		6,891.36
DISCOUNT ON CAPITAL STOCK SOLD		895,859.00
COMMISSION ON BONDS SOLD		35,195.00
		$3,248,381.01

LIABILITIES

CURRENT LIABILITIES:		
Accounts payable	$1,177.01	
Wages payable	426.50	
Bills payable, "bank"	25,000.00	
		$26,603.51
BOND INTEREST accrued to 31st July, 1929		9,076.60
BRITISH CANADIAN SECURITIES, LTD.		18,951.01
RESERVE FOR DEVELOPMENT		100.000.00
BOND ACCOUNT:		
Authorized $500,000.00; issued and advance payments	$174,754.89	
Less unpaid thereon	1,240.00	
		173,514.89
CAPITAL STOCK:		
Authorized 3,000,000 shares of $1 each; issued and paid up		2,920,235.00
		$3,248,381.01

Buckingham Mines, Limited

This company owns a group of claims in Asquith and Fawcett townships in the West Shiningtree area, district of Sudbury.

The officers are: James E. Day, president; and F. L. King, secretary. The directors are: J. E. Day, T. J. Day, H. Monford Smith, Israel Singer, and John McMurren.

The mine has not been worked since September, 1929, and the company is endeavouring to refinance.

The head office is at 116 Federal Building, Toronto.

Canadian Champion Reef Mining Company, Limited

This company is capitalized at 5,000,000 shares of $1 par value.

The officers and directors are: D. W. Lang, president; W. D. McKay, vice-president; K. G. Robertson, secretary; G. W. Adams and F. W. Bennett, directors. The head office is at 1302 Canada Permanent Building, Toronto.

This company holds 183 acres in the West Shiningtree area, district of Sudbury, including what is known as the West Tree mine.

During 1924 and 1925, 3,390 feet of diamond-drilling was done and a shaft sunk to a depth of 92 feet. A total of 178 feet of drifting was done on the 92-foot level.

In 1928, an option was given D. W. Lang to purchase the balance of the treasury stock. In the fall of 1929, Mr. Lang gave a suboption to F. W. Bennett, in behalf of, it is understood, the Bennett-Pacaud Mining Company, Limited.

The monies that were received from time to time from Mr. Lang in exercising his option were used for development purposes at the mine, and during 1928 and 1929 the shaft was sunk to a depth of 520 feet and stations were cut at the 100-, 250-, 375-, and 500-foot levels. A total of 650 feet of drifting and 210 feet of crosscutting was accomplished.

Operations in 1929 were confined to the last three months of the year, with J. M. C. Dunlop in charge. An average of 30 men was employed.

Work was suspended on April 15, 1930.

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, assi tant 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 this area by the Western Canada Airways, Limited, with base at Allanwater.

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-

drilling campaign was started which totalled 6,881 feet. In the fall of the year a three-compartment shaft was sunk 35 feet by hand.

The following steam plant was hauled to the property early in 1930 and erected: two 110-h.p. return tubular boilers, a 934-foot cross-compound C.I.R. compressor, and a 12- by 15-inch single-drum Flory hoist, together with the requisite other plant, and supplies necessary for twelve months operation.

During the year approximately 30 men were employed on the property. A. J. Keast is mine manager.

In a paper prepared for the Canadian Mining Institute meeting, M. E. Hurst, of the Ontario Department of Mines, says of the Central Patricia gold property:—

> The principal deposit on this property consists of a network of quartz veins and associated sulphides which occupy a zone of fracturing intersecting lenses of iron formation. The ore zone strikes east-west and dips steeply to the north. A short distance to the north, a sheet-like body of altered quartz porphyry or quartz-sericite schist runs parallel to the ore zone. It has been suggested that this represents a later intrusion and is responsible for the mineralization, but evidence obtained so far is insufficient to warrant such an assumption.

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.

Under the arrangements made with the shareholders and bondholders of the old Coniaurum company, bondholders are to receive 1,200,000 shares in the new company on the basis of 1½ shares for each $1 of bonds held. Common shareholders in the old company are to receive 600,000 shares in the new company in the ratio of one new share for each two old shares held. Ventures, Limited, after the former bondholders and shareholders had been provided for, contracted for or took option on the balance of the authorized shares, approximately 4,260,000, at an advanced scale of prices, which will place altogether $2,500,000 cash in the treasury, should development warrant the taking up of all the options.

The following is the balance sheet from July 4, 1929, the date of incorporation of the new company, to December 31, 1929:—

ASSETS

Cash in banks and on hand		$191,864.31	
Bullion settlement outstanding		60,272.03	
Accounts and interest receivable		1,073.55	
Balance of funds on deposit with Toronto General Trusts Corporation for redemption of 7% first mortgage bonds of Coniaurum Mines, Limited (no personal liability)	$14,740.05		
Less: Bonds outstanding and accrued interest	10,700.00		
		4,040.05	
		$257,249.94	
Inventory of supplies		36,767.72	
			$294,017.66
Mining properties		$2,200,084.14	
Buildings, machinery, and equipment		759,238.23	
			2,959,322.37

ASSETS—*Continued*

Mine development expenditures by predecessor company	$1,162,197.27		
Less: Written off at $1 per ton	39,000.00		
		$1,123,197.27	
Prepaid insurance		2,342.51	
Organization expense		5,628.83	
			1,131,168.61
			$4,384,508.64

LIABILITIES

Accounts and wages payable			$43,701.87
Capital stock (authorized 6,000,000 shares, no par value):			
Issued and to be issued, 2,512,207 shares (under option, 3,325,000 shares)		$4,354,731.99	
Less: Deficit (subject to depreciation on buildings, plant, and equipment)		13,925.22	
			4,340,806.77
			$4,384,508.64

The following is an extract from the report of the board to the shareholders:—

Operations at the property since the new company took it over on August 20, 1929, and until the end of that year, showed a working profit of $25,074.78, before write-offs. Resources in hand at the latter date, less liabilities, totalled $252,658.30.

Development under the auspices of the new company had not yet received much fresh impulse up to the end of the year, time being required by this company's engineers to study the problems involved. This has now been done and the first steps taken towards sinking to greater depth through a winze starting from the 2,000-foot level. Delays in getting deliveries of the electrical equipment required will militate against prompt execution of this work.

The mine manager, John Redington, makes the following statement regarding the work at the mine:—

Reviewing operations during the year 1929, I would say that development was curtailed considerably owing to the special conditions experienced throughout the year. No new ore bodies were encountered, but the known ore was more fully developed by a number of sublevels and raises, as well as by extension of the main levels.

A summary of this development accomplished during the year shows:

	Feet
Drifting	2,600
Crosscutting	473
Raising	371
Diamond-drilling	79

Of the above footage 2,082 feet was in ore with an average value of $6.66 across a width of 4.2 feet. Veins Nos. 2, 7, 12, 14, and 15 were attacked on the 500-, 850-, 1,150-, 1,375-, 1,500-, 1,625-, 1,750-, and 2,000-foot levels, and by careful mining and sorting we have been able to mine the narrow widths at a small margin of profit.

The mill treated 103,293 tons of ore with an average recovery of $6.453, or 96.6 per cent. of the gold content, and operated 88.7 per cent. of the possible running time.

Stoping and ore extraction for the year showed a total of 141,769 tons broken with 91,574 tons trammed to mill. Ore reserves at the end of the year showed 70,412 tons of broken ore in the stopes, of approximately present milling grade. An accurate estimate of the value of ore in place cannot be made until further work is accomplished.

Cooper Gold Mines, Limited

The authorized capital of this company is 3,000,000 shares of $1 par value. The Pioneer Mining Corporation owns a controlling interest in the company.

The property consists of the Cooper and Minto blocks, containing 24 claims, in the Michipicoten area, four miles from Wawa on the Algoma Central railway.

Underground operations during 1929 were confined to the Jubilee vein.

Development footage for the year ending March 1, 1930, is as follows:—

Level	Station-cutting	Drifting	Crosscutting	Raising	Winzing
	cu. ft.	feet	feet	feet	feet
2nd	.....	737	521	.....	.....
3rd	.....	708	549	46	.....
4th	.....	332	889	94	123
5th	1,776	626	745	43	.....
Totals	1,776	2,403	2,704	183	123

A 20-ton test mill was finished and put in operation at the end of February, 1929; up to March 1, 1930, it had milled 2,462 tons. Underground operations were suspended March 29, 1930, and later, the pumps were taken out and the mine allowed to flood.

John Knox, Jr., was manager of the property.

De Santis Gold Mining Company, Limited

The De Santis Development Company, Limited, was incorporated on December 28, 1926. Its authorized capital was $40,000, divided into 400 units of $100 par value each. An option agreement was reached between the De Santis Development Company, Limited, P. De Santis, and G. Romualdi, who were the original stakers of the claims in Turnbull township, Kamiskotia gold area.

Prior to the De Santis Development Company, Limited, taking over the De Santis claims, P. De Santis, in 1923, brought out 600 pounds of picked ore by dog team, which was forwarded to the Government Testing Laboratory in Cobalt and gave a return of $240 to the ton. Later on, in the winter of 1924, he also brought out 5,500 pounds of picked ore, which was treated at the same laboratory and gave a return of $140 to the ton. By operating a small hand stamp-mill, 13 ounces of gold was recovered.

In May, 1928, the company was reincorporated under the name of "The De Santis Gold Mining Company, Limited" (no personal liability), with an authorized capital of $4,000,000, at a par value of $1 per share. The new company agreed to take over all the assets of the De Santis Development Company, Limited, and took up the option agreement with P. De Santis and G. Romualdi. The terms were as follows: "P. De Santis, G. Romualdi, and the De Santis Development Company, Limited, to receive 2,100,000 shares of the new issue, which give the De Santis Gold Mining Company, Limited (no personal liability), an absolute title to 8 patented claims and 4 unpatented claims." The balance of 1,900,000 shares to remain in the treasury.

In July, 1928, there was a block of 50,000 shares offered in preference to the original stockholders, which was all absorbed in the limited time allowed.

The intention of the company at present is to issue another block of 200,000 shares, at 50 cents per share, to enable the directors to continue further development of the property by sinking the shaft to a greater depth and extending present lateral works.

The officers and directors of the company are as follows: Peter De Santis, president; Biagio Ferreri, vice-president; Giuseppe Giustini, secretary-treasurer; Luigi De Luca, Luigi D'Alessendri, Giacobbe Torlone, Ettore Marinacci, F. Prest, A. Fresco, Dominico Colomeco, directors.

The property consists of 8 patented and 4 unpatented claims, situated near the southwest corner of Turnbull township. The shaft and camp buildings are on claim No. 8,722.

Early in 1929 an option was taken on an additional 17 claims, adjoining the original group to the east. It is intended to do surface work on these claims during the summer of 1929.

The plant consists of two vertical boilers, 12 and 15 h.p.; one Canadian Ingersoll-Rand compressor, straight-line type, capacity 110 cubic feet per minute; and one 6- by 8-inch Jenckes hoist. The buildings are all of log construction and include a power-house, 20 by 40 feet; a cookery, 20 by 30 feet; sleeping camp, 20 by 30 feet; storehouse, 18 by 24 feet; and a two-storey office, 20 by 24 feet.

A shaft has been sunk to a depth of 150 feet, and 1,000 feet of drifting and crosscutting was done at the 125-foot level.

The vein is exposed in the shaft for a distance of 50 feet. The shaft is vertical, 5 by 9 feet, and 150 feet deep. The vein strikes north and dips steeply to the west. It is nearly vertical for several feet from surface, then dips out at an angle which brings it 30 feet west of the shaft at the 125-foot level. Where exposed in the north wall of the shaft, the quartz vein is 5 feet wide. In most places the quartz where seen is much narrower than this.

When development was in progress, the company employed 14 men. Peter De Santis is manager.

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, Alex. Fasken, G. C. Miller, Dwight B. Lee, G. H. Harris, Wallace Nesbitt, Innis P. Allen, Morton F. Stern, and R. F. Segsworth.

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:—

ASSETS

CAPITAL:			
Mining claims and properties		$3,486,593.36	
Plant, etc. (less mill destroyed by fire) at depreciated replacement values, as per appraisal, plus additions since		2,174,259.72	
			$5,660,853.08
CURRENT:			
Cash in banks	$311,192.44		
Call loans	500,000.00		
Bullion en route	98,026.76		
Accounts receivable	3,414.87		
Interest receivable	86,405.25		
Government, railway, and other bonds at cost	3,370,863.96		
Supplies—mining and milling	171,630.79		
		$4,541,534.07	

ASSETS—*Continued*

DIVIDEND ASSURANCE FUND consisting of:			
Cash in bank	$57,945.55		
Call loans	550,000.00		
Government, railway, and other bonds at cost	2,031,387.50		
		2,639,333.05	
			7,180,867.12
PREPAYMENTS AND DEFERRED CHARGES			12,510.07
			$12,854,230.27

LIABILITIES

CAPITAL AND SURPLUS:			
Capital—authorized 1,000,000 shares of no nominal or par value, all issued for the properties and assets of the old company, the Dome Mines Company, Limited, at $7 per share (of these shares 46,666 are held in trust for the company and all dividends paid thereon are immediately returnable to the company)		$7,000,000.00	
Surplus		3,172,172.03	
			$10,172,172.03
CURRENT:			
Accounts payable		$39,794.44	
Salaries and wages payable		46,457.92	
Accrued income and other taxes		128,703.06	
Dividend payable 20th January, 1930	$250,000.00		
Less: Dividends on the shares held in trust for the company as above	11,666.50		
		238,333.50	
Unclaimed capital repayment and dividends		37,639.45	
			490,928.37
RESERVES:			
Operating equalization		$31,244.48	
Amortization of premium on bonds		15,934.33	
Expenses of cleaning up fire wreckage		45,753.35	
Depreciation plant and equipment, etc.		2,098,197.71	
			2,191,129.87
			$12,854,230.27

The appropriation account for the year 1929 is as follows:—

Reserved for depreciation of buildings, plant, etc.		$15,178.14
Dividends Nos. 46, 47, 48	$715,000.50	
Dividend No. 49 payable 20th January, 1930	238,333.50	
		953,334.00
Surplus 31st December, 1929		3,172,172.03
		$4,140,684.17
Surplus 31st December, 1928	$2,362,605.16	
Less: Bonus to mine management and staff for 1928	15,350.00	
		$2,347,255.16
Profit for year ended 31st December, 1929		1,793,429.01
		$4,140,684.17

The following statements are from the report of the general manager for the year 1929:—

Production was maintained normally until the destruction of the mill by fire on the night of October 28. Since then mining and development has been carried on at a reduced rate to give employment to as many of our married employees as possible, and to hold the staff together. Also a clean-up plant has been installed in the refinery and the work of cleaning up the ruins of the mill proceeded with as far as possible.

During the year 535,600 tons was hoisted; 467,300 tons was ore, of which 452,900 tons was sent to the mill and treated, and 14,400 tons was stored in one of the old open pits. The remainder, 68,300 tons, was waste, which was dumped on the surface.

The 452,900 tons milled yielded bullion worth $3,432,542.99, the average yield per ton being $7.579. For the preceding year the yield per ton was $7.1439.

In addition to the above production, bullion worth $157,646.31 was recovered from the ruins of the mill in November and December.

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

EARNINGS STATEMENT

For the Year ended December 31, 1929

EARNINGS:		
Amalgamation bullion		$2,460,906.49
Cyanidation bullion		1,129,282.81
		$3,590,189.30
Non-operating revenue		321,170.46
		$3,911,359.76
OPERATING AND MAINTENANCE EXPENDITURE:		
Mining, including hoisting	$665,783.44	
Development	611,829.09	
Crushing and conveying	68,825.00	
Milling	420,192.69	
Bullion expense	23,298.22	
Fire protection	7,207.26	
Warehouse expense	10,828.49	
Auditors' expense	2,655.20	
Administrative expense:		
Mine office	110,301.70	
Executive offices	20,349.31	
Provincial and municipal taxes	58,997.45	
Insurance	28,205.34	
	$2,028,473.19	
Reserve for Dominion of Canada and U.S. income tax	89,457.56	
		$2,117,930.75
PROFIT FOR THE YEAR		$1,793,429.01

Mining

The following are particulars of the principal stopes:—

No. 301.—From this stope above the 3rd level 7,704 tons, averaging $5.61 per ton, was drawn and 40,352 tons of broken ore remains to be drawn.

Sixth Level.—From stopes Nos. 505 to 603, 4,673 tons, averaging $4.94 per ton, has been drawn and 72,109 tons of broken ore remains to be drawn. From No. 621 stope in Dome Extension 8,938 tons, averaging $4.93 per ton, has been drawn. The sill has been broken down into No. 715 stope, through which the remainder of the tonnage will be drawn.

Seventh Level.—The main hanging wall area has been drawn empty, yielding 6,496 tons, averaging $5.37 per ton.

No. 715 stope under No. 621 stope in Dome Extension has yielded 9,283 tons, averaging $4.13 per ton, and 20,543 tons of broken ore remains in it to be drawn.

No. 741 stope has yielded 7,023 tons, averaging $7.16 per ton, and 1,138 tons of broken ore remain in it.

Eighth Level.—No. 841 stope in the greenstone yielded 12,068 tons, averaging $5.38 per ton, and 19,341 tons of broken ore remain to be drawn. Stoping has been almost completed in this stope.

Ninth Level.—No. 936 stope in the greenstone yielded 16,157 tons, averaging $8.69 per ton, and 20,308 tons of broken ore remains to be drawn.

Tenth Level.—No. 1,022 stope and the sills above it yielded 67,195 tons, averaging $10.69 per ton. This stope has been drawn empty and preparations made to break the sill down into the 11th level stopes.

The four greenstone stopes on this level, Nos. 1,041, 1,042, 1,044, and 1,054, have yielded 73,532 tons, averaging $6.75 per ton, and 124,711 tons of broken ore remain to be drawn.

Eleventh Level.—The greenstone stopes on this level, Nos. 1,136, 1,140, and 1,141, yielded 20,542 tons, averaging $8.40 per ton, and 87,090 tons of broken ore remains to be drawn.

Twelfth Level.—The hanging-wall areas on this level and the sills above it yielded 43,604 tons averaging $9.98 per ton. Only a small tonnage, 1,854 tons, remains to be drawn here.

The eastern stopes, Nos. 1,308 to 1,232, and the sill of No. 1,130 stope yielded 45,299 tons, averaging $10.07 per ton, and 16,152 tons remains to be drawn.

The greenstone stopes on this level, Nos. 1,235 and 1,236, yielded 26,296 tons, averaging $7.30 per ton, and 39,633 tons of broken ore remains to be drawn.

Thirteenth Level.—At the 13th level, the hanging-wall area has yielded 7,204 tons, averaging $8.12 per ton, and 35,886 tons of broken ore remains to be drawn.

In the greenstone a small stope under No. 1,235 stope has yielded 7,384 tons, averaging $5.02 per ton, and 7,632 tons of broken ore remains to be drawn.

Fifteenth Level.—No. 1,509 stope at the eastern end of the 15th hanging-wall area yielded 10,987 tons, averaging $7.32 per ton. About 8,000 tons of very low grade material remains in this stope; it is badly diluted with slate.

Sixteenth Level.—No. 1,612 stope at the eastern end of this level has yielded 5,104 tons, averaging $5.81 per ton, and is finished.

In the greenstone a new stope has been opened up in the area indicated by diamond-drill hole No. 1,181, described in last year's report. This stope, No. 1,617, has yielded 5,453 tons, averaging $7.32 per ton, and 1,947 tons of broken ore remains to be drawn.

Another stope in the greenstone, No. 1,618, lying 150 feet north of No. 1,617, has yielded 1,912, tons, averaging $7.35 per ton, and 943 tons of broken ore remains in it.

Eighteenth Level.—Stopes Nos. 1,801 to 1,805 yielded 20,968 tons, averaging $7.77 per ton, and 27,625 tons of broken ore remains to be drawn.

Development

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

SUMMARY OF DEVELOPMENT WORK FOR YEAR 1929

Level	Drifts	Cross-cuts	Drifts and crosscut slashing	Raises	Winzes	Box-holes	Raises, winzes, and boxhole slashing	Total	Dia-mond drilling
	feet	feet	feet	feet	feet	feet	feet	feet	feet
3rd	.....	.....	36	33	.....	135	26	230	.....
5th	.....	.....	5	.....	.....	.....	.....	5	151
6th	.....	90	21	.....	.....	.....	.....	111	.....
7th	96	188	43	68	5	72	.....	472	.....
8th	262	.....	55	107	52	45	.....	521	.....
9th	219	5	38	76	105	121	3	567	81.5
10th	372	236	69	221	45	606	52	1,601	140
11th	465	518	99	59	62	393	7	1,603	1,294
12th	859	722	193	339	14	616	7	2,750	889
13th	418	719	86	107	8	538	13	1,889	2,647
14th	550	995	201	57	148	119	3	2,073	1,398
15th	343	312	82	.....	24	.....	.....	761	713
16th	1,596	752	260	554	148	379	30	3,719	1,548.5
17th	212	263	69	.....	16	29	5	594	2,443.5
18th	780	941	173	255	6	274	23	2,452	2,167
23rd	1,275	41	2	.....	.....	.....	.....	1,318	831
Total	7,447	5,782	1,432	1,876	633	3.327	169	20,666	14,303.5

Waste hoisted, 68,300 tons.

The greater portion of the development work has been done in the greenstone areas north of the sedimentary basin where approximately 16,777 feet of drifting, crosscutting, raising, winzing, and box-holing has been done in the course of searching for and opening up the various ore shoots.

At the 10th, 11th, 12th, and 13th levels, crosscuts have been advanced northerly into Dome Extension ground for distances of 202, 322, 702, and 744 feet, respectively. These crosscuts penetrate the greenstones, and while narrow zones showing some mineralization and quartz stringers have been located, no important ore body has been found. Some of the quartz stringers show considerable visible gold but are too small to yield any important tonnage of ore.

At the 14th level, No. 1,411 crosscut also has been driven northerly for 967 feet. It penetrates the greenstones above the intersection of ore shown in diamond-drill hole No. 1,181 recorded last year (32 feet averaging $7.43). Crosscut No. 1,411 does not, however, show any ore of this character, only a few scattered assays having been obtained in sampling. A total of 523 feet of drifting has been done in the vicinity and a short ore body of about 85 feet, averaging $5.56 over the width of the drift, has been located; this appears to be the top of another ore body, which extends downward to some point below the 16th level.

At the 16th level, crosscut No. 1,614 from No. 1,603 drift has been driven 629 feet to reach this area, and drifts and crosscuts, totalling 933 feet, have been driven to open this ore body at the 16th level. The work has disclosed an ore zone 440 feet in length, and stoping operations indicate an average width of about 25 feet. The grade of the ore drawn was $7.32. Much of

the ore is quite low grade, but patches containing visible gold are encountered, which improve the grade somewhat.

The 16th and 14th levels have been connected by raising and winzing, and this ore body has been developed at the 15th level horizon by 462 feet of drifting and crosscutting. This work has shown an ore body at this horizon of 235 feet in length and 25 feet in width. The grade is better here, the average of the sampling over the width of the drift being $8 for a length of 235 feet.

At the 16th level, No. 1,614 crosscut has been advanced north of the ore body No. 1,617 just described and another ore zone, known as No. 1,618, has been found and opened up by 162 feet of drifting. This ore body is lower in grade than No. 1,617, the drifting done showing 160 feet averaging $2.52. A stope started above this drift is showing better grade ore. Crosscutting at the 15th level has failed to locate any ore corresponding to this shoot.

From a station in No. 1,614 crosscut, 70 feet north of No. 1,618 ore body, three diamond-drill holes have been drilled beneath the 16th level. These show the following intersections:—

Hole No.	Bearing	Dip	Intersection
1,196.....	S. 1° 29′ W.	41° 03′	From 70 to 87 feet, $2.88 over 17 feet. From 255 to 290 feet, $5.05 over 35 feet.
1,198.....	S. 41° 23′ W.	43° 51′	From 98 to 124 feet, $4.07 over 26 feet. From 363.5 to 383 feet, $3.75 over 19.5 feet.
1,201.....	S. 35° 37′ E.	46° 28′	From 62.5 to 81 feet, $6.22 over 18.5 feet. From 252.5 to 283 feet, zone 31.5 feet.

Also a drift has been driven eastwards into the sediments from the east end of the No. 1,617 ore zone, which terminates at the sediments for 496 feet and two diamond-drill holes, totalling 1,011 feet, drilled to explore the sediments farther east. No ore whatever has been found in this drift or the diamond-drill holes.

At the 18th level the area beneath No. 1,617 ore body has been reached by No. 1,809 crosscut, which was advanced 784 feet during 1929. The crosscut failed to locate any ore body, and 768 feet of drifting in the zone has so far disclosed only bunches of ore.

The 16th and 18th levels have been connected in this zone by raising and winzing, and 447 feet of drifting and crosscutting has been done at the 17th level horizon. This work so far, like that at the 18th level, has failed to locate any payable ore body, though short lengths of mineralized ground have been disclosed.

A crosscut at the 23rd level has been advanced 1,275 feet northeasterly through the greenstones towards the possible downward extension of the zones which have contained the ore bodies in the upper levels. This crosscut has penetrated only unfavourable formation so far but will have to be advanced some distance farther yet.

During the year, 14,303.5 feet of diamond-drilling was done. This was almost wholly in connection with the development work in the greenstone area, and while only a few intersections of economic importance have been obtained, this drilling has been of assistance and has given much geological information which is of importance, as the occurrence of these shoots of ore appears to be dependent in some way on the geological structure and conditions.

Of the tonnage milled, the stopes yielded 411,600 tons, averaging $8.1683 per ton, and development work 41,300 tons, averaging $5.0203 per ton, a total of 452,900 tons, averaging $7.8812 per ton.

The expenditure on mining was $665,783.44, or $1.47 per ton milled.

The expenditure on development and exploration work charged to operating was $611,829.09, or $1.351 per ton milled. This includes $98,692.51 for outside exploration work carried on during the year or written off from suspense.

The ore drawn from the Dome Extension ground during the year was 103,713 tons, containing $655,722.87, or $6.3225 per ton.

Eighteen fire doors of steel and concrete have been installed in the drifts and crosscuts leading from No. 3 shaft; by closing these it is now possible to completely isolate No. 3 shaft from the mine.

Ore Reserves

The ore reserves are estimated at 1,300,000 tons; this includes 740,000 tons of broken ore. Most of the additions to ore reserves made during the year were in the greenstone stopes.

Exploration

Our exploration engineers have continued their efforts to find desirable mining properties throughout the year without success. The number of propositions considered and examined probably exceeds any previous year.

Mill

The following are the results of the mill operation for the period from January 1 to October 28, when it was destroyed:—

	Total value	Value per ton	Extraction, per cent.
Heads	.....	$7.8813	.....
Amalgamation bullion	$2,343,653.33	5.1748	65.6591
Cyanidation bullion	1,088,889.66	2.4042	30.5060
Total	$3,432,542.99	$7.5790	96.1651

The tonnage milled during the period was 452,900, as against 548,000 for the full year 1928. The extraction was 96.1651 per cent., as against 95.6307 per cent. for the year 1928. The improvement in this respect is believed to be due to more coarse gold in the ore, though more gold may have been recovered from the mill.

During the summer the walls of the main tailing storage dam have been raised to give an increased storage capacity of about two years.

General

Operating costs amounted to $4.479 per ton milled, as compared with $3.852 for the previous year; the difference is accounted for by the mill having operated for less than ten months during the year; there was also an increase in ore broken in stopes, in development work done, and in exploration. Development work was also carried out at greatly increased distances from the main shaft. For the first ten months of the year when the mill was operating, the cost was $3.943 per ton milled.

Since the mill was burned, careful consideration has been given to various proposals for treating our ore. It appears unlikely that a decision can be reached in this matter without making some metallurgical tests, and steps have been taken to do this. The work of clearing away the debris has been taken in hand and is being accomplished as quickly as weather conditions permit. It is expected that our plans will be completed as soon as it will be possible to start on their execution.

The closing down of the crusher station has afforded us an opportunity to install a Symons cone crusher, which will greatly improve the operation of this plant and lessen the cost of milling.

Dunkin Gold Mines, Limited

This company has an authorized capital of $4,000,000, divided into shares of $1 par value each. Of these shares, 1,500,000 were issued for the property and 1,500,000 have been issued to carry on the development work, leaving the balance of the shares in the treasury.

The officers of the company are: R. Home Smith, president; J. H. Black, vice-president; J. S. Masson, secretary; Colin A. Campbell, manager. The directors are: R. Home Smith, J. H. Black, J. R. L. Starr, J. S. Masson, Jas. A. Dunn, W. F. Spence, and S. A. Shoemaker. The head office of the company is the Northern Ontario Building, Toronto, and the mine address is Narrow Lake, Ont.

The company's holdings include thirteen claims at the end of the west arm of Narrow lake, K.R.L. 4,428-30, 4,433-38, 4,447-49, 4,926, located in the township of Skinner, district of Kenora (Patricia portion).

Early in 1927, a considerable amount of assessment work was done on the properties, and the vein was uncovered for 250 feet with a width of from 2 to 12 feet. The vein has been traced by cross-trenches from the lake on claim K.R.L. 4,447. It runs east across K.R.L. 4,434 to the lake and shows up again on K.R.L. 4,435. The strike is N. 80° E., and the dip is 75° N.

A plant was hauled to the property and installed early in 1928. This includes the following: an 80 h.p. locomotive boiler; a Canadian Ingersoll-Rand air compressor, FR-1, straight-line, capacity 528 cubic feet per minute; a Canadian Ingersoll-Rand hoist, 7 by 6 feet, type SSR.

A headframe, 30 feet in height, was erected, the shaft being located near the centre of claim K.R.L. 4,434. Sinking of a three-compartment shaft was started by hand on July 25, 1928.

The shaft was sunk during the year to a depth of 271 feet with levels at the 125- and 250-foot horizons. The following drifting and crosscutting were done:—

Level	Crosscutting	Drifting
	feet	feet
125-foot	56	.....
250-foot	423	227

The buildings at the property, all of log construction, include the following: two sleep camps, 20 by 30 feet and 16 by 22 feet; cookery, 20 by 30 feet; storehouse, 18 by 24 feet; office, 18 by 24 feet; power-house, 33 by 36 feet; dry-house, 18 by 22 feet.

A saw-mill with about 7,000 board feet capacity was erected on the lakeshore below the shaft-house during the winter.

When operations were in progress during the summer, a crew of 30 men was employed.

The property was shut down on March 29, 1929, and arrangements were made to sell the equipment.

Golden Summit Mines, Limited

The Golden Summit Mines, Limited, operated their property on the boundary line of Maisonville and Grenfell townships, district of Timiskaming, with a force of 10 men from June, 1929, to April 15, 1930, at which time the force was reduced to 2 men. The officers and directors of the company are: Thomas A. Wilson, president; Charles Ling, vice-president; William J. Simpson, secretary-treasurer; John A. Gunn, John M. Calder, Benjamin Kerr, Henry A. Marsh, directors. W. J. Simpson is manager. The company has a capital of $2,500,000, and the head office is at 594 Bloor Street West, Toronto.

The development for the year comprised 142 feet of shaft-sinking and 86 feet of drifting east of the shaft on the 125-foot level. There was also some trenching and test-pitting done.

Gold Rock Mines, Limited

This company has an authorized capitalization of 4,000,000 shares of no par value.

The officers and directors are: J. O. Robillard, president; T. W. Bathurst, vice-president; H. L. Nichol, managing director and secretary-treasurer; R. S. Harrison, director. The head office is at 315 Ottawa Electric Building, Ottawa.

The properties held by this company are located in the Dryden gold area and consist of five groups of claims. These claims were taken over from the Gold Rock Mining Syndicate, Limited, being paid for by shares in the present company.

The company has a winter road, 24 miles long, from Wabigoon, on the Kenora division of the Canadian Pacific Railway, to the camps on Upper Manitou lake. In the summer transportation is by water with a portage between Manitou lake and Wabigoon lake.

Underground work to date has been confined to what is known as the Haycock property. A shaft has been put down 87 feet and a crosscut driven 170 feet.

Miles Walker is in charge of operations.

Haslat-Duck Lake Mines, Limited

This company has an authorized capital of 5,000,000 shares of $1 par value.

The officers and directors are: F. A. Kent, president; W. H. MacMahon, vice-president; W. F. Stewart, secretary-treasurer; J. M. Aitken, F. C. Loring, J. E. Thompson, and R. C. Harrison, directors. The head office is at 202 Hamilton Trust Building, Toronto.

The property of the Haslat–Duck Lake Mines, Limited, consisting of 27 claims, is situated on Duck lake, which is about 16 miles north of Schreiber, a divisional point on the Canadian Pacific railway. Transportation is by canoe in summer and by tote road in winter.

During the winter of 1928-29, a small steam plant was taken in from Schreiber, and during 1929 two shafts were sunk to a depth of 100 feet and some 60 feet of lateral work was done. However, most of the work has been confined to stripping, trenching, and test-pitting, and some 35 veins of various widths have been exposed, some of which show values in lead, zinc, copper, and gold.

On December 15, 1929, all operations at the property were closed down owing to lack of finances.

M. L. Bouzan was in charge of operations.

Hayden Gold Mines, Limited

This company is capitalized at $5,000,000, in shares of $1 par value. There are 4,297,168 shares issued.

The following are the officers and directors of the company: Jas. S. Pierce, president; B. W. Lang, vice-president; W. Spaulding, secretary-treasurer; B. J. Fryatt, R. Berkinshaw, Joseph Montgomery, B. Sproule, E. D. Phillips, and Henry McK. Hasserot, directors. The head office is at 509 Brisbane Building, Buffalo, N.Y., and the mine office is at Timmins, Ont.

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.

A diamond-drill campaign starting in December, 1927, has been carried on, and some 10,000 feet of drilling accomplished. An electrical survey has also been made during the year.

In May, 1929, the old buildings on the property were reconstructed, and following this some new structures were erected. A tile hoist-house, 30 by 32 feet, which also houses the compressor and a small 20 h.p. heating boiler, was built. A 10- by 16-foot electric substation, a 12- by 14-foot magazine, and a 12- by 16-foot boiler-house were also put up. The camp buildings will accommodate about 22 men.

Previous operators on this property have sunk the main shaft 719 feet and established levels at the 100-, 200-, 300-, 400-, 550-, and 700-foot horizons. On all levels but the 550-foot the main vein on which the shaft started has been drifted on. The total lateral work on the property amounted to about 1,400 feet.

In August, the dewatering of the mine began, and in October the water was below the 550-foot level. Work on the 300-foot level was at once started, and during the year a total of 685 feet of crosscutting and drifting done. On the 700-foot level 260 feet of lateral work was done during the year. Early in 1930 the work was curtailed somewhat on account of finances.

An average of 12 men was employed throughout the year. Seymour Stevens is in charge of the property.

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, Ontario.

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

The following information is taken from the nineteenth annual report of the directors to the shareholders, covering operations for the year ending December 31, 1929:—

ASSETS

CAPITAL:			
Mining properties			$22,493,785.17
Plant, brought forward from 1928		$1.00	
Plant, additions during 1929		39,330.50	
		$39,331.50	
Less depreciation for 1929		39,330.50	
			1.00
Investments in other companies and properties:			
Brought forward from 1928		56,923.14	
Outlay during 1929		7,011.37	
		$63,934.51	
Less depreciation for 1929	$4,301.53		
Less expenditures on properties abandoned	5,556.75		
		9,858.28	
			54,076.23
Tailings disposal site:			
Brought forward from 1928		8,416.80	
Less depreciation for 1929		8,415.80	
			1.00
Outlay to date in respect of Kamiskotia claims			399,581.34
			$22,947,444.74
DEFERRED:			
Material and supplies on hand		$439,572.47	
Solutions on hand		98,315.44	
Precipitates on hand		5,176.00	
Litharge, slags, etc., on hand		743.00	
Charges paid in advance, fire insurance		1,028.70	
			544,835.61
CURRENT:			
Cash on hand, in bank	$409,261.50		
Bullion in transit	389,016.81		
Accounts receivable	42,607.47		
		$840,885.78	
Investments:			
International Bond and Share Corporation stock	$11,195,980.00		
Call loans	595,000.00		
Accrued interest on investments	208,626.90		
		11,999,606.90	
			12,840,492.68
			$36,332,773.03

LIABILITIES

CAPITAL STOCK:			
Authorized		$25,000,000.00	
In treasury		400,000.00	
			$24,600,000.00
CURRENT LIABILITIES:			
Wages unpaid		$151,455.21	
Accounts payable		281,157.70	
			432,612.91
Reserve for taxes, Dominion of Canada and municipal			190,000.00

LIABILITIES—*Continued*

SURPLUS:		
Balance of account from 1928	$10,669,553.72	
Added to surplus per profit and loss account	440,606.40	
Net surplus carried forward		$11,110,160.12
		$36,332,773.03

The president makes the following statement with reference to the newly formed International Bond and Share Corporation and the Kamiskotia property:—

During the year the organization of the International Bond and Share Corporation, the securities subsidiary incorporated by the Hollinger company, was completed, and the company commenced operations on the first of August, as of which date they took over the investments of the Hollinger company at their then market value, namely $11,195,980, the Hollinger company receiving in payment preferred and common shares of the subsidiary company. This transaction explains the item on the balance sheet under investments "International Bond and Share Corporation stock, $11,195,980.00," and accounts for the disappearance from the balance sheet of the investments formerly held by your company. Statements are now being prepared showing the condition of the subsidiary company and further details will be submitted at the annual meeting. The other items under investments, namely, call loans and accrued interest on investments, are self-explanatory.

No further comment on the balance sheet seems to be necessary but it is perhaps desirable to point out that, as the result of the year's operations, the substantial sum of $440,606.40 has been added to surplus, which now stands at $11,110,160.12.

Pending a decision of the Ontario Government to extend the Timmins branch of the Temiskaming and Northern Ontario Railway to the Kamiskotia district, a distance of about seventeen miles, work on your Kamiskotia property has been shut down throughout the entire year. Your directors pointed out last year that the building of the railway would not only serve a promising new mining field but should prove of value as a colonization road. They have shown their faith in your property by the expenditure to date of almost $400,000, they are willing to expend at least $500,000 in the erection and equipment of a concentrator, and they are even prepared to go further and have offered to make a substantial contribution towards meeting any operating loss on the proposed branch line, notwithstanding their contention that the extension of the railway is entirely a government enterprise, the cost of which should be borne by the Government as has been done in the case of other extensions. The Hollinger company is only interested in a comparatively small portion of the vast area that will be opened up by the proposed railway, and your directors feel that they have gone as far as should reasonably be expected in offering to assume a special obligation in connection with an enterprise for the benefit of the entire province.

The number of our shareholders continues to increase and is now about eight thousand. The geographical distribution of the ownership of the outstanding shares is as follows: owned in Canada, 4,492,461 shares; in the United States of America, 392,879 shares; in Great Britain, 19,454 shares; elsewhere, 15,206; total, 4,920,000 shares.

Conditions at the mine and mill are satisfactory.

Labour conditions were also satisfactory throughout the year, and there is no reason to anticipate any change in this situation. The available supply of labour keeps well ahead of our requirements.

The following is taken from the report of the general manager for the year ending December 31, 1929:—

PROFIT AND LOSS STATEMENT

SOURCES OF INCOME:	
Gold and silver produced	$9,433,767.14
Premium on U.S. exchange	63,802.15
Interest on investments and other income	669,637.96

PROFIT AND LOSS STATEMENT—*Continued*

DEDUCT (taxes):			
Province of Ontario	$19,806.60		
Royalty to town of Timmins	17,059.98		
Municipal to town of Timmins	91,250.25		
Municipal to township of Tisdale	2,143.44		
Dominion of Canada re 1928	3,974.65		
Dominion of Canada and municipal, reserve for	190,000.00		
		$324,234.92	
Adjustments on sale and realization of securities		21,033.13	
DEPRECIATION:			
Plant	$39,330.50		
Tailings disposal site	8,415.80		
Investments in other companies and properties written down	4,301.53		
Expenditures on properties abandoned	5,556.75		
		57,604.58	
			402,872.63
NET PROFIT FROM OPERATIONS			$3,638,606.40
PAID OUT IN DIVIDENDS			3,198,000.00
ADDED TO SURPLUS			$440,606.40

BULLION STATEMENT

Inventory, January 1, 1929:			
Solutions			$120,583.80
Slags, litharge, and miscellaneous			743.00
Precipitates held over			4,430.00
Total			$125,756.80
Values produced in 1929:			
Ore milled		$9,805,963.14	
Tailings loss		372,196.00	
			9,433,767.14
			$9,559,523.94
Inventory, December 31, 1929:			
Solutions			98,315.44
Slags, litharge, and miscellaneous			743.00
Precipitates held over			5,176.00
			$104,234.44
Bullion shipped			9,455,289.50
			$9,559,523.94

The yearly average costs are as follows:—

DISTRIBUTION OF GENERAL CHARGES

Account	Sundries	Labour	Stores	Total	Per ton ore milled
General miscellaneous charges and administration	.....	$305,705.05	$54,702.59	$360,407.64	$0.2328
Surface services	.....	35,866.84	26,328.73	62,195.57	.0401
Insurance	$14,167.68	.....	.....	14,167.68	.0091
Marketing bullion	32,119.80	.....	.....	32,119.80	.0207
Workmen's compensation	.....	215,169.69	.....	215,169.69	.1389
Milling charges	.....	393,670.31	622,698.49	1,016,368.80	.6561
Mining charges	.....	2,982,117.43	1,443,181.61	4,425,299.04	2.8565
Total charges	$46,287.48	$3,932,529.32	$2,146,911.42	$6,125,728.22	$3.9542

Employees

The average number of men employed during the year has been 2,105, distributed as follows:—

Miners:		Mechanics:		General:	
Exploration	32	Operation	98	Mill and refinery	178
Development	344	Maintenance	151	Engineering staff	54
Production	1,090			Clerical staff	41
				Miscellaneous	117
Total	1,466	Total	249	Total	390

The Mill

Milling results were as follows:—

Ore milled	tons	1,549,157
Average value per ton		$6.33
Gross value	$9,805,963.14	
Deduct loss in tailings	372,196.00	
Net value recovered		$9,433,767.14

Average tons per day	4,268
Per cent. of possible time run	95.7
Tons per 100 per cent. running time	4,460
Solution precipitated per ton ore, tons	1.14
Value per ton in tailings	$0.24
Cyanide consumed per ton of ore, lbs.	0.430
Zinc consumed per ton of ore, lbs.	.054
Zinc consumed per ton of solution, lbs.	.047
Lime consumed per ton of ore, lbs.	2.083
Lead nitrate per ton of ore, lbs.	.009
Average value of pregnant solution	$5.37

The Mine

The development progress during the year was as follows:—

Level	Drifts	Crosscuts	Raises	Diamond-drilling	Timbering stopes	Excavation
	feet	feet	feet	feet	feet	tons
Surface	.....	.....	.....	5,778	.....	.....
100-foot	103	195	.....	2,842	.....	.....
200-foot	4,248	1,927	58	11,190	960	.....
300-foot	3,851	663	362	7,168	1,232	312
425-foot	2,710	2,028	462	8,220	635	144
550-foot	2,425	1,411	167	5,466	311	50
675-foot	3,757	2,026	.....	9,023	1,013	.....
800-foot	3,401	1,315	.....	7,216	1,368	.....
950-foot	2,049	1,226	.....	3,080	382	284
1,100-foot	2,453	1,190	.....	2,993	103	.....
1,250-foot	1,103	419	.....	1,189	212	.....
1,400-foot	2,050	955	.....	2,892	207	.....
1,550-foot	1,308	442	.....	2,992	118	.....
1,700-foot	879	533	.....	2,662	187	.....
1,850-foot	547	741	.....	2,956	179	.....
2,000-foot	1,223	781	.....	7,824	570	.....
2,150-foot	1,269	330	17	1,241	2,085	.....
2,300-foot	2,238	983	.....	5,851	1,657	.....
2,450-foot	3,198	2,074	.....	9,607	1,292	.....
2,600-foot	2,450	2,987	17	6,185	476	.....
2,750-foot	1,720	3,257	.....	8,997	.....	340
3,050-foot	160	171	.....	183	.....	.....
3,350-foot	39	323	.....	442	.....	.....
3,650-foot	54	247	.....	.....	.....	260
3,950-foot	280	2,950	.....	3,627	.....	.....
Total	43,515	29,174	1,083	119,624	12,987	1,390

The total drifting, crosscutting, and raising was 73,772 feet. There was no shaft-sinking done during the year.

PRODUCTION

Level	Broken ore in mine, Jan. 1, 1929	Ore broken during 1929	Ore removed during 1929	Broken ore in mine, Dec. 31, 1929
	tons	tons	tons	tons
Above 100-foot	15,494	3,068	15,487	3,075
Above 200-foot	235,229	213,368	274,465	174,132
Above 300-foot	74,967	113,460	128,756	59,671
Above 425-foot	19,875	97,609	73,532	43,952
Above 550-foot	70,274	43,836	60,292	53,818
Above 675-foot	76,768	135,289	131,587	80,470
Above 800-foot	30,916	171,686	110,783	91,819
Above 950-foot	31,400	84,820	71,869	44,351
Above 1,100-foot	53,952	39,850	59,315	34,487
Above 1,250-foot	67,525	73,581	93,001	48,105
Above 1,400-foot	61,038	50,466	53,693	57,811
Above 1,550-foot	90,464	46,867	72,750	64,581
Above 1,700-foot	93,411	31,551	37,997	86,965
Above 1,850-foot	113,929	25,367	47,422	91,874
Above 2,000-foot	60,719	48,622	46,480	62,861
Above 2,150-foot	10,022	93,845	84,725	19,142
Above 2,300-foot	5,832	96,861	70,026	32,667
Above 2,450-foot	787	90,653	64,563	26,877
Above 2,600-foot	60	34,690	31,882	2,868
Above 2,750-foot	.....	15,725	15,725	.....
Above 3,050-foot	.....	1,098	1,098	.....
Above 3,350-foot	.....	341	341	.....
Above 3,650-foot	.....	341	341	.....
Above 3,950-foot	.....	2,678	2,678	.....
Total	1,112,662	1,515,672	1,548,808	1,079,526

SUMMARY OF ORE RESERVES

Vein No.	Tons	Value per ton	Estimated gross value, Dec. 31, 1929	Estimated gross value, Dec. 31, 1928
Veins over $10:				
97	71,713	$19.06	$1,366,663	$1,691,931
206	10,767	13.33	143,537	548,900
64	4,078	11.91	48,583	48,583
86	91,606	11.81	1,081,567	1,419,959
13	12,607	11.74	147,992	186,390
38	5,650	11.39	64,356	64,356
84	200,717	11.38	2,284,106	2,381,486
1	76,404	11.07	845,518	849,183
5	18,517	11.06	204,829	217,595
50	92,944	11.04	1,025,989	1,242,558
56	30,935	10.80	334,013	412,096
26	9,270	10.55	97,811	228,634
111	6,247	10.39	64,904	98,327
99	17,952	10.25	184,004	157,257
15	54,180	10.22	553,576	512,813
20	54,568	10.05	548,537	573,120
16	15,090	10.01	151,043	151,043
96	.....	.....	.....	10,950
200	.....	.....	.....	46,713
Total	773,245	$11.83	$9,147,028	$10,841,894
Veins, $10 to $8:				
2	87,875	$9.96	$875,568	$869,374
63	59,538	9.82	584,383	676,731
8	11,136	9.62	107,180	101,543
4	32,542	9.57	311,458	263,771
66	38,637	9.41	363,766	485,963
51	29,414	9.37	275,518	368,966
58	57,183	9.36	535,135	760,062

SUMMARY OF ORE RESERVES—*Continued*

Vein No.	Tons	Value per ton	Estimated gross value, Dec. 31, 1929	Estimated gross value, Dec. 31, 1928
Veins, $10 to $8—*Continued:*				
48	5,703	$9.24	$52,677	$64,670
221	867	9.20	7,976	.....
91	187,790	9.12	1,713,410	1,575,695
37	21,202	9.12	193,369	149,822
85	253,304	9.11	2,307,753	2,727,739
65	115,943	9.08	1,052,610	909,927
101	61,578	9.02	555,183	710,969
14	15,133	8.99	135,988	357,413
55	230,457	8.98	2,069,787	2,541,194
88	33,486	8.98	300,630	439,131
33	42,936	8.92	382,932	499,042
113	2,443	8.85	21,615	64,844
59	122,769	8.83	1,084,146	441,130
92	71,560	8.82	631,356	1,236,848
114	269,448	8.75	2,358,014	2,088,721
44	68,183	8.67	591,073	770,246
53	134,560	8.61	1,158,438	1,300,251
177	55,291	8.60	475,592	236,842
95	276,775	8.56	2,369,098	1,288,437
61	4,543	8.50	38,615	38,615
12	100,295	8.39	841,411	1,451,096
52	35,304	8.33	294,231	372,982
21	5,119	8.31	42,544	41,916
17	4,425	8.31	36,772	65,007
93	43,275	8.31	359,531	296,697
87	14,623	8.30	121,348	278,232
54	100,021	8.24	824,204	885,920
9	30,366	8.22	249,655	275,920
214	12,347	8.01	98,892	75,049
220	1,195	8.00	9,560	122,437
124	.....	.....	.....	16,825
19	.....	.....	.....	46,196
Total	2,637,266	$8.88	$23,431,418	$24,896,223
Veins, $8 to $6:				
39	3,787	$7.89	$29,895	$29,895
103	1,310	7.79	10,202	.....
11	2,276	7.74	17,618	.....
107	245,286	7.69	1,886,846	2,424,072
24	4,115	7.56	31,121	.....
226	3,650	7.38	26,949	92,660
150	2,245	7.35	16,501	39,426
25	4,713	7.29	34,335	.....
47	29,674	7.23	214,400	225,943
68	28,577	7.20	205,625	490,333
10	31,001	7.16	222,067	109,628
67	16,211	7.07	114,670	141,148
115	9,164	7.04	64,513	97,915
3	10,922	6.95	75,938	86,149
7	4,567	6.67	30,462	59,727
151	17,853	6.47	115,455	.....
82	1,648	6.44	10,613	42,350
18	24,727	6.42	158,690	189,932
224	4,468	6.36	28,422	32,994
218	15,043	6.19	93,061	67,889
112	.....	.....	.....	307
153	.....	.....	.....	23,924
Total	461,237	$7.34	$3,387,383	$4,154,292
Total ore reserves	3,871,748	$9.29	$35,965,829	$39,892,409
Surface outcrops	10,530	7.08	74,505	231,620
Probable ore under $6	2,477,743	4.75	11,779,064	11,086,206
Total	6,360,021	$7.52	$47,819,398	$51,210,235

Development

During the year 1928 it became evident, owing to changes in the character of the ore bodies in the lower levels, that the system which had heretofore proved rapid and satisfactory, where the veins were regular and of comparatively uniform grade, would not serve under the changed conditions. Therefore, it was determined to suspend a large part of the development programme on the lower levels, pending a geological investigation of the problem.

As was announced at the last annual meeting, Dr. L. C. Graton of Harvard, with a corps of assistants, was engaged to conduct this work. They have so far confined their efforts to fundamental studies of general geological features during the past year and will continue in this phase of the work during 1930. In the meantime, mining and development have been continued on the upper levels, above the 800-foot principally, from which 790,000 tons were hoisted, with a depletion of 372,000 tons. Above this horizon the value of the remainder is approximately $9, and a further 900,000 tons of additional reserve remain, of a value between $4.50 and $6, which will yield a profit, as the greater part of the development chargeable against this has been done. A further three-quarters of a million tons was taken from the lower levels, where the reserve tonnage was increased by 206,000 tons, notwithstanding the reduced programme of development.

Referring to the development schedule, it will be seen that 29,174 feet of crosscuts were driven in 1929, as compared with 51,120 feet in 1928, showing a decrease of about 22,000 feet, which is in accordance with the notation re deferred development as above. This must necessarily be reflected in the ore reserves, which were depleted to the extent of 200,000 tons, as compared with 875,000 tons during 1928. These figures are not exactly comparable as the milling rate was greater in 1928 than in 1929, but they indicate better conditions.

Work was also continued on the Schumacher and adjacent sections on the lower levels, with developments as follows: The shaft was completed at 4,040 feet. Levels were opened at 3,050, 3,350, 3,650, and 3,950 feet. Thus far over 100 feet of ore has been opened up below the 2,900-foot level, with values ranging from $8 to $8.50 and with other footages of lower values around $6. This work has not advanced far enough to make a reliable statement of tonnages, but progress will be made toward this end during the year. On the 2,900-foot level and above, veins aggregating about 1,200 feet in length, of approximately $8 ore, are in sight, as developed by drifting and diamond-drill holes. This ore will be available for milling during 1930.

Exploration

Our field force have been actively engaged throughout the year, and many properties have been investigated. None have so far been found interesting, but, having in mind the progress of Northern Ontario during the past ten years, we will continue to investigate, with optimism, as many prospects as possible.

General

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

Total income from all sources	$156,236,583.00
Working expenses, including all charges	94,418,925.00
Profits	$61,817,658.00
Paid out in dividends	51,342,400.00
Surplus	11,110,160.12

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.

Horse Shoe Mines, Limited

In the spring of 1929, this company started work on the old Regina mine in the Lake of the Woods area, about 42 miles from Kenora. The Regina mine was first known as the Black Eagle mine and dates back to 1893.

The authorized capital of this company is 4,500,000 shares of $1 par value.

The officers and directors are: A. Kelly Evans, president; W. A. Lamport, vice-president; J. C. Grace and Jas. Lumbers, directors. The head office is at 801 Excelsior Life Building, Toronto.

The work done was confined to repairing and altering the surface plant and dewatering the mine. Operations were suspended in August, 1929.

C. W. Dalby was in charge.

Jackson-Manion Mines, Limited

The Jackson-Manion Mines, Limited, is capitalized at $5,000,000 in shares of $1 par value; 2,500,000 shares have been issued.

The officers of the company are as follows: W. H. Russell, president; H. E. Harcourt, vice-president; H. Keefer, secretary; H. A. Currie, treasurer. W. J. Sheppard, J. B. Tudhope, Hon. J. D. Chaplin, Hon. R. J. Manion, and Hon. A. Turgeon are directors. The head office is located at 1507 Bank of Hamilton Building, Toronto.

The company is interested in 25 claims in the townships of Dent and Mitchell, Woman Lake area, district of Kenora (Patricia portion).

The Woman Lake area is accessible from the Canadian National railway by way of Hudson and Gold Pines (Pine Ridge), the latter at the outlet of Lac Seul. Large motor boats navigate between these two points, a distance of 115 miles. From Gold Pines there are two water routes, the most used of which is that down the English river to the mouth of the Chukuni, up the Chukuni to Pakwash (Shallow) lake, and Bruce lake to Trout Lake river, and up to Woman river, which is followed to Woman lake.

The area may be reached by air, the Western Canada Airways, Limited, maintaining an excellent passenger, mail, and express service. The trip from Hudson to Woman lake may be made in about an hour and thirty minutes by plane. The boat trip requires two days.

Active development was carried on throughout the year. The shaft reached a depth of 404 feet, with three levels, at the 125-, 250-, and 375-foot horizons. To the end of March, 1929, the following work had been accomplished:—

Level	Cross-cutting	Drifting		Raising	Diamond-drilling[1]
		north	south		
	feet	feet	feet	feet	feet
125-foot	80[2]	288	188	.....	.....
250-foot	161	279	95	95	295
375-foot	78	13	69	.....	582

[1]Surface diamond-drilling (to July 20, 1929), 4,900 feet.
[2]To and through the vein.

Work on the property was suspended early in August, 1929.

During the early months of 1929, a force of 65 men was maintained at the property under the superintendence of D. M. Thomson.

Jones Porter Mines, Limited

This company is capitalized at $3,000,000, divided into shares of $1 each. There are 1,607,800 shares issued. The officers and directors are: A. J. Doane, president; M. H. McArthur, secretary-treasurer; William A. Porter, John Jones, L. L. Anthes, W. G. Harris, all of Toronto, and L. T. Burwash, of Ottawa, directors. The head office of the company is at 169 Yonge Street, Toronto.

The holdings of the company, in the southeastern portion of Deloro township, district of Cochrane, consist of 14 claims in a group. Gold was discovered on claim No. 10,800 in the summer of 1925.

Early in 1928 a shaft was put down 138 feet and a station cut at the 125-foot level. No further work underground has been done, but early in 1929 the plant of the old Croesus mine at Matheson was moved to the property and partially erected.

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, and A. M. McQueen. W. M. Sixt is mine manager.

The head office is at 810 Lumsden Building, Toronto.

On an average, 110 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:—

The work of the year consisted chiefly of a downward exploration of your property. All other work of any kind, however important it might appear to be, was made secondary to this one main object.

In carrying out this plan, the winze was sunk from a depth of 3,251 feet to a depth of 4,033 feet, or a vertical distance of 782 feet. The station at the 3,225-foot level was completed, and stations were cut at 3,350-, 3,475-, 3,600-, 3,750-, 3,875-, and 4,000-foot levels.

The horizontal work consisted of 1,492 feet of crosscutting and 3,712 feet of drifting, all of the latter, except that on the 3,875-foot level, being on the main fault plane.

In addition to sinking, crosscutting, and drifting, 1,322 feet of diamond-drilling was done on the 3,225-foot level and 837 feet on the 3,600-foot level, 762 feet of this drilling on the 3,225-foot level having been done on behalf of the Chaput-Hughes Mines, Limited, in continuation of the work done for that company in 1928 on the 2,850-foot level.

New stopes were opened on the 2,850-, 2,975-, and 3,600-foot levels.

The total quantity of ore and rock raised during the course of this work was 81,363 tons, in addition to which 5,854 tons of rock was dumped underground in the old stopes.

During the year, 53,595 tons of ore were milled, from which gold to the value of $353,625.15 was recovered, or a yield of $6.60 to the ton. The extraction amounted to 90.21 per cent. of the gold content of the ore, and consequently the ore that went to the mill contained gold to the value of $7.32 to the ton.

Our total cost of operation was $430,767.29, and of this amount $187,000 was spent on exploration and development, but almost entirely on exploration. The heaviest single item of our cost was electric power, which amounted to a total of $55,760.04, or $1.04 per ton milled. We pay one cent per k.w. hour for power used, which, as you all know, is $65.39 per h.p. year, on which we received a load factor discount of 7 per cent., making the cost $60.81. In addition to this we pay a service charge that last year amounted to $14,709.26, which raised our rate to $82.60 a h.p. year.

As you can see by the above statement it has been necessary for us to draw on our reserve this year in order to get down quickly to the lower and richer ore-bearing zone. This was done in the confident belief that when the lower horizon, where porphyry would be present in large quantity, was reached more and richer ore would be found, after which the millheads could be raised and production could be increased.

The condition of the mine, as far as has been determined up to the present time, is about as follows: As in other parts of the Kirkland Lake area, much of the country rock on our claim is a dark, often almost black, lamprophyre, which, together with the sedimentary sandstones and conglomerates lying on it, and syenite, porphyry, and diabase intruded into it, have been sliced in two by a great steeply dipping fault running in a general east and west direction. The gold-bearing veins are in, or in the vicinity of, this fault. In our mine, syenite, mostly bright red in colour, forms two bands which extend through the lamprophyre and dip downward and westward at an angle of about 50 degrees from the vertical. Where the fault cuts these bands of syenite, ore-bearing veins occur in it, constituting two great westward-pitching ore shoots. In the lamprophyre above, between and below these syenite bands, there is very little ore in the fault. But we know that most of the ore in the mines to the east of us occurs associated with porphyry, not syenite or lamprophyre. We also know that a great mass of intrusive red porphyry outcrops about three-quarters of a mile east of our eastern boundary, and also that the western end of this great porphyry mass slopes westward as it goes down. We had encountered narrow dikes of porphyry, doubtless apophyses from this underlying mass, but we had never reached that mass itself. However, we have now reached it, as you will realize from the following brief statement. In a horizontal drill-hole, 300 feet deep, drilled northward from near the east end of the 3,225-foot level and north of the fault, we ran through 141 feet of porphyry all told. On the 3,600-foot level we also had a great width of porphyry north of the fault, but in addition we cut through porphyry for a width of 70 feet in the main crosscut south of the fault, and about 400 feet farther east on the same level, and also south of the fault, we found the porphyry 143 feet wide. A diamond-drill hole drilled downward forty feet south of the south end of this porphyry showed that this rock was getting still wider as it went down, and this diamond-drill hole also encountered three gold-bearing veins in a width of 60 feet, at about the 3,875-foot level.

At the end of the year the crosscuts on the 3,875- and 4,000-foot levels had not reached the south side of the fault, but porphyry was present in abundance north of it.

In the last week of December, the crosscut from the winze on the 3,875-foot level reached one of the three veins mentioned above, about 400 feet west of where it had been cut by the diamond-drill, and it was high grade.

On January 7, 1930, R. E. Hore, a mining geologist who has a very intimate knowledge of the pre-Cambrian rocks of Northern Ontario, and of the ore contained in them, visited the mine, and the following is an extract from his report:—

"From observations at the 32nd, 36th, 38th, and 40th levels, it is clear that a horizon similar to that in which the chief ore bodies of the camp occur has been finally reached. It is reasonable to expect that more important ore bodies than any yet found at this mine will be found in the near future.

"The length of favourable ground is now increasing rapidly. There is reason to expect that good results will be obtained in opening the 38th and 40th levels both east and west from the crosscuts.

"The ore of your upper levels occurs chiefly in two westward pitching shoots in a faulted mass of alkali syenite, which also pitches downward to the west. The secondary shaft has passed through the horizon of the footwall syenite, and the deeper workings are now in ground in which porphyry masses alternate with lamprophyre.

"The trend of all the formations exposed in the lower levels, as in the upper levels, is westward with depth.

"From my observations at the mine the work that you have done to date has obtained results which your early interpretation of the geological structure permitted you to expect. The poor results at the 32nd level were not anticipated, and the reason for the paucity of gold in this neighbourhood is not yet apparent. The deeper work shows, however, that the favourable porphyry-lamprophyre ground is not far below where you expected to find it, and there are already strong indications that it will prove up to expectations as a host for rich ore bodies.

"While it is somewhat easier to operate at lesser depths, the mining of large tonnages of ore from below 4,000 feet presents no obstacles which have not already been encountered and readily overcome elsewhere. The conditions for deep mining at Kirkland Lake are peculiarly favourable and far superior to those of many mining districts. If rich and large ore bodies like those of Teck-Hughes and Lake Shore mines occur below your 4,000-foot level, as may be reasonably expected, you should have a long period of profitable operations."

A competent system of ventilation has been installed to the bottom level of the mine.

Some of the large unused drifts have been converted into refuge stations, in accordance with the recommendation of the U.S. Bureau of Mines, and in case of danger the miners can take refuge in them. These stations are supplied with food, water, and light, are furnished with comfortable benches, and the doors are fire- and gas-proof. They are large enough to provide a livable supply of air for the whole crew of the mine for from two to four weeks. The men are trained to go to them in case of danger and wait until they are told that they can come out in safety, rather than to attempt a personal stampede which is usually disastrous. A second exit from the mine will very soon be completed.

During the year we purchased mining claim L. 2,644, which lies immediately south of our mining claim L. 1,236, from the Chaput-Hughes Mines, Limited, as well as two other claims farther south, the consideration being 239,123 shares of our company. We had done a large amount of development work on this property in a long crosscut and drift on the 1,600-foot level, and long diamond-drill holes on the 2,850- and 3,225-foot levels, without finding commercial ore, taking our pay for the work largely in stock in the company, and thus we became its largest shareholder. We were willing to take most of our pay in stock, because we believed that at great, but reachable depth, the fault which was dipping southward would dip into that claim, and that the ore shoot which accompanied that fault in the country to the east of us would pitch or rake westward, and that we would eventually get it. Otherwise the property would have been of no interest or value to us. Now the former shareholders of Chaput-Hughes Mines, Limited, will share with us in any success that we may achieve.

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 720 men was employed.

The following information is taken from the fourteenth annual report of the company for the year ending June 30, 1929:—

During the year 367,015 tons of ore were treated, yielding bullion to the amount of $5,504,858.64. This shows an increase of 129,053 tons milled over last year, with a corresponding increase in bullion of $1,875,541.07.

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
Total			$19,306,892.93	$6,820,000

Mining and Development

During the year 526,284 tons of ore were broken. Of this amount 92,922 tons were from development and 433,362 from mining, of which 367,015 tons were hoisted and milled and the balance, 159,269 tons, added to the broken ore reserves, which now amount to 393,297 tons, valued at $6,524,797.23.

No. 3 shaft has been completed from the 1,000- to the 2,000-foot level, with stations cut at 200-foot intervals. Crosscuts connect this with No. 1 shaft on all levels to the 1,600-foot level.

A steel headframe for the No. 3 shaft is now on order, also a 12- by 8-foot hoist. An additional compressor unit is also being installed.

No. 2 vein has been opened up to the western boundary on the 1,200- and 1,400-foot levels, and on the 1,600-foot level the drift extends the entire length of the property. Approximately 600 feet of drifting has been done on this vein on the 1,800-foot level, with values slightly better than any level yet encountered. The vein has also been cut on the 2,000-foot level, and shows excellent widths and values.

As more information is now available on the 1,600-foot level than on any other level, careful attention has been given to an estimate of the ore reserves between this and the 1,400-foot level, which shows a value of $13,000,000.

DEVELOPMENT FOOTAGE FOR YEAR 1928

Level	Drifting	Crosscutting	Raising	Shaftsinking	Ore passing	Winzes	Total footage	Diamond drilling	Boxholes	Stationcutting	Total cubic footage
	feet	feet	feet	feet	feet	feet	feet	feet	cu. ft.	cu. ft.	cu. ft.
200-ft.	.....	6	.....	.....	.....	20	26	.....	.....	12,159	12,159
400-ft.	513	31	159	.....	.....	.....	703	.....	.....	.....	.....
600-ft.	544	25	180	.....	.....	.....	749	.....	.....	.....	.....
800-ft.	1,117	157	433	.....	.....	.....	1,707	491	3,372	.....	3,372
1,000-ft.	263	132	5,197	60	193	.....	5,845	182	21,800	20,000	41,800
1,200-ft.	3,233	306	850	186	.....	.....	4,575	1,264	7,600	20,377	27,977
1,400-ft.	2,408	270	1,425	199	.....	.....	4,302	1,413	14,800	12,200	27,000
1,600-ft.	2,478	560	263	273	.....	.....	3,574	3,620	.....	21,346	21,346
1,800-ft.	588	43	.....	145	.....	.....	776	.....	.....	29,781	29,781
2,000-ft.	.....	.....	.....	184	.....	.....	184	.....	.....	.....	.....
Total...	11,144	1,530	8,507	1,047	193	20	22,441	6,970	47,572	115,863	163,435

SUMMARY OF ORE AND WASTE HOISTED FOR THE YEAR 1928

Level	Ore from development	Ore from mining	Waste
	tons	tons	tons
200-foot	200	.....	2,435
400-foot	2,973	16,239	17
600-foot	2,476	26,208	116
800-foot	10,067	120,309	163
1,000-foot	20,321	76,833	15,956
1,200-foot	23,378	11,735	12,390
1,400-foot	18,757	22,769	8,066
1,600-foot	11,586	.....	15,444
1,800-foot	3,078	.....	6,711
2,000-foot	86	.....	5,960
Total	92,922	274,093	67,258

SUMMARY OF DEVELOPMENT AND EXPLORATION WORK SINCE BEGINNING OF OPERATIONS

	Feet
Drifting	38,335
Crosscutting	8,134
Raising	21,806
Sinking	4,462
Ore-passing	1,754
Winze	245
Diamond-drilling	23,409
	Cu. ft.
Box-holing	166,011
Station-cutting	277,989
Sump	26,239

Milling

The mill operated very satisfactorily during the year, and results obtained through double filtration have been very gratifying. An additional ball and tube mill were installed during the latter part of the fiscal year, as well as a Symons cone crusher, filters, presses, and refinery equipment.

The increased tonnage opened up underground has made additional milling equipment necessary and three ball mills and six tube mills, together with the necessary tanks, filters, and other equipment, have been ordered and when installed will effect a material increase in milling capacity.

Costs

No special attempt has been made during the year to bring the cost per ton milled, as given below, to a minimum. The slightly high figures are favourably reflected in the amount of ore placed in sight and the development on the lower levels, as well as the increase in broken ore reserves.

	Total cost	Cost per ton
Development	$856,540.97	$2.34
Mining	947,169.03	2.58
Milling and refining	448,201.56	1.22
General and administrative expense	73,631.64	.20
Total	$2,325,543.20	$6.34
Depreciation	297,199.86	.81
Grand total	$2,622,743.06	$7.15

General

The most interesting item of the year's work was the opening up of a vein system parallel to No. 2 vein, which has been proven to exist from the 200- to the 1,600-foot levels. This will compare favourably in grade to No. 2 vein, and is known to extend from our western boundary east to a point near the Wright-Hargreaves line.

The problem of mine backfilling has already been considered, and gravel claims to the east have been secured. Preliminary work, preparatory to handling daily tonnage of material from these claims, is now in progress.

New shops of fireproof construction are now being erected. Plans for a new office building have been completed, and construction is now under way.

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 eighteenth annual report of the company, for the fiscal year ending March 31, 1929:—

Gross production and earnings exceed any figure previously established. Ore reserves now gross $19,417,424, with an average grade of $8.30 per ton. Comparing this total with $16,179,205, of $8 grade, as reported in the previous year, and having regard for this year's gross mine production of $4,657,188, it will be seen that the ore developed in the period under review had an estimated gross value of $7,895,407.

The company continues to pursue an aggressive development policy and constantly studies its probable future requirements, having regard for increased efficiency and economic capacity.

Research work in connection with our milling practice, while not yet definitely conclusive, has been productive of results reflecting great credit upon those conducting the work, and the information thus obtained is being carefully considered with a view to determining whether or not we may be warranted in changing our milling practice.

ASSETS			
CURRENT ASSETS:			
Cash in banks and on hand		$184,370.65	
Bullion in transit		138,617.61	
Call loan		700,000.00	
Marketable securities (at market or less)		2,331,378.50	
Accounts receivable		4,127.97	
Interest receivable		24,767.67	
Supplies on hand at cost		270,770.29	
			$3,654,032.69
INVESTMENTS IN SUBSIDIARY COMPANIES:			
Blue Diamond Coal Co., Limited, and Canadian Coal Fields, Limited		$853,492.23	
McIntyre Mercantile Co., Limited		1.00	
			853,493.23
FIXED ASSETS:			
Mining properties		$4,194,339.97	
Plant and equipment:			
April 1, 1929	$3,550,986.84		
Net additions this year	139,083.37		
		3,690,070.21	
			7,884,410.18
DEFERRED CHARGES:			
Operating and administrative prepayments			30,633.95
			$12,422,570.05
LIABILITIES			
CURRENT LIABILITIES:			
Payrolls payable		$65,432.33	
Accounts payable		47,143.58	
Provision for municipal, provincial, and Dominion taxes		176,817.41	
Provision for sundry liabilities		25,718.19	
			$315,111.51

LIABILITIES—*Continued*

RESERVES:			
General reserve		$400,000.00	
Reserve for depreciation of plant and equipment		3,559,318.81	
			3,959,318.81
CAPITAL LIABILITIES:			
Capital stock authorized, 800,000 shares at $5 par value		$4,000,000.00	
Capital stock issued, 798,000 shares at $5 par value			3,990,000.00
Surplus			4,158,139.73
			$12,422,570.05

The profit and loss statement for the year ending March 31, 1930, is as follows:—

EARNINGS:			
Bullion recovery			$4,457,000.97
OPERATING COSTS:			
Mining and development	$1,716,515.55		
Crushing and conveying	83,716.68		
Milling	380,391.37		
Miscellaneous camp costs	49,421.27		
		$2,230,044.87	
ADMINISTRATIVE AND GENERAL EXPENSE:			
Management and general expense, mine	$97,636.09		
Administrative and general expense, Toronto office	81,874.45		
Transfer, registrar, stock issue, and dividend expense	6,766.53		
Insurance	14,842.11		
		201,119.18	
Total operating costs, before providing for taxes and depreciation			2,431,164.05
Operating profit, before providing for taxes and depreciation			$2,025,836.92
NON-OPERATING REVENUES:			
Interest and discounts earned		$148,678.90	
Miscellaneous earnings		19,981.90	
			168,660.80
			$2,194,497.72
APPROPRIATIONS:			
Provision for municipal, provincial, and Dominion taxes for current year			122,197.90
Net profit for the year, before depreciation provision, transferred to surplus account			$2,072,299.82

The following is the surplus account:—

Surplus as at April 1, 1929			$3,809,536.48
Add net profit, year ending March 31, 1930, before providing for depreciation			2,072,299.82
			$5,881,836.30
DEDUCT:			
Dividend No. 42, June 1, 1929		$199,500.00	
Dividend No. 43, Sept. 3, 1929		199,500.00	
Dividend No. 44, Dec. 2, 1929		199,500.00	
Dividend No. 45, Mar. 1, 1930		199,500.00	
		$798,000.00	
Provision for depreciation, buildings, and equipment		258,304.91	
Development undistributed, mine—written off		157,888.35	
Development expenditures on outside properties—written off		96,614.47	
Sundry adjustments		12,888.84	
Amount transferred to general reserve		400,000.00	
			1,723,696.57
Surplus as at March 31, 1930			$4,158,139.73

The following data are from the report of the general manager, R. J. Ennis, for the year ending March 31, 1930:—

PRODUCTION

Ore treated.....tons	550,495
Value per ton	$8.46
Gross value	4,657,188.00
Bullion recovered	4,433,626.45
Bullion recovered per ton	8.05
Bullion contained:	
Gold, 213,291.940 fine ounces	$4,408,936.89
Silver, 51,627.807 fine ounces	24,689.56
Premium on U.S. funds	23,374.52
	$4,457,000.97

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
Total		4,802,573	$9.12	$43,783,896.27	$8.63	$41,455,948.91

MINING

	Tons
Ore broken in stopes	520,451
Ore from development	73,008
Total	593,459
Ore hoisted	550,593
Waste hoisted	3,528
Total	554,121
Waste used as back-fill	112,893

The ore broken in the mine during the year amounted to 593,459 tons, an increase of 23.5 per cent. over the preceding year; 550,593 tons were hoisted, and broken ore reserves increased by 42,866 tons. During the year 45 per cent. of production came from cut-and-fill stopes.

The following is a summary of ore hoisted from the different levels; no stoping has yet been done on the levels below the 2,875-foot. The tonnage hoisted from these levels consisted of ore and vein material broken in development work.

Level	Tons	Assay	Value
500-foot	52	$4.50	$233
600-foot	84	3.75	314
1,000-foot	322	15.05	4,845
1,250-foot	210	2.20	461
1,375-foot	36,409	7.80	285,067
1,500-foot	27,357	6.60	180,971
1,625-foot	16,750	6.70	112,079
1,750-foot	42,420	7.35	311,889
1,875-foot	56,499	7.00	396,353
2,000-foot	57,729	10.55	607,925
2,125-foot	45,910	8.20	376,327
2,250-foot	26,987	11.80	318,434
2,375-foot	87,991	6.20	546,561
2,500-foot	84,296	9.05	762,876
2,625-foot	29,064	11.70	340,492
2,750-foot	3,811	9.40	35,762
2,875-foot	11,744	7.85	92,311
3,000-foot	4,980	11.95	59,446
3,125-foot	2,882	5.15	14,910
3,250-foot	2,231	3.50	7,867
3,375-foot	5,477	3.75	20,472
3,500-foot	822	2.25	1,840
3,625-foot	12	2.00	24
3,750-foot	2,773	4.00	11,092
3,875-foot	3,781	4.50	16,015
Total	550,593	$8.15	$4,504,566

Development

Development work performed during the year amounted to 27,895 feet, a decrease of 6,476 feet from that of last year. This work included 17,271 feet of drifts, of which 2,540 feet was on line and 14,731 feet in vein material; 8,267 feet was in ore of $10 grade over drift width. Advance in ore was 34 per cent. greater than last year and is reflected in the estimate of ore reserves.

No. 3 Vein.—Stopes produced 118,116 tons of an average grade of $8 per ton. From the 1,500-, 1,625-, and 2,125-foot levels, a total of 3,241 feet of drifting was done, of which 1,041 feet was in ore of $12 grade over drift width.

No. 5 Vein.—Stopes produced 22,131 tons of an average grade of $8.90 per ton. A small amount of sublevel development work was done on the lower levels of this vein.

No. 7 Vein.—Stopes produced 129,391 tons of ore, of an average grade of $10 per ton. On the 2,500-, 2,625-, and 2,750-foot levels, 991 feet of drifting was done, of which 398 feet was in ore of $10 grade over drift width.

No. 8 Vein.—Stopes produced 15,563 tons of ore of an average grade of $8.90 per ton. No development work was done on this vein during the year.

No. 9 Vein.—Stopes produced 43,926 tons of ore, of an average grade of $9.10 per ton. On the 3,375- and 3,875-foot levels, 492 feet of development work was done, of which 238 feet was in ore of $8 grade over drift width.

No. 10 Vein.—Stopes produced 52,850 tons of ore, of an average grade of $6.30 per ton. On the 3,000-, 3,125-, and 3,875-foot levels, 1,053 feet of drifting was done, of which 666 feet was in ore of $15.80 grade over drift width.

No. 12 Vein.—Stopes produced 1,306 tons of low-grade ore. On the 2,000-, 2,125-, 2,250-, and 2,375-foot levels, 1,268 feet of drifting was done, of which 566 feet was in ore of $14.50 grade over drift width.

No. 13 Vein.—Stopes produced 40,364 tons of ore of an average grade of $9 per ton. On the 1,875-, 2,000-, 2,125-, 2,500-, 2,625-, 2,750-, 2,875-, 3,000-, 3,125-, 3,250-, and 3,875-foot levels, 3,623 feet of drifting was done, of which 1,874 feet was in ore of $11.10 grade over drift width.

No. 14 Vein.—Stopes produced 26,700 tons of ore, of an average grade of $7.60 per ton. On the 1,625-, 1,750-, 1,875-, 2,000-, 2,125-, 2,250-, 3,375-, and 3,875-foot levels, 3,617 feet of drifting was done, of which 1,656 feet was in ore of $6.25 grade over drift width.

No. 15 Vein.—On the 2,250-, 2,375-, and 3,875-foot levels, 1,051 feet of drifting was done, of which 545 feet was in ore of $5.50 grade over drift width. This is a new vein lying in a break south and east of No. 14 vein in the eastern part of the property.

No. 16 Vein.—Stopes produced 32,003 tons of ore, of an average grade of $9.20 per ton. On the 2,125-, 2,250-, 2,375-, and 2,500-foot levels, 1,861 feet of drifting was done, of which 1,369 feet was in ore of $8 grade over drift width.

No. 11 Shaft.—Ore handling facilities at No. 11 shaft were completed in October, and since then the full mine tonnage has been raised through this shaft. The completion of this work has enabled us to pursue development on most of the veins previously exposed in this area, from the 1,500-foot level down to the 3,875-foot.

Favourable developments on the upper levels necessitated stations at the 1,375- and 1,625-foot horizons and these have been cut, working from the No. 6 shaft or west side, without interruption, to No. 11 shaft operation.

On the levels below the 2,875-foot, a total of 6,422 feet of drifting has been done to date; 3,597 feet, or 56 per cent., was in ore of average grade over drift width. This record is better than the average obtained throughout the mine.

Mining operations on the 3,875-foot have until recently been confined to main drives and crosscuts. Drifting on veins commenced the latter part of the year, and 1,150 feet of drifting has opened up 205 feet of ore averaging $6 over drift width. As development work proceeds on the veins exposed, we anticipate results equal to the mine average.

ORE RESERVES, 1929-30

	Tons	Assay	Value
McIntyre claims	695,205	$7.20	$4,981,717
McIntyre Extension claims	157,368	10.50	1,659,598
Jupiter claims	1,076,462	9.40	10,073,952
Plenaurum claims	164,095	6.40	1,048,755
	2,093,130	$8.50	$17,764,022
Broken ore	252,546	6.50	1,653,402
Total	2,345,676	$8.30	$19,417,424

SUMMARY OF DEVELOPMENT AND EXPLORATION, 1929-30

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.	feet	cu. ft.	feet
1	1,145	1,071	37	.....	.....	5,280	.....	.....	2,253	5,280	2,201
2	1,128	1,081	111	.....	.....	11,240	.....	.....	2,320	11,240	1,917.5
3	1,449	834	237	.....	.....	.....	.....	.....	2,520	.....	2,678
4	1,384	857	289	.....	.....	.....	.....	.....	2,530	.....	2,621
5	1,594	736	163	.....	.....	.....	.....	.....	2,493	.....	2,869
6	1,152	730	83	.....	.....	.....	.....	.....	1,965	.....	2,783
7	1,279	666	31	.....	.....	.....	.....	.....	1,976	.....	2,650
8	1,358	574	34	.....	.....	.....	.....	.....	1,966	.....	2,284
9	1,364.5	459.5	305	.....	.....	.....	.....	.....	2,129.5	.....	2,459
10	1,718.5	244	397	.....	.....	14,904	.....	.....	2,359	14,904	2,486
11	1,856	434	384	.....	.....	.....	.....	.....	2,674	.....	2,384
12	1,843	547	410	.....	.....	1,800	.....	.....	2,800	1,800	2,377
Total	17,271	8,233.5	2,481	.....	.....	33,224	.....	.....	27,985.5	33,224	29,709.5
Previous years	130,230.3	65,150.3	14,310.4	579.7	12,619.9	622,920	36,823	139,699	222,890.6	799,442	212,044.5
Total	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

OPERATING COSTS

	Total	Per ton milled
MINING:		
Exploration	$52,442.41	$0.0953
Development	402,727.23	.7315
Breaking and stoping	1,247,236.41	2.2657
Examination of prospects	14,109.50	.0256
Total mining costs	$1,716,515.55	$3.1181
Crushing and transportation	$83,716.68	$0.1521
Milling	380,391.37	.6910
Heating and maintenance, buildings and camps	49,421.27	.0897
Bullion marketing and general expense, mine office	97,636.09	.1773
Administration and general expense, Toronto office	88,640.98	.1611
Insurance, general	14,842.11	.0270
Total	$2,431,164.05	$4.4163

ANALYSIS OF MINING COSTS PER TON MILLED

	Stoping	Drifting	Cross-cutting	Raising	Stations and sumps	Total cost	Cost per ton
Labour	$583,531.44	$140,613.75	$60,099.05	$40,585.90	$3,756.98	$828,587.12	$1.5052
Explosives	88,354.77	56,462.90	23,658.84	6,628.38	297.18	175,402.07	.3186
Supplies	50,388.46	18,914.20	11,146.55	21,434.08	2,017.50	103,900.79	.1887
Power	37,469.02	7,827.45	3,219.80	2,680.52	130.30	51,327.09	.0932
Timbering	147,550.94	.....	215.80	843.72	3,567.32	152,177.78	.2764
Shaft repairs	7,695.52	.....	.....	.....	.....	7,695.52	.0140
Back-filling	55,277.85	.....	.....	.....	.....	55,277.85	.1004
Steel-sharpening	29,814.14	16,691.64	7,120.68	2,559.36	156.79	56,342.61	.1023
Drill repairs	13,008.72	4,010.38	1,649.42	1,369.46	100.69	20,138.67	.0366
Surveying and engineering	23,252.70	5,460.97	2,132.63	2,002.80	122.82	32,971.92	.0599
Sampling and assaying	36,218.66	3,021.42	1,360.28	1,136.05	.....	41,736.41	.0758
Pumping	4,815.11	1,786.43	3,202.27	158.46	.....	9,962.27	.0181
Ventilating	6,225.45	3,310.87	1,695.40	867.20	106.29	12,205.21	.0222
Tramming	66,991.36	22,175.85	10,950.42	4,481.71	160.13	104,759.47	.1903
Surface tramming	.....	1,809.67	1,308.28	728.33	311.51	4,157.79	.0076
Hoisting	96,642.27	29,310.00	15,991.27	8,388.29	877.59	151,209.42	.2747
Total	$1,247,236.41	$311,395.53	$143,750.69	$93,864.26	$11,605.10	$1,807,851.99	$3.2840
Less: Charged to undistributed development	.....	.....	74,050.68	72,232.57	11,605.10	157,888.35	.2868
	$1,247,236.41	$311,395.53	$69,700.01	$21,631.69	.....	$1,649,963.64	$2.9972
Exploration	.....	.....	.....	.....	.....	52,442.41	.0953
						$1,702,406.05	$3.0925
Examination of prospects	.....	.....	.....	.....	.....	14,109.50	.0256
Total	.....	.....	.....	.....	.....	$1,716,515.55	$3.1181
Unit cost per ton	$2.2657	$0.5656	$0.1266	$0.0393	.....	.....	.....

Milling

The cyanide mill operated continuously at full capacity during the year. To confirm laboratory experiments a flotation unit was installed in November. It is now handling 200 tons of ore per day with very satisfactory results and it has demonstrated that this method is applicable to the treatment of McIntyre ores, with a reduction in costs and improved metallurgical results.

MILLING COSTS

	Labour	Supplies	Repairs and maintenance	Power	Total	Costs per ton
Ball milling	$8,078.66	$25,719.39	$345.60	$12,396.75	$46,540.40	$0.0845
Tube milling	7,896.71	53,573.94	748.40	29,541.22	91,760.27	.1667
Classification	7,777.18	3,484.56	947.45	3,714.68	15,923.87	.0289
Flotation	4,606.66	4,413.53	178.20	2,876.08	12,074.47	.0219
Pumping and elevating	6,006.98	4,683.65	668.60	4,144.01	15,503.24	.0282
Agitation	6,006.98	2,275.98	367.80	5,993.52	14,644.28	.0266
Thickening	6,006.98	2,251.97	361.20	2,197.37	10,817.52	.0197
Clarification	8,793.29	3,428.62	474.20	1,666.00	14,362.11	.0261
Precipitation	6,366.29	12,408.12	91.40	2,048.53	20,914.34	.0380
Re-agents	.....	69,585.91	.....	.....	69,585.91	.1264
Filtration	15,113.34	3,964.68	589.50	3,472.47	23,139.99	.0420
Refining and assaying	15,580.43	6,727.03	192.30	510.18	23,009.94	.0418
Heating	.....	5,184.72	106.60	.....	5,291.32	.0096
Tailings disposal	4,788.57	7,024.00	2,567.15	2,443.99	16,823.71	.0306
Total	$97,022.07	$204,726.10	$7,638.40	$71,004.80	$380,391.37	$0.6910

ADDITIONS TO PLANT, BUILDINGS, AND EQUIPMENT

Cyanide mill	$17,953.94
Crushing plant, loading and discharging bins	90,407.44
Workshops and equipment	1,233.24
Surface transportation and railway siding	16,690.03
Office equipment	643.72
General buildings	2,822.06
Fire equipment	1,069.43
Medical department	3,041.42
Hoisting equipment	1,725.20
Heating equipment	10,777.81
Underground equipment	100,194.60
	$246,558.89

ADDITIONS TO PLANT, BUILDINGS, AND EQUIPMENT—*Continued*

Less construction incomplete March 31, 1929	$102,084.19
	$144,474.70
Add construction incomplete March 31, 1930	10,589.85
	$155,064.55
Less equipment and buildings sold or demolished	15,981.18
	$139,083.37

General

The volume and grade of the ore reserves were increased during the year, largely through the opening up of veins adjacent to No. 11 shaft. Results obtained from this development, as far as it has proceeded, are quite satisfactory, and warrant the expectation of continued success.

McMillan Gold Mines, Limited

This company has a capitalization of 3,000,000 shares of $1 par value. The officers and directors are: John H. Banks, president; G. A. Foot, vice-president; C. B. Goldsborough, secretary-treasurer; Dr. F. C. Fraser, E. J. McMillan, Geo. Arents, W. J. Galligan, R. L. Patterson, and F. Davison, directors. The head office is at Sudbury.

The property held by this company consists of 36 claims in Mongowin and Scadding townships, district of Sudbury.

The president's report for the year ending December 31, 1929, gives the following information:—

Up to the suspension in November, the work done in 1929 was as follows:—

	Feet
325-FOOT LEVEL:	
Drifting west of shaft	7
Drifting east of shaft	240
Crosscutting west of shaft	47
Crosscutting east of shaft	46
425-FOOT LEVEL:	
Drifting east of shaft	345
Crosscutting east of shaft	38
Winze east of shaft	10
Raises (2) east of shaft	32
DIAMOND-DRILLING:	
From surface, 4 holes	1,260
From 525-foot level, 2 holes	778

Including that prior to 1929, the total work done to date is approximately as follows:—

	Feet
Diamond-drilling (10 holes)	4,388
Sinking	560
Crosscutting	1,740
Drifting	3,480
Raising (for diamond-drill set-ups)	32

Operations were suspended in November, 1929, owing to lack of funds. E. J. McMillan was in charge of the property.

March Gold, Limited

This company has an authorized capitalization of $1,500,000, divided into shares of $1 par value each. The shares formerly had a par value of 10 cents, but the change was ratified at a meeting of shareholders held June 15, 1927. The parent company in the United States has a capitalization of $3,500,000, divided into shares of $1 par value each.

The officers of the company are: Henry Kobler, president; B. C. Conderman, vice-president; Samuel B. Darlich, secretary; F. J. C. Bull,

treasurer; Bernard N. Hyman, chairman of the board. M. Knutson is manager at the property. The directors of the company are: Bernard N. Hyman, Henry Kobler, Samuel B. Darlich, Geo. R. Feine, F. J. C. Bull, Charles J. Schmidt, Henry Tiedt, Gustave Loesch, and Jacob Schwingel, all of Buffalo, N.Y., and B. C. Conderman of Hornell, N.Y. The head office of the company is at 402 Wallbridge Building, Buffalo, N.Y., and the mine office address is Box 533, South Porcupine, Ont.

The company owns five claims in the township of Deloro, district of Cochrane. These claims comprise H.R. 823, H.R. 833, and H.R. 900 of the original March group and the Maidens-McDonald group, H.R. 832 and H.R. 926, purchased from the Coniagas Mines, Limited.

There are five shafts sunk on the property, No. 1 situated on H.R. 823 being the first sunk by the March Gold, Limited, to a depth of 800 feet. No work has been done through this shaft for several years. No. 2, an incline, 60° N., is sunk on H.R. 833 to a depth of 190 feet and is connected at the 170-foot level with No. 3, a vertical three-compartment shaft located on H.R. 833.

An inclined shaft, known as No. 4, located on H.R. 832, is sunk along No. 6 vein at 65° N. to a depth of 220 feet (vertical), the work having been done by the original holders. This shaft is now connected with No. 3, which lies 460 feet to the southwest.

A vertical shaft sunk to a depth of 115 feet on H.R. 833 is not connected with other workings of the March or Maidens-McDonald groups. The plant erected at this shaft has been dismantled.

All underground work of the past year has been confined to claims H.R. 926 and 832. The total development footage for the year ending December 31, 1929, is as follows:—

	Feet
Crosscutting	189
Drifting	1,100
Sinking winze	101

The mill operated throughout the year with a total production of $256,303.51.

There were employed at the property during the year about 85 men.

Metals Development, Limited

This company is capitalized at $2,500,000, in shares of $1 par value. There are 1,896,818 shares issued.

The following is a list of officers and directors of the company: Dr. M. H. Lebel, of Montreal, president; W. R. Salter, vice-president; M. F. Blue, secretary; H. S. Crabtree and H. Borgford, of Toronto; Auguste Decoy, Dorval; W. J. Evans and T. E. Armstrong, New Liskeard; and J. P. Sherry, Memramcook, N.B. J. W. Morrison is consulting engineer.

The company is interested in several claims in the North Clearwater lake section, district of Kenora (Patricia portion). The property is best reached from Woman lake. A fair road, about a mile in length, has been built to the camp location on claim No. 5,603.

Surface work has been done on 17 claims and has shown up several long breaks and many different geological conditions. Two systems of veins have been located.

The veins first located had a strike almost due north, but the most promising occurrence of gold is in a vein of banded quartz on claim No. 5,603, which strikes N. 47° E. and dips 50° S. Minerals found in this vein are galena, sphalerite, pyrite, some chalcopyrite, and gold.

When inspected in July, 1929, an inclined shaft had been put down on the vein to a depth of 100 feet, and 61 feet of drifting on the vein had been

accomplished. This work has all been in ore of a fair grade, showing spectacular free gold in places.

The property is equipped with a Sullivan portable compressor, 125-cubic-foot capacity, gasoline driven, and a small Turbo hoist driven by the compressor. A horse whim was in process of construction in July. New camp buildings have been put up on claim No. 5,603 sufficient to house 20 men.

When inspected, 7 men were employed on the property. J. C. Nelson is manager.

Mineral Research Corporation

The company is operating on the old Davidson-Carr property located in Thunder Bay district, at the north end of Northeast bay of Sturgeon lake, about six miles by direct line east of the St. Anthony mine. The property can be reached by water from Sturgeon lake proper, or from a point on the Canadian National railway, five miles east of Savant Lake station. The route is across Buckingham lake, with a portage of a mile and a quarter into Northeast bay, and a short paddle to the mine. The winter road starts from a point on the west shore of the bay due west of the mine, and terminates five miles away at mileage 76 on the Canadian National railway, where supplies are put off for the property.

In the winter of 1928-29, a small steam plant was installed on the property and the following camp buildings were erected: headframe, 18 feet high; hoist-house and blacksmith shop combined, 12 by 20 feet; boiler-room and compressor house combined, 30 by 15 feet; office, 18 by 20 feet; bunk-house for twenty-six men, 22 by 40 feet; stable, 14 by 14 feet; and icehouse, 10 by 10 feet.

Underground operations consisted of sinking a 60-degree inclined shaft on the vein to a depth of 160 feet, and doing 30 feet of drifting on the 130-foot level and 230 feet on the 160-foot level. At the time of inspection on July 10, 1929, the mine was partially filled with water, and underground operations for the present were discontinued. A diamond-drill campaign was in progress from the surface, of which 424 feet had been done in two holes.

Three veins besides the one sunk on have been located on the surface. The vein system has a general strike of N. 45° W. and dips 60° N.

Twelve men were employed on the property. A. R. Globe is in charge of operations.

Moss Mines, Limited

This company has an authorized capital of 4,000,000 shares of $1 par value, of which 2,678,293 shares have been issued. The officers are: Norman R. Fisher, president and managing director; Alistair Fraser, vice-president; James Cooper, secretary-treasurer. The directors are: R. Blackburn, C. Z. Gzowski, F. B. Little, J. D. Paterson, and F. M. Rose.

The head office is at 75 Sparks Street, Ottawa, and the executive offices are at 132 St. James Street, Montreal.

Moss Mines, Limited, hold some 900 acres in Moss township, district of Thunder Bay, including what was known as the Huronian mine. The property is situated on Jackfish lake, and supplies are brought in from Kashabowie, 80 miles west of Fort William on the Canadian National railway, over a 26-mile route.

Underground work was carried on continouusly throughout 1929 from the new vertical three-compartment shaft, which was completed to 400 feet in 1928. Levels were opened up on the 125-, 250-, and 375-foot horizons. A total of 3,848 feet of drifting and crosscutting was accomplished during the year 1929.

Nothing tangible was done towards installing a mill, but the installation of one is planned for the near future.

The company employed an average of 29 underground and 25 surface workers during the year.

J. G. Harkness is mine superintendent.

Patricia Dent Gold Mines, Limited

This company is interested in a group of claims about four miles north of the Jackson-Manion on the west shore of Clearwater lake, district of Kenora (Patricia portion).

Two shafts have been sunk, each to a depth of 50 feet. These are on claims Nos. 4,134 and 4,135. There are many small breaks on the property, and these have been much trenched. There is camp accommodation for 20 men. When inspected in July, 1929, there were 7 men employed. The work was in charge of J. C. Dodd.

Polaris Gold Mines of Canada, Limited

This company was incorporated under the laws of Ontario on January 5, 1928, with a capitalization of 5,000,000 shares, par value $1. There are 2,660,000 shares issued, of which 2,500,000 are for property.

The officials of the company are as follows: Ralph T. Polk, president; Manley D. Davis, vice-president; Harry Thompson, secretary-treasurer; all of Detroit, Mich. W. C. Churchill, Detroit, R. F. Stibbard, Timmins, W. E. F. Paine and J. H. S. Kerr, Toronto, are directors.

The holdings of the company are: 4 claims, Nos. 13,362, 13,365, 13,363, and 13,367, in the township of Mountjoy; 6 claims due east of claim P. 13,650 in the township of Jamieson, Kamiskotia area; and 4 claims in Whitney township, previously known as the Fitzgerald veteran claims, all in the district of Cochrane.

The activities of the company have been centred for the most part on the Mountjoy claims. The company started clearing and erecting a plant on May 15, 1928, and sinking began in August.

The plant consists of a single-drum Jenckes steam hoist, 8 by 12 inches; air compressor, 250 cubic foot per minute capacity; a 3- by 8-foot air receiver; and a 70 h.p. boiler, all housed in one building, 30 by 30 feet. There is also on the property a blacksmith shop and storehouse combined, 14 by 32 feet, and an office and first-aid room combined, 12 by 16 feet. Two cottages were built for the management.

The shaft has two compartments, the hoisting compartment being 4 feet 10 inches by 4 feet 9 inches. The shaft on April 15, 1929, had reached a depth of 216 feet.

While sinking was in progress there was an average of 14 men employed on the property.

The property stopped operations on April 15, 1929. When work is again resumed it is planned to place more equipment, capable of going to 1,000 feet.

W. C. Churchill was manager until the shut-down.

Porcupine United Gold Mines, Limited

The Porcupine United Gold Mines, Limited, has an authorized capital of 1,500,000 shares of $1 par value, all of which is issued to the Porcupine United Gold Mines, Incorporated, except the qualifying shares issued to the directors.

The officers of the company are as follows: Bernard N. Hyman, president; Ray M. Stanley, vice-president; Henry Kobler, treasurer; Samuel B. Darlich, secretary; Charles Schmidt, director, all of Buffalo, N.Y. The

head office is located at 330 Wallbridge Building, Buffalo, N.Y. Offices are also maintained by Colonel Newton M. Young in the Excelsior Life Building, Toronto. The mine office is at Timmins, Ont.

Porcupine United Gold Mines, Incorporated, is organized under the laws of Delaware with a capitalization of 3,500,000 shares of fully paid and non-assessable stock of the par value of $1 a share. The officers of the company are the same as those of the limited company and the following are the directors: Charles Schmidt, William Kam, Gustave Loesch, Herman Mayer, George Feine, all of Buffalo, and Mark P. Murtha, of New York. The offices are the same as those of the limited company.

The group of claims in actual development are those adjoining the Hollinger mine and formerly worked as the Rochester mine. All the work on the property is concentrated on claim No. 13,427.

The property, acquired under option late in 1928, was dewatered to the 500-foot level and sampled. Later the mine was completely dewatered to the 900-foot level, the lowest workings.

Short, narrow, high-grade veins, showing native gold, which had been previously developed by other operators and to some extent by this company, are being stoped and the ore treated in a small mill erected in the early part of 1929.

The following is a summary of the ore treatment: An ore bin of small capacity in the headframe of the shaft supplies the feed to a 10- by 7-inch jaw crusher. Passing through a small set of rolls, the ore is carried by conveyer belt to the mill and hoisted by a bucket elevator to a second mill-feed bin.

The ore is ground in a Hardinge ball mill, diameter 4½ feet, and the discharge is to two 8- by 4-foot copper amalgamating plates with blankets at the foot. The plates discharge to a Dorr drag classifier in closed circuit with the ball mill and plates. The overflow of the classifier goes to two James tables, the concentrates from which are sent to the March Gold mill for cyanidation. About 70 per cent. of the gold is caught on the plates and blankets. The mill is treating about 15 tons daily.

There are 21 men employed at the property. Jos. T. Baldwin is manager, and R. A. Vary is in charge of the mill.

Power and Mines Corporation, Limited

The officers and directors of the company during 1929 were: Sir Frederick O. W. Loomis, president; R. C. Alwin, secretary-treasurer; Granville Gilmore, R. A. Darwin, Nap. G. Kirouac, H. C. Perchard, and W. H. Perram, directors.

The authorized capital stock of the company consists of 300,000 seven per cent. cumulative preference shares, $5 par value, of which 30,000 shares have been issued, and 1,500,000 common shares of no par value, all issued.

The company operates the Grace mine, Michipicoten area, district of Algoma. Underground development work, consisting of some drifting and crosscutting on the 2nd, 3rd, and 4th levels, was carried on until March, 1929, when underground operations were discontinued and a programme of surface exploration was commenced. Underground operations were not resumed until 1930.

During 1929, a 50-ton pilot test mill, using combined amalgamation and flotation, was installed to replace the old California stamp battery, which was in commission nearly thirty years ago.

An average of 30 men was employed, 12 underground and 18 on surface. J. A. S. Roussac was succeeded by C. A. Chisholm as manager of the property. Operations were suspended in the spring of 1930 due to lack of finances.

The head office is at 1254 St. Catherine Street West, Montreal.

Ridgedome Mines, Limited

Ridgedome Mines, Limited, has a capitalization of 3,000,000 shares of $1 par value, of which 1,870,515 shares have been issued. The following is a list of the officers and directors: D'Arcy D. Bogue, president and treasurer; Ernest Dussault, vice-president; James E. Bogue, secretary; Arthur Bethiaume and E. H. Rayner, directors. The head office is at 104 St. James Street, Montreal.

The company is interested in 16 claims in Ogden township and 17 claims in Fripp township, all in the Porcupine mining area. Operations during 1929 were all carried out on the Ogden property, some 5½ miles south of Timmins.

A small mining plant consisting of a Jenckes hoist, 6 by 8 feet, a two-drill Alley McLellan air compressor, and a 50 h.p. locomotive-type boiler was installed in the early summer. Sinking commenced in August, the shaft being put down past the 125-foot horizon and a level started. About 70 feet of crosscutting was done, cutting the vein about 20 feet from the shaft. A small amount of drifting was also accomplished. The shaft is situated on claim T.R.S. 1,178. Considerable trenching has been done on claims P. 13,934 and 13,935. Underground work was discontinued in the winter, and a diamond-drill programme started. Eight men were employed on the property at underground work. C. J. B. Armstrong is in charge of operations.

Ritchie Gold Mines, Limited

Ritchie Gold Mines, Limited, has a capital of 3,000,000 shares of $1 par value. The officers and directors of the company are: O. E. Earle, president; J. J. Byrne, vice-president and managing director; G. M. Hagen, secretary-treasurer; A. P. Earle and T. J. Day. The head office is at Room 607, 11 King Street West, Toronto. The property is situated in Gauthier township, district of Timiskaming.

The following work was done during the year: sinking, 528 feet; stations, 81 feet; crosscutting, 698.7 feet; drifting, 444.5 feet; and diamond-drilling, 2,000 feet. The mine closed in December, 1929.

On an average, 15 men were employed during the year.

St. Anthony Gold Mines, Limited

The St. Anthony Gold Mines, Limited, is capitalized at $3,000,000 in shares of $1 par value, 1,757,252 of which have been issued.

The officers of the company are: A. E. Matthews, president; T. S. Giles, secretary; A. S. Dickson, treasurer; R. W. Brigstocke, A. R. Osborne, T. Magladery, W. F. Jamieson, and G. W. Ecclestone are directors. The head office is in the Toronto General Trusts Building, Toronto, and the mine office address is Savant Lake, Ont.

The company holds 11 claims, H.W. 744-46, B.G. 151-54, H.W. 699, S.V. 415, S.V. 396 (power site), and B.G. 168, in the Thunder Bay district, Sturgeon lake area. It is also interested in 45 claims in Montbray township, Quebec.

The Sturgeon lake property was first worked about 1900, and as early as 1902 two shafts, each 100 feet deep, had been sunk and considerable open cut work done. It was in active operation and produced until 1908. The most recent attempt at operation was made in 1917 when the Kerr Lake Mining Company of Cobalt did 1,500 feet of drifting and crosscutting and 250 feet of raising and sinking. The mill was also run for a short time for sampling purposes at this time.

There are five levels, and stoping has been done on the four upper ones. The deepest working is the 500-foot horizon.

The present company started work on the property on October 14, 1928, doing 3,000 feet of diamond-drilling from surface. After the freeze-up

45 car loads of supplies, mostly coal, were freighted to the mine by tractors from Savant Lake station on the Canadian National railway, a haul of about 12 miles.

Early in the new year the dewatering of the shaft and workings started and was completed in May, by which time the old upper workings had been completely sampled.

At the time of inspection in July, 1929, the mill was nearly ready to operate. The mill is of an early design, and it is expected that a cyanide unit will be added, with a view to making a better recovery than former operators and also to treating the old tailing dump. This dump is supposed to contain 30,000 tons of $3.50 grade.

The mine is reached in summer by a 3½-mile road from Savant Lake to the north end of Sturgeon lake and from there by water for about 8½ miles. The company at present operates a 36-foot motor launch on Sturgeon lake. The route is the same in winter.

There were at the time of inspection 33 men on the payroll. H. A. Swart is superintendent at the property.

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; Ralph Hochstetter, Oliver Cabana, and James Y. Murdoch, 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, 1930, is as follows:—

Production

During the period, 75,408 tons of ore were milled with bullion recovery of $690,400.14, or an average recovery per ton milled of $9.16. The mill ran 97.3 per cent. of the possible time and treated an average of 206.7 tons per day.

It will be noted that recovery per ton was below last year's average. This is chiefly accounted for by the proportionately large increase in development rock sent to the mill.

Mining

The tonnage of ore broken in stoping amounted to 67,919, while ore coming from development was 17,664, making a total of 85,583 tons for the year. Waste broken was 29,794 tons; of this, 23,754 tons was hoisted to surface. Included in the total waste was 18,668 tons from, and immediately surrounding, No. 4 shaft.

The estimated tonnage of broken ore in stopes on March 31 was 55,807. An additional 6,528 tons remained on the surface dump, giving a total of 62,335 tons.

Development and Exploration

Claim L. 2,101.—Sinking of the two-compartment No. 4 shaft was started May 17, 1929, and at the end of last March it had reached a depth of 1,480 feet, thus showing an average advance per month of 140 feet. In addition, two sumps, one double, and nine single stations were completed, and another station was just started. Rock excavations from these sumps and stations amounted to 24,534 cubic feet.

An enclosed headframe, waste disposal trestle, and hoist-house were constructed, and a 4- by 4-foot double-drum electric hoist, suitable for work to approximately 2,000 feet, was installed. The shaft was also completely timbered and lined to 1,450 feet, and counterbalance and cage guides were installed to the 1,250-foot elevation, thus permitting operation of the surface hoist to this point.

During the previous year certain stoping had been done above 850 feet, almost to the next level, but as this work interfered somewhat with early shaft-sinking it was temporarily suspended. Later, when sinking was resumed below 1,000 feet, exploration was started on the 700-, 600-, and 500-foot levels in the order named. In addition to diamond-drilling, drifting, and crosscutting, a combined manway and ore pass system was driven. This, commencing from No. 850 stope, was completed to a point 25 feet above the 600-foot level and permits disposal of ore directed by gravity to 1,000 feet, where electric haulage connects with No. 2 shaft.

Above 1,000 feet in the No. 4 shaft area, exploration done since sinking commenced has indicated encouraging occurrences of ore. This, coupled with results of previous diamond-drilling, leads to the reasonable expectation of eventually developing a tonnage of importance there.

Below that level, no work has yet been undertaken aside from shaft-sinking and the cutting of stations, in addition to promising diamond-drill intersections secured before the shaft was started. The shaft itself cut two separate veins between the 1,000- and the 1,250-foot horizon, and sampling of the walls indicated ore in both. Shaft-sinking also exposed what is apparently a strong fault in this section. The displacement is to the north on the lower side, thus tending to carry the ore in that direction. This fault and the probable existence of another vein likely accounts for the assumed position on the 1,500- and 1,750-foot levels of what is indicated as being a large ore body lying north of a point vertically below the 800-foot level ore.

During the past few months a daily average of 50 tons has gone to the mill from this area of the mine.

Claims L. 2,100, L. 2,226, and L. 2,227.—Two of the most important developments were ore extensions from the No. 1,001 vein system at and above the 1,000-foot level, east of No. 2 shaft, and the continuation of Nos. 1,004, 1,023, 1,056, and 1,058 vein series above 1,000 feet. An area of exceptional promise was also partially developed on Nos. 1,024, 1,056, and 1,058 ore bodies above the 1,125-foot level, after crosscutting north from No. 2 shaft at that depth.

Mill ore continued to be drawn from the No. 1,001 vein section, that just south of No. 2 shaft, on practically all levels from approximately the 400- to and including the 1,750-foot. This part of the mine produced a large tonnage of better than average grade during the year.

On the 1,750-foot level, in what is designated as No. 1,711-12 vein, the work indicated one continuous ore section 150 feet in length, and box-holes have recently been started there in preparation for stoping. As yet this ore has not been traced to 2,000 feet. A diamond-drill hole on the 2,000-foot level has, however, indicated the probability of the downward continuation of what may be this same vein.

Another working place on the 1,750-foot level, namely No. 1,707-8, is now ready for stoping over two sections having a combined length of 285 feet. This vein lies about 100 feet south of No. 2 shaft.

Diamond-drill indications between 2,000 and approximately 2,500 feet, as well as crosscutting, drifting, and diamond-drilling from the 1,500- to the 2,000-foot level, shows that below 2,000 feet the so-called main south vein fracture dips to the north at about 70 degrees. Exploration to the end of the fiscal year disclosed no consistent ore of probable importance along this major fracture below approximately 1,650 feet. Certain favourable ore indications and short occurrences of ore were, however, indicated below that level. Promising structure was also found in many sections. This, added to the fact that the fracture is better defined and the vein material is on an average wider and of greater known extent than any other thus far disclosed on your property, leads to the belief that ore possibilities exist at greater depth. On this assumption diamond-drilling is planned below 2,500 feet.

Diamond-Drilling

One drill operating continuously and a second machine working part time completed a total of 13,998 feet. Results fully justified the expenditure for this method of prospecting.

To summarize the approximate 14,000 feet of work of this class completed, it can be said with confidence that diamond-drilling contributed largely to the success for the year. It was wholly responsible for the finding of certain ore bodies. It also very materially aided discovery and development of ore in Nos. 1,065 and 1,126 areas, as well as numerous other sections of less probable tonnage and value. In addition, drilling from the 500-foot level near No. 2 shaft has indicated the existence of two steeply inclined veins on claim L. 2,226. One appears to be narrow and high grade; the other shows a greater than average width, good structure, and normal values. A hole is now being drilled on the 400-foot level, and further exploratory work is planned, as it is reasonable to believe this vein system may be the eastward continuation of valuable ore occurrences being developed farther to the west at the same horizon, as well as in No. 1,004 stope almost vertically below these intersections.

DEVELOPMENT AND EXPLORATION FOOTAGES

	Feet
Drifting	4,121
Crosscutting	1,951
Raising	488
Raise stations, sublevel drifts, and diamond-drill stations	711
Box-holes	1,228
Box-hole pillar drifts	827
Stope winzes	70
Shaft-sinking	1,480
Total	10,876
Diamond-drilling	13,998
	cu. ft.
Shaft stations and sumps	24,534

Reducing the shaft-sinking, station-cutting, and sump excavation work to an equivalent drift footage, based on cubic feet of material broken, we have for the year what would be equal to a total of 13,123 feet of advance. This is exclusive of diamond-drilling.

OPERATING COSTS

	Expense	Per ton milled
Development and exploration	$206,426.48	$2.738
Mining	236,501.18	3.136
Milling	100,570.17	1.334
General charges	50,176.06	.665
Administrative charges	19,756.45	.262
Total	$613,430.34	$8.135

In arriving at a reasonably accurate conclusion of what has been accomplished during the year, the following points should be considered: To the net operating profit of $26,694.29, shown on the balance sheet, should be added the proportion of shaft-sinking charged directly to operation (from which as yet it has been possible to derive but small benefit) and the profit available from the increase in broken ore. These three items combined represent a total of approximately $93,000.00. A further abnormal expenditure, charged entirely to operation, was an amount of $40,790.59 for diamond-drilling.

The total cost of electric power for the year was $71,625.97. This is equivalent to 95 cents per ton milled, or $77.42 per horse-power consumed. It will thus be very evident that this continued and unwarranted high power charge very seriously affects net revenue. Nor do present conditions appear to offer any immediate possibility of much, if any, relief at properties in this district using less than 5,000 h.p.

New Buildings and Equipment

Two company residences and a storehouse were moved to new locations and slightly remodelled; a small office addition was made to the machine shop; a 32- by 36-foot hoist building and a suitable headframe were erected at No. 4 shaft, and a 5,500-foot tailing disposal system was constructed and put in operation from the mill to the northeast section of Kirkland lake.

Equipment installed during the year included a vibrating screen and an elevator placed in the crusher station in closed circuit with the rolls; a lathe, shaper, pipe machine, power drill, etc., added to the machine shop; and an automatic stoker put in to feed fuel to the heating boiler.

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 officials of the company are: H. H. Vaughan, president; R. M. Davy, vice-president; P. W. Ogden, secretary-treasurer. The directors are: H. H. Vaughan, R. M. Davy, L. Soliague, E. E. Campbell, F. C. Shorey, Dr. J. Bonsall Porter, and R. W. Norrington. The head office is at Room 602, 1111 Beaver Hall Hill, Montreal.

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.

Underground operations were started on the Tashota area claims in 1928, a shaft was sunk to a depth of 235 feet, and levels were opened up at the 100- and 200-foot horizons. In February, 1929, underground work was suspended and a surface diamond-drill campaign started. Work was resumed underground in September and carried on for the remainder of the year.

Development during 1929 consisted of 542 feet of drifting and crosscutting and 5,282 feet of diamond-drilling.

An average of 18 men was employed, 8 underground and 10 on the surface. W. A. Coughlin was manager of the property

The annual report of the company gives the following balance sheet as at December 31, 1929:—

ASSETS

CURRENT:		
Cash in bank	$2,910.02	
Supplies	2,020.05	
		$4,930.07
FIXED:		
Mining claims and options at cost	$728,050.00	
Plant, machinery, equipment, and buildings	34,672.42	
		762,722.42
DEFERRED CHARGES:		
Development and organization expense	$173,587.70	
Discount on shares	936,054.10	
Prepaid insurance, etc	322.26	
		1,109,964.06
		$1,877,616.55

NOTE.—The company holds a contract from Stobie Forlong and Company, Limited, for the purchase of 752,425 shares of the company's capital stock, with a balance of 555,759 shares yet to be taken up.

LIABILITIES

CURRENT:			
Accounts payable			$6,681.55
CAPITAL:			
Authorized, 4,000,000 shares of $1 each		$4,000,000.00	
Subscribed and fully paid, 1,867,535 shares of $1 each		1,867,535.00	
Subscribed and not fully paid, 4,000 shares of $1 each	$4,000.00		
Less subscriptions unpaid	600.00		
		3,400.00	
			1,870,935.00
			$1,877,616.55

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: Charles L. Denison, president; Albert W. Johnston, vice-president; George C. Miller, secretary; Wm. C. Himrod, treasurer; K. P. Emmons, assistant treasurer; Robert W. Pomeroy, J. F. Thompson, Conrad E. Wettlaufer, and W. W. Reilley, directors. D. L. H. Forbes is general manager, and 625 men are employed at the mine in Leck township.

The report of the general manager for the fiscal year ending August 1, 1929, is as follows:—

During this period 331,150 tons of ore were treated, and bullion amounting to $4,889,127.32, or $14.764 per ton, was recovered. This recovery is equivalent to 236,511.587 ounces of gold, or 0.7142 ounces of gold per ton of ore. The gross revenue was $4,980,339.47, or $15.039 per ton. The total direct operating cost was $1,961,811.17, or $5.924 per ton. Depreciation written off on buildings and plant amounted to $215,944.98, or $0.652 per ton, making the total of direct and indirect charges $2,177,756.15, or $6.576 per ton. After making a provision of $259,065.32 for federal and provincial taxes, the net surplus was $2,543,518.00.

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	$382,632.86	$1.155	$1.618
Mining	894,917.56	2.702	3.784
Milling	457,177.60	1.381	1.933
General expense	227,083.15	.686	.960
Total direct charges	$1,961,811.17	$5.924	$8.295
Depreciation	215,944.98	.652	.913
Total direct and indirect charges	$2,177,756.15	$6.576	$9.208

Included in the above operating costs is the sum of $234,408.67 paid to the Northern Ontario Power Company, Limited, for an average monthly power demand of 3,932 horse-power. This is equivalent to a charge of $59.62 per horse-power year.

Construction work charged to capital account absorbed $180,802.11, practically all of which was expended on surface equipment and buildings for South shaft. By the end of the fiscal year this construction work was all completed and South shaft sunk to a depth of 1,422 feet.

Central shaft was sunk from the 19th to the 25th level and completely equipped for the handling of ore and waste from all six of the new levels as well as for the crushing and skip-loading of ore coming from levels below the 13th down to the 19th.

A total development footage of 8,522.9 was accomplished during the year, and the combined total length of all mine workings at August 31 came to 65,143.6 feet. Classified under the usual headings the work done was as follows:—

	Feet
Drifting	3,022.3
Crosscutting and shaft stations	1,375.7
Raising	2,118
Shaft-sinking	2,006.9
Total	8,522.9

Diamond-drilling amounted to 11,450.7 feet.

New ore was found on the 6th, 7th, 10th, 15th, 20th, 21st, and 25th levels. Although drifting along the ore zone on new levels below the 19th had proceeded only short distances and only on the 20th, 21st, 22nd, and 25th levels by the end of the fiscal year, a total ore length of over 800 feet had been opened up on these levels and the conditions of ore deposition had been proved to be similar to those on upper levels. The average width of the ore zone on the new levels was found to correspond with the average width on other levels, while satisfactory indications of ore bodies, of excellent grades and good stoping widths, were obtained from crosscuts and drill-holes. The opening up of the 20th and 21st levels is being attended to first and will be followed by a gradual development of the 22nd, 23rd, 24th, and 25th levels along with the sinking of Central shaft extension three-compartment winze from the 25th to the 30th level. This work is planned for completion by the time the South shaft will have reached the 30th level and be ready for connection with Central shaft workings.

Development work produced 11,363 tons of ore that was treated in the mills and 58,250 tons of waste rock that was dumped on surface.

While the year's programme of underground work was in the nature rather of preparation for deep mining and possible further expansions than of finding new ore, we were abl : at the same time to develop sufficient new ore to replace the tonnage extracted and to leave the reserves of blocked and broken ore undiminished at the end of the year.

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 35 men was employed until the mine closed in November, 1929.

Work completed in 1929 was as follows: A transmission line was cut from the Gold Hill Mines, Boston Creek, to the Telluride property, a distance of 5½ miles; all the poles except fifty were erected. Three 100 k.v.a. Ferranti transformers were installed with switch-house complete. A 50-ton concentrator (amalgamation and flotation) was designed and built by South Western Engineering Corporation, of Los Angeles, California. An office and a bunk-house to accommodate 50 men were under construction when the mine closed. The lateral work underground consisted of:—

Level	Feet
90-foot	45
150-foot	425
250-foot	1,525
350-foot	station only

A station was slashed out on the 250-foot level, 350 feet west of the old shaft, to start raising a new shaft.

Trethewey-Ossian Mines, Limited

Trethewey-Ossian Mines, Limited, operated their property in Pacaud township, district of Timiskaming, during 1929 from August 1 to October 5, with a working force of from 15 to 20 men. J. L. Trethewey is president; T. C. Glenn, treasurer; and J. Torrance, director.

A shaft was sunk 140 feet, and 90 feet of drifting and 77 feet of cross-cutting was done on the 125-foot level.

The following buildings were built on the surface: bunk-house, 34 by 20 feet; cook-house, 40 by 16 feet; office, 16 by 16 feet; blacksmith shop, 20 by 16 feet; power-house, 24 by 20 feet.

Sidney A. Pain was manager.

United Mineral Lands Corporation

This company is a consolidation of the interests of the Premier Paymaster Mines Company, the United Mineral Lands, Limited, and the Porcupine Paymaster Mines, Limited. The holdings of the Canadian company are in Deloro township, district of Cochrane, and comprise ground formerly owned by the Standard Gold Mines, Limited, and the McLean Gold Mines, Limited, the claims lying along the north border of Deloro township.

During the year ending December 31, 1928, the following underground work was done on the Paymaster property:—

Level	Diamond-drilling	Drifting	Raising
	feet	feet	feet
100-foot	185	247	.....
200-foot	.....	17	.....
300-foot	4,016	764	125
400-foot	.....	413	17
600-foot	.....	246	.....
800-foot	2,693	742	.....
Total	6,894	2,430	143

On the 425-foot level of the adjoining Ankerite mine, 21 feet of cross-cutting and 502 feet of drifting were done. This work lies for the most part on the company's property.

During the year the new concentrator was put in operation but not thoroughly tested before the company ceased active work in November.

A small staff of underground men continued development by drifting and diamond-drilling throughout the remainder of 1928 and well into 1929. Since early summer, 1929, no work other than pumping has been done on the property. M. Donovan is mine manager, and from 15 to 30 men have been employed since the curtailing of the work.

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: F. H. Hamilton, president; John H. Black, vice-president; J. Ingram, secretary. The directors are: F. H. Hamilton, John H. Black, W. H. Stafford, R. T. Shillington, Sir A. Hamilton Grant, A. S. Hamilton, E. Turk. 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 balance sheet for the year ending July 31, 1929, is given in the seventh annual report of the company as follows:—

ASSETS

CAPITAL:		
Mining claims and properties, as per balance sheet, July 31, 1924	$1,432,442.84	
Acquired during year ended July 31, 1927, from British Porcupine Mines, Limited, less subsequent adjustments	213,149.19	
		$1,645,592.03
Mine, mill, camp and office buildings, plant machinery and equipment, as appraised July 31, 1924	$301,240.87	
Additions at cost to July 31, 1928, including British Porcupine Mines, Limited	154,337.87	
Additions at cost for year ended July 31, 1929	18,666.51	
		474,245.25
Shares in other companies at cost		117,540.27
		$2,237,377.55
CURRENT:		
Cash on hand and in banks	$53,474.91	
Provincial and railway bonds at cost (market value $526,000)	537,584.60	
Bullion en route and on hand	57,851.71	
Accounts and interest receivable	6,829.65	
Mining and milling supplies	30,225.81	
		685,966.68
DEFERRED:		
Insurance and other prepayments	$13,928.69	
Syndicate participations and deferred expenditures on outside properties	11,410.86	
		25,339.55
		$2,948,683.78

LIABILITIES

CAPITAL:		
Capital stock authorized (2,500,000 shares at $1 per share) issued and outstanding	$2,250,000.00	
Surplus	357,840.33	
		$2,607,840.33
CURRENT:		
Accounts and wages payable	$37,803.13	
Accrued charges	6,941.53	
		44,744.66
RESERVES:		
Reserve for depreciation of buildings, plant, and machinery	$279,311.70	
Reserve for Dominion income and provincial production taxes	16,787.09	
		296,098.79
		$2,948,683.78

The operating account for the year ending July 31, 1929, shows the following:—

EXPENDITURE

Development	$107,124.39
Mining, including hoisting	196,773.96
Crushing, conveying and milling	121,132.42
Shipping and marketing bullion	5,201.39
General camp maintenance	12,222.83
Administration and general expense, mine	20,655.61
Administration and general expense, Toronto office	7,961.52
Transfer, legal, and directors' fees, etc.	17,731.70
Insurance, including compensation	20,349.98
Provincial and municipal taxes	8,387.07
Balance carried down	300,544.14
	$818,085.01

REVENUE

Bullion proceeds, plus exchange	$797,113.78
Bond and bank interest earned	20,971.23
	$818,085.01

The profit and loss appropriation account for the year ending July 31, 1929, is as follows:—

DEBIT

Examination expenditures on outside properties written off	$6,419.19
Reserved for depreciation of buildings, plant, and machinery	61,190.62
Reserved for Dominion income taxes	10,168.20
Surplus July 31, 1929, carried to balance sheet	357,840.33
	$435,618.34

CREDIT

Surplus July 31, 1928	$135,019.80
Sundry adjustments	54.40
Balance brought down	300,544.14
	$435,618.34

During the period ending July 31, 1929, 100,540 tons of ore were hoisted, of an average grade of $7.93 per ton, and produced bullion to the value of $797,113.78. The cost per ton milled during this period was $5.15 as against $5.44 for the same period last year.

The following report on operations at the mine is taken from the annual report of the manager, Robt. E. Dye:—

Results of Development

During the fiscal year under review, active exploration and development work was conducted in various parts of the property. Fair results were obtained in several places, but by far the most important developments of the year took place in the No. 709 drift area on No. 9 vein southeast of the Central system. In this area a productive zone was encountered extending from the 866-foot level up to the 400-foot horizon. An ultimate production of approximately $1,000,000 in ore of $9 per ton grade is now assured from this section with chances of extending the present known limits of the ore zone.

Work in the northern part of the property at the 400-foot level has recently come into an ore occurrence which, it seems certain, is a continuation of some of the southerly Hollinger veins. At the time of writing, October 30, an ore section is exposed at the 400-foot level for a length of 175 feet, which assays in excess of $7 per ton over an average width of 110 inches. The area is now being investigated at the 500-foot level by means of a crosscut. This very considerable body of indicated ore was not taken into account in arriving at the ore reserves estimate presented herewith.

Summary of Underground Operations

During the fiscal year ended July 31, 1929, the following development work was done:—

Operation	Feet	Total cost	Cost per foot
Drifting and crosscutting	6,243	$77,421.53	$12.40
Raising	473	8,665.98	18.31
Diamond-drilling, underground	8,113	14,558.96	1.79

Some 100,259 tons of ore was hoisted, of which 88,733 tons was taken from the stopes. The cost of ore delivered to the primary crushing plant averaged $1.97 per ton.

The Mill

The mill operated continuously during the year and the following results were obtained:—

Tons milled	100,540
Average value per ton	$8.63
Gross value	$867,749.38
Bullion recovered	$797,113.78
Average running time, per cent.	95.5

Production

From bullion produced during the year	$797,113.78
From bullion produced during former years	3,688,216.90
	$4,485,330.68

The above figures do not include bullion produced by the Porcupine Crown before this property was acquired by the company.

COST OF PRODUCTION

	Total cost	Cost per ton
Development	$107,124.39	$1.07
Ore extraction	196,773.96	1.96
Crushing, conveying, and milling	121,132.42	1.20
Shipping and marketing bullion	5,201.39	.05
General camp maintenance	12,222.83	.12
Administration at mine	20,655.61	.21
Head office expense	7,961.52	.08
Corporate expense	17,731.70	.18
Taxes	8,387.07	.08
Insurance	20,349.98	.20
Total	$517,540.87	$5.15

Ore Reserves

As at July 31, 1929, the ore reserves were estimated at 127,500 tons of an average value of $8.16 per ton, or a total gross value of $1,040,000. This represents an increase of 10,600 tons and of $150,000 in gross value over the corresponding figures for the previous year.

During the period covered by this report, a total of 100,259 tons of ore of a gross value of approximately $868,000 was extracted. It will be seen, therefore, that the ore developed during the year amounted to approximately 110,800 tons of ore of an estimated gross value of $1,018,000. These figures do not make any allowance for the ore section recently exposed at the 400-foot level in the northern part of the property, from which a considerable tonnage of ore is already assured.

West Dome Lake Gold Mines, Limited

This company has an authorized capital of 7,000,000 shares of no par value. All the undertakings of the Consolidated West Dome Lake Mines, Limited, were taken over by this company on incorporation for a consideration of 3,500,000 fully paid shares of no par value. Of the shares remaining in the treasury, 403,895 shares were taken up by the shareholders at 10 cents under the offering made June 18, 1927; 667,000 shares were subscribed for by the directors at 15 cents; 10 shares were issued to the incorporators; and 300,000 shares were sold under an underwriting arranged by the directors. The balance of unsubscribed shares in the treasury on December 31, 1927, was 2,129,095.

The holdings of the company consist of 8 mining claims and a fraction of the Ritchie veteran claim situated in the southeastern portion of the township of Tisdale, district of Cochrane, adjoining the property of the Dome Mines, Limited, on the west.

The officers of the company are: Sir Henry Pellatt, president; Wm. H. Kinch, vice-president; F. L. Hutchinson, secretary-treasurer; D. M. McPhail, manager. The directors of the company are: Sir Henry Pellatt, M. P. Van Der Voort, R. L. Baker, Toronto; Wm. A. Taylor, A. A. McKelvie, F. L. Hutchinson, New Liskeard, Ont.; and Wm. H. Kinch, Buffalo, N.Y.

The report to the shareholders for the period ending December 31, 1928, contained the following from the president's letter:—

The mill was not operated during 1928, but was started in January, 1929, when development had reached the 1,325-foot level and, as a result of the improvements carried out, has been treating an increased tonnage very efficiently. Unfortunately the grade of ore treated has been lower than we anticipated. This has been due to irregularities and narrowing of the veins as

stoping has proceeded, causing dilution; also results to date from development on the 1,325-foot level have been disappointing. While good values have been obtained in short sections on this level, the vein widths have been too narrow to make ore. On this level we are evidently working on a lean horizon. This has occurred before on upper levels, but at present we lack money to carry development to deeper and possibly more favourable ground.

The mine has not been meeting operating expenses since the mill was started, and the company lacks development capital. The share offering made to shareholders with the report issued December 1, 1928, was subscribed only to a very small extent. It is not possible to sell the remaining treasury shares on the present basis, and some form of reorganization is therefore necessary if development is to continue and if the excellent chances which the company has in some sections of its property are to be tested. The eastern section, in particular, where vein widths are much better and the geology highly favourable, warrants more exploration. So far, work has necessarily been confined to one level in that section.

You will find enclosed with this report, notice of the annual general meeting and of a special general meeting called to consider a by-law covering a proposed reorganization of the company. The reorganization provides for the formation of a new com any with a capital of 3,500,000 shares of no par value and the sale to such new company of all the assets and undertakings of this company for 1,500,000 shares, being equal to one share for each four shares of this company now issued. This would leave 2,000,000 shares in the treasury of the new company.

The following statements are from the report of the manager:—

Mining

Development and exploration work during the year was as follows:—

Level	Drifting	Cross-cutting	Raising	Sinking	Slashing
	feet	feet	feet	feet	feet
1,050-foot	1,371½	567½	100	.....	281½
1,050-foot sub	16	17	.....	.....	.....
1,200-foot	878½	73½	166	136½	71
1,325-foot	4½	35	.....	.....	6
Total	2,270½	693	266	136½	358½

In addition to the above, a station, 13 by 11 by 10 feet, was cut at the 1,325-foot level.

Development

Development work underground was confined to drifting east and crosscutting north on the 1,050-foot level and drifting east on the 1,200-foot level. A raise was put through from the 1,200-foot level to the 1,050-foot level and then continued by sinking from the 1,200- to the 1,325-foot level.

On the 1,200-foot level a total length of 630 feet of ore was developed, namely "B" and "C" lenses. The "B" lens contained a length of 246½ feet by 3.66 feet in width, average grade $15.33. The "C" lens contained a total length of 383½ feet divided into three sections as follows: No. 1 section, 231 feet by 2.5 feet wide, average grade $5.12; No. 2 section, 127½ feet by 2.63 feet wide, average grade $8.26; No. 3 section, 25 feet by 2.5 feet wide, average grade $6.88.

On the 1,050-foot level drifting was carried east for a distance of 2,800 feet from the Main shaft and considerable exploration carried on by crosscutting, short drifts, and raises. In this easterly section a length of over 450 feet of low-grade ore was developed in three shoots. In places this ore is from 15 to 20 feet wide, and in my opinion this section warrants a great deal more development.

The mill was started on January 18, 1929, and continued operations until January, 1930, during which time production amounted to $179,164.64. Development during this period was: drifting, 480 feet; crosscutting, 61 feet; raising, 263 feet. The mine was closed down on January 19, 1930, except for pumping.

Negotiations are being made with United Mineral Lands, Limited, regarding an amalgamation of the two companies.

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 425 men are employed. The report of the general manager for the year 1929 is as follows:—

During this period 188,238 tons of ore were treated in the mill, producing $1,741,872.74 in bullion. This is a recovery of $9.25 per ton treated.

ANALYSIS OF OPERATING COSTS

	Total	Cost per ton milled
Development and exploration	$363,416.51	$1.930
Stoping	345,430.96	1.835
Transporting ore (hoisting, etc.)	203,040.31	1.079
Milling charges	233,602.61	1.241
Marketing bullion	12,151.55	.065
New road construction and general surface	7,220.31	.038
Stock transfer and registrar charges	3,655.15	.019
General and undistributed charges (storehouse, maintenance, mine buildings, administration and management, property taxes, insurance, interest and exchange, legal expenses, contributions and miscellaneous)	112,379.44	.597
Depreciation plant and equipment	45,134.28	.240
Total	$1,326,031.12	$7.044

SUMMARY OF DEVELOPMENT AND EXPLORATION
December 31, 1929

	Drifting	Shaft-sinking	Cross-cutting	Raising	Diamond-drilling
	feet	feet	feet	feet	feet
December 31, 1928	44,240.5	4,456	7,378	.....	28,384.5
Fiscal year	17,218.75	249	4,922.9	942	9,678
December 31, 1929	61,459.25	4,705	12,300.9	942	38,062.5

PRODUCTION RECORD, 1921-29

Year	Tons milled	Bullion produced	Value per ton
1921	36,081	$468,665	$13.00
1922	66,181	762,752	11.52
1923	79,242	754,978	9.52
1924	84,487	1,088,725	12.89
1925	147,939	1,913,401	12.93
1926	153,392	2,150,844	14.02
1927	209,164	2,151,916	10.51
1928	256,331	1,845,923	7.20
1929	188,238	1,741,872	9.25
Total	1,221,055	$12,879,076	$10.55

Construction work and betterments charged to capital account consumed $60,000. This included three new agitators in the mill, a new low-pressure compressor, various new equipment in the mine, assay office, and on the surface.

In May, a study of the available ore reserves together with the results of current developments, made it desirable to curtail production until reserves could again be built up to such proportions that the old milling scale might be resumed. At this time it was thought necessary to use every available resource in the development of new ore, and at the same time it was estimated that the smaller scale production would meet all expenses. This estimate was more than met.

During the last half year the mine has responded generously to the development programme. The available reserves have been increased to such a point that your management feels confident of its ability to maintain the present production of about 550 tons per day during the coming year. It has been fully realized that with a mill already built and paid for, it is good business to keep the tonnage as high as possible, limited only by the economic capacity of the mine to produce the ore in the most profitable manner.

The better grade of ore milled during the latter half of the year is due not alone to the better grade of ore developed, but also to a change in the mining methods whereby much of the dilution found unavoidable in the many stopes using the "shrinkage" method is being eliminated.

Two timbering methods of mining ore bodies with poor walls have been put into practice with success, stull stopes and square set stopes. These methods will be further enlarged on during the coming year.

There are now being developed on the property three vein systems, the old North and South systems with what is called the "incline" vein system. This latter was first discovered on the 1,250-foot level during 1928 and has been opened up this year on four new levels, 1,470 feet of ore having been developed on this vein during the year.

The grade of ore coming from these exposures is above the average grade of the run of mine. These ore bodies, with a dip of sometimes only 45 degrees, have a weak hanging wall and cannot be successfully mined by the old "shrinkage" method, the dilution becoming excessive.

On the No. 1 or North vein system, excellent ore has been opened up on the 1,375-, 1,500-, and 1,750-foot levels on sections of the old Middle claim ore shoot, which had been faulted. These sections aided very materially to maintain production during the shortage period as they were quickly made available for mining.

On the East claim a new ore body was developed on the 700-foot level of the North vein system. A length of 600 feet was developed to the major easterly fault, where the ore body was faulted south 60 feet. This ore is now being developed east of this fault with a length of 300 feet opened up to date; this ore is well up to the standard grade of the mine.

This same ore body has been intersected on the 500-foot level where a total of 450 feet has already been opened up on two parallel breaks. The present programme of development includes exploring these shoots on the 400-, 800-, and 1,100-foot levels.

The No. 1 shaft was sunk 249 feet, opening up two new levels at 2,125 and 2,250 feet. There appears to be more than one enriched break on these horizons. On the 2,125-foot level there has been developed 600 feet on No. 2,101 vein and 200 feet on No. 2,103 vein.

On the 2,250-foot level, there has been developed 700 feet on the No. 2,201 vein and 80 feet on the No. 2,204 vein. One section of the ore body on the No. 2,201 vein was of as high grade as anything previously developed in the mine.

Two diamond-drill holes have cut the lower extension of this ore zone at the 2,500- and 2,900-foot horizons. The structure and values intersected are excellent.

On the No. 2 or South vein system, there were four major developments in 1929: (1) No. 2,005 ore body east of the shaft on the 2,000-foot level where 500 feet were developed. (2) No. 2,002 ore body west of the shaft on the same level; this was 100 feet long on the sill but lengthened to 125 feet in the stope. (3) and (4) No. 1,775 east and west ore body on the 1,750-foot level east of the shaft and directly above No. 2,005 stope. The area directly above these ore bodies is virgin territory holding out great promise for extensions.

On the 550-foot level an important ore shoot, No. 512, was found 900 feet east of No. 3 shaft, about 150 feet long by about 12 feet wide, lying almost under the old No. 2 shaft. This discovery and the finding of commercial ore on the surface still farther east gives to this area considerable importance.

Lately, what appears to be an important discovery is the No. 502 ore body lying below and a little west of the old No. 404 stope. This development is being rapidly pushed.

The future programme of development has for its objectives the continuation of the opening of No. 1 vein system on the East claim and on the two lower levels (the interference of the Sylvanite corner which occurred on the upper levels of this vein is not expected to take place on the lower levels, inasmuch as the vein is sufficiently far south to miss it); also, the working out of many smaller good prospects in the older workings on both No. 1 and No. 2 veins; then, in the latter part of the year, to start sinking operations with the object of opening up four or five new levels.

The ore reserve situation has been greatly relieved. The present available reserve of broken and unbroken ore is more than 300 per cent. greater than it was at May, 1929. Should developments continue to be as satisfactory as they have been in the past few months, it would not be very long before the mine would be in a position to produce to the capacity of the mill. However, it is considered unwise to hurry this until developments fully warrant it.

The following estimate of ore reserves is given, and in presenting these figures it should be remembered that the Kirkland Lake ores in general, Wright-Hargreaves ores in particular, are extremely erratic in both widths and values, so that great care has to be exercised in any analysis made as a result of the estimate.

However, it has been our endeavour to present conditions as they are, after making such necessary discounts for the high erratics in the sampling, and adjusting the widths to those expected in actual mining operations. After further experience in the mining of these ores, no doubt our methods of computing tonnage and values may be changed to obtain more accurate estimates.

ORE RESERVES ESTIMATE, DECEMBER 31, 1929

Tons	418,877
Grade	$11.30
Value	$4,727,551.53

An intensive study of the metallurgy in connection with the present equipment in the mill indicates that with some minor changes in the flow-sheet and some new equipment, a further economic saving may be made. A more complete report on this subject is expected to be ready in the near future.

GRAPHITE

Black Donald Graphite Company, Limited

Work for the greater part of 1929 was confined to efforts to develop the mine from the new shaft, which has reached a depth of 340 feet. Considerable difficulty was experienced in keeping the shaft pumped out. It was finally dewatered in October and work on it was temporarily suspended. When operations were resumed early in 1930 no further difficulty was met.

During November and December, the McConnell incline was developed for about 75 feet.

The ore procured from this incline, together with ore which had accumulated in the dump, enabled the mill to produce 1,450 tons of finished graphite.

An average of 60 men was employed. R. F. Bunting is manager.

GYPSUM

Canada Gypsum and Alabastine, Limited

The Canada Gypsum and Alabastine, 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.

At Caledonia four 100 h.p. boilers were discarded and a John Inglis 400 h.p. boiler installed, with new boiler-house and coal-handling equipment.

From 95,263 tons of rock mined, the following finished products were obtained: 63,260 tons of plaster, 23,425,000 square feet of Gyproc, and 3,060,000 square feet of gypsum blocks. J. D. Kerr was superintendent, employing an average of 236 men.

At Lythmore an air shaft was sunk and 18,152 tons of rock were mined, from which 15,000 tons of plaster were made. Joseph Mark was superintendent, employing an average of 49 men.

In January, 1930, the company name was changed to Gypsum, Lime and Alabastine, Canada, Limited. The head office of the new company is at Paris, Ont.

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 operates a producing lead mine, mill, and smelter near Galetta in the township of Fitzroy, Carleton county.

Operations were continuous throughout the year 1929. The main shaft was sunk an additional 122 feet, giving a total depth of 1,448 feet, and a new level was opened up at the 1,400-foot horizon. Development work for the year, other than shaft-sinking, was as follows:—

Level	Station-cutting	Crosscuts	Drifts	
			East	West
	equiv. feet	feet	feet	feet
1,275-foot	.....	68	.....	1,387
1,400-foot	57	271	88	.....

At the smelter the scotch hearth was in continuous operation. The blast furnace was used from June 24 to July 14, 1929, smelting slag from the scotch hearth.

An average of 122 men was employed during 1929, divided as follows: underground, 88; mill, 15; smelter, 14; 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 has an authorized capitalization of 4,000,000 shares of $1 par value.

The officers are: J. J. McFadden, president; T. W. Lawson, vice-president; W. L. Paterson, secretary-treasurer. The directors are: J. J. McFadden, T. W. Lawson, N. A. Timmins, G. L. Babson, and J. H. Collins. The head office is at 921 New Birks Building, Montreal.

The property held by this company consists of 25 claims in the township of Hess, district of Sudbury, and a road has been built from the head of Lake Geneva to the property, a distance of about three miles.

The Lake Geneva Mining Company, Limited, was formed under the terms of an option obtained by the Towagmac Exploration Company, Limited, from the Collins-Babson interests. This option, in addition, called for 250 feet of shaft-sinking, 600 feet of drifting and crosscutting, 500 feet of raising, and the construction of a 50-ton mill.

Underground work was suspended in the fall of 1929 as the work required underground had been completed. The total underground exploration accomplished was: 250 feet of shaft-sinking, 802 feet of drifting and crosscutting, and 456 feet of raising. The shaft consists of three compartments, and stations were cut at the 160- and 235-foot levels. All lateral work, with the exception of 25 feet, was done on the 235-foot level.

The annual report of the company for 1929 states that the total tonnage of ore blocked out by drifts and raises and indicated by diamond-drilling (previous to 1929) is figured at 73,700 tons, with an average grade estimated at 44 cents gold, 2.33 ounces of silver, 4.24 per cent. lead, and 11.30 per cent. zinc.

During the winter of 1929-30 additional Diesel equipment and a major part of the mill machinery, capable of 100 tons daily, was taken into the property in preparation for fulfilling the final terms of the option.

W. E. Bawden is in charge of operations.

North American Metals Corporation, Limited

The holdings of this company consist of two properties in the township of Dorion, district of Thunder Bay, known as the Dorion and the Ogema mines. Operations were suspended early in 1929.

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 and J. Gordon Hardy, directors. The head office is at 100 Adelaide Street West, Toronto.

The first annual report of the company covering operations to October 31, 1929, contains the following report of Ernest Craig, mine superintendent:—

Property Features

The company owns a total of 7,960 acres, the main portion of which is composed of one group of claims constituting 7,440 acres and situated in the western part of Falconbridge township, with a small portion in the eastern extremity of Garson township. The norite-sediment contact crosses the property for a total distance of 16,570 feet, the strike of which is approximately east and west. The initial drilling recorded by the Longyear company indicates that the ore zone has a length of at least 10,420 feet, lying along the contact of the norite and sediments.

Work actually commenced on the property on September 7, 1928, and consisted primarily of making the necessary surface preparations, viz., providing suitable housing and transportation facilities preparatory to mine development.

A three-compartment shaft was started September 17 and completed to a depth of 1,033 feet, 60 feet of which was sunk through a sand and gravel overburden prior to encountering bed rock.

While sinking, stations were established at 225, 350, and 1,000 feet from the shaft collar, respectively, and in each case crosscuts were driven north to encounter the ore body.

Intensive development was confined to the 225- and 1,000-foot levels. On the former, drifts were extended east and west following the south contact of the ore body, off which crosscuts were driven north to determine widths and provide stope openings. Raises have also been put up at intervals of 111 feet to provide stope entrances on this horizon.

Development on the 1,000-foot level consists of a drive east and west along the north side of the ore body with short crosscuts at intervals, while an additional crosscut is being driven north to a point 300 feet north of the ore body for the purpose of establishing one of the diamond-drill stations planned for a deep drilling campaign.

In preparation for stoping, box-holing commenced on the 225- and 1,000-foot levels shortly before the close of the current period.

On October 31, 1929, the total mine development footage was distributed as follows:—

	Feet
Shaft	1,033
Drifts and crosscuts	3,056
Raises	268
Total	4,357
Box-holes completed	9

Ore Estimates

On the 225-foot level the ore body has been opened up for a distance of 680 feet with an average width of 55 feet, thereby calling for 3,767 tons per vertical foot of depth. The average grade is 2.97 per cent. nickel, 1.02 per cent. copper, and combined 3.99 per cent., after eliminating 12.8 per cent waste. On the basis of 3,767 tons per vertical foot, and figuring 108 feet above the level to rock surface, a gross tonnage of 406,800 tons is estimated.

The only work accomplished to date on the 350-foot level consists of one crosscut through the ore zone. At this point the ore body proper is narrow, approximating 5 feet of massive sulphides, with an additional 15 feet of disseminated sulphides, showing some high-grade ore along the extreme northerly contact. In estimating the ore width on this level it seems reasonable to consider 15 feet as a fair average, although we have very little data available to confirm this figure. Adopting 15 feet as the average ore width, and taking for length the same as developed on the 225-foot horizon, we estimate 299,200 tons of ore between the 350- and 225-foot levels.

The ore on the 1,000-foot level has been opened up for a distance of 1,060 feet and outlined by crosscuts at irregular intervals. This work has established an average width of 9 feet 6 inches, thus giving 1,014 tons per foot vertical. The average grade is 2.97 per cent. nickel, 0.92 per

cent. copper, and 3.8 per cent. combined, after eliminating 9.3 per cent. waste. It is difficult to calculate the tonnage between the 1,000- and 350-foot levels due to the fact that this sector has not been developed, but as the nature of the ore body is very regular, it seems reasonable to estimate 661,000 tons.

The total ore reserves thus indicated within our underground workings amount to 1,367,000 tons, averaging 2.97 per cent. nickel and 0.97 per cent. copper, or 3.94 per cent. combined. The workings are shown on the attached maps.

Diamond-Drilling

During the early part of the period 3,000 feet of drilling was done from surface and at irregular intervals along the ore body. These holes were put down for the express purpose of corroborating the previous Longyear results as to grade, and same were found to check very closely. At the present time we are about to drill to deep levels from the 1,000-foot horizon to investigate the ore occurrences at depth.

Surface Construction

Mine.—This consisted of installing a complete mining plant of ample capacity to take care of the immediate schedules of production, and the erecting and equipping of substantial buildings and attending utilities. Accommodation for 225 men has been provided, exclusive of dwellings referred to in a later paragraph.

Smelter.—The smelter is being erected in accordance with the design of Anton Gronningsater, with J. R. Gill as assistant. Same is located 2,000 feet southeast of the mine shaft and on the northeast shore of Boucher lake.

While the initial capacity of the smelter will be 250 tons per day, most of the equipment is capable of handling double this amount, therefore an increase to 500 tons per day can be attained with very few additions. At the time of this report the main smelter tructure and subsidiary buildings have been completed and practically all heavy machinery installed, hence it is reasonable to assume that we will be ready to go into production some time in the month of January, providing no unforeseen contingencies develop in the meantime.

The flow-sheet of this reduction works is simple. Following crushing and waste-picking on belts at the shaft, the sorted ore will be transported by aerial tram to the smelter bins. Charge cars will take it to the blast-furnace, the matter from which will be blown in basic-lined converters to an 80 per cent. metallic product. This will be barrelled and shipped to the company's electrolytic refinery in Norway, and the refined metals sold on the European market.

Power

Electric energy is being secured from the Wahnapitae Power Company's No. 3 plant and is transmitted a distance of 6½ miles over our privately owned line to the property.

Transportation

During the period, approximately 11,500 tons of freight were transported by truck to the property. All car-load shipments were unloaded at Garson, a distance of 31½ miles from the property, but smaller consignments were transported from Sudbury, a distance of 14 miles.

On October 17, a spur of the Canadian National Railways was completed from Garson to the smelter site, thus solving the transportation problem in a very satisfactory manner.

Dwellings

Twenty-five substantial five-room cottages have been erected for the purposes of housing permanent employees. Same are equipped with all modern conveniences. Educational and medical facilities have been satisfactorily taken care of through the erection of a suitable school and first-aid hospital.

The report of J. Gordon Hardy, consulting engineer and vice-president, is, in part, as follows:—

Ore Reserves

We are now able to indicate ore reserves within the area bounded by our underground workings . . . . The figure of 1,367,000 tons sorted ore has been calculated as probable, and there is not much chance of this being an overstatement.

Hitherto the Longyear estimate, based on their drilling results, has had to stand. There was no check on their figures until we had carried out our underground development work. This work now shows their assumption that the ore area shown by their drilling down to 250 feet would continue of equal size to 500 feet to be unjustified. It is true that in our workings we have only touched the ore body at one point between the 250- and 500-foot horizons, in our crosscut from the shaft at 350 feet, but the evidence there presented, coupled with that given by our 1,000-foot level, makes us believe that there exists a definite pinching in the ore body before the 350-foot level is reached. This condition is by no means unusual in the nickel range and can just as readily be compensated by our encountering elsewhere a swell that we had not counted on.

The comparison above made is with the Longyear estimate of 1,600,000 tons to 500 feet depth and within the "swell" of 600 feet in length. Our results show somewhat less tonnage than this, even when we extend the area down to 1,000 feet instead of their 500 feet depth.

Ore Reserves

What comparison we may ultimately make with the larger Longyear estimate of 5,700,000 tons over a length of 7,500 feet and to a depth of 500 feet we have yet no means of checking. Our work has not gone far enough to permit the expression of an opinion, but we do know that the ore-bearing contact in our ground is much longer than the 7,500 feet quoted.

As a matter of fact, however, the question of available tonnage is not one that gives us concern. In less than a year we have developed underground enough ore to keep our smelter running at double its present capacity for at least seven years, and we have such evidence of continuous and lengthy mineralization within our property that we are satisfied all tonnage demands will be met as they develop.

Much more important is the question of the metal content of our tonnage, and here we have been fortunate enough to find underground a somewhat better grade than that indicated by the Longyear drilling. The latter showed an average of 2.32 per cent. nickel and 1.19 per cent. copper for the tonnage now covered by our underground workings. Our much more complete investigation and sampling underground yields an average of 2.97 per cent. nickel and 0.97 per cent. copper. The gross value recoverable from this grade of ore . . . is estimated at $21.90 per ton.

The deep-drilling campaign now inaugurated is planned to give us intersections from the 1,000-foot level down to the 3,000-foot. So far there has been no difference in the ratio between nickel and copper in the ore found on the 225-foot or 1,000-foot levels, and the average grade of ore on these two levels is about the same.

Lateral development is being pushed on both the 225- and 1,000-foot levels, particularly to the west. The last westerly exposure on the upper level measured 50 feet in thickness and is still going strong. The western face of the 1,000-foot also shows strongly and with increasing width. Drill records show good intersections for 800 feet farther west, and there is just a suggestion that the ore rakes in that direction. The eastern faces are not so good and our drilling records show that we have to go some 400 feet farth r east to where we can expect betterment.

Estimated Costs

Figuring on a recovery per ton of sorted ore of 50 pounds nickel and 15 pounds copper plus 4 cents in precious metals per pound of nickel, the cost of producing nickel is estimated at 20 cents per pound. This after crediting copper and precious metals to the nickel and on the initial tonnage basis of around 250 tons of ore treated per day.

When marketing conditions permit us to double this output, the cost of nickel, with like credits, should fall to 18 cents per pound.

Estimated Earnings

On the initial tonnage basis and production of somewhat over 2,000 tons of nickel annually, the above cost should yield earnings of $656,000 yearly, or 20 cents per share at present outstanding.

Without further financing, this scale of operations can be doubled as soon as we have established a market for our products, and then the annual earnings should mount to $1,487,000, or 46 cents per share. These estimates are based on a selling price for nickel in Europe of £165 per long ton and £75 for cathode copper. It is obvious that earnings will at first go into this expansion and into establishing reserves.

Beyond this point of production further financing would be required. Smelting equipment would have to be rearranged and increased. The Norway refinery would be up to its limits and additional refining capacity should then be installed in Canada. I would repeat that there is every reason to believe that the mine can continue to develop any tonnage supply that such probable additional capacity would demand.

Smelter

Construction of this installation has progressed satisfactorily, and would have been even more rapid had equipment manufacturers lived up to their delivery promises. Even yet some deliveries are hanging fire and may delay the expected January commencement of operations.

Refinery

The Kristiansand (Norway) nickel refinery purchased by Falconbridge, and held by a Norwegian subsidiary named Falconbridge Nikkelverk, has been overhauled and is in process of doubling its capacity to that of 2,500 tons of refined nickel yearly. Much of this added equipment will permit of an ultimate output of around 4,000 tons of refined nickel yearly, so that increase to this latter figure will not entail any great extra expenditure of time or money. This development is under the personal supervision of our consulting metallurgist, Anton Gronningsater, of long experience in nickel.

In addition to handling our own Falconbridge output, this refinery will treat on a toll basis certain Norwegian production, which should add to Falconbridge earnings. Mr. Gronningsater reports that actual operation of this Norwegian production commenced at the end of October.

Our own matte should begin to arrive at the refinery by the end of February, and will then commence to fill up the system of the increased installation. It is not expected that refined nickel from our own production will reach the market before July, 1930.

Marketing

A sales contract has been entered into with the well-known metal firm of Brandeis, Goldschmidt and Company, of London, for the marketing of our Kristiansand output. Their wide connections and experience in European metal selling should be of material assistance to us in this important department of our venture.

BALANCE SHEET, OCTOBER 31, 1929

Assets

Cash on hand and in banks	$1,124,629.99	
Amounts receivable on investments sold	552,500.00	
Other accounts receivable	1,890.15	
Mining supplies	28,479.81	
		$1,707,499.95
Receivable on capital stock subscriptions in monthly instalments to March 2, 1930		675,000.00
Ventures Limited		4,046.05
Mining properties and claims	$2,551,299.03	
Mine and smelter buildings, machinery, and equipment	731,487.83	
		$3,282,786.86
Incorporation expenses	$1,385.00	
Development and administrative expenses deferred	252,968.45	
Prepaid insurance	3,529.02	
Commission on shares sold	250,000.00	
		$507,882.47
Falcon ridge Nikkelverk A/S, investments in and advances to	$643,666.16	
Special advance recoverable as a tonnage charge on custom metal as and when refined	219,000.00	
		$862,666.16
		$7,039,881.49

Liabilities

Capital, authorized 5,000,000 shares no par value, issued and to be issued 3,213,305 shares (options outstanding, 550,000 shares)	$6,909,581.64
Accounts and wages payable	130,299.85
Contingent liability, for completion of capital expenditure on mine and smelter and Nikkelverk refinery.	
	$7,039,881.49

CONSOLIDATED BALANCE SHEET, OCTOBER 31, 1929

Assets

Cash on hand and in banks	$1,130,745.99	
Amounts receivable on investments sold	552,500.00	
Other accounts receivable	1,890.15	
Mining stores	46,461.44	
		$1,731,597.58
Receivable on capital stock subscriptions		675,000.00
Ventures Limited		4,046.05
Mining properties and claims	$2,551,299.03	
Purchase price of Norway refinery ($389,333.33), less sale of old material	379,713.00	
Mine and smelter buildings, machinery and equipment, and new equipment and construction at refinery (Norway)	917,418.37	
		$3,848,430.40
Incorporation expenses	$1,385.00	
Preliminary organization, development and administrative expenses deferred	320,682.13	
Prepaid insurance	3,529.02	
Commission on shares sold	250,000.00	
		$575,596.15
Special advance recoverable as a tonnage charge on certain custom metal as and when refined		219,000.00
		$7,053,670.18

LIABILITIES

Capital, authorized 5,000,000 shares no par value, issued and to be issued 3,213,305 shares (options outstanding, 550,000 shares)	$6,909,581.64
Accounts and wages payable	144,088.54
Contingent liability, for completion of capital expenditures at mine and smelter and Nikkelverk refinery.	
	$7,053,670.18

From October 31, 1929, to December 31, 1929, mine development footage was distributed as follows:—

	Feet
Drifts and crosscuts	1,222
Raises	69
Total	1,291
Box-holes completed	29

This brings the total mine development footage as at December 31, 1929, to the following:—

	Feet
Shaft	1,033
Drifts and crosscuts	4,278
Raises	337
Total	5,648
Box-holes completed	38

An average of 131 men was employed during 1929, of whom 40 were employed underground.

Ernest Craig is superintendent; J. R. Gill, smelter superintendent; and W. Samuel, 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.

The directors whose term expires in 1930 are: John P. Bickell, Toronto; D. Owen Evans, Sir Harry McGowan, Rt. Hon. Lord Melchett, Hon. Henry Mond, Robert L. Mond, London, England; William E. Corey and Wm. N. Cromwell, New York; Wm. W. Mein, San Francisco, Cal.; Thomas Morrison and Grant B. Shipley, Pittsburgh, Pa.; Wm. J. Hutchinson and Seward Prosser, Englewood, N.J.

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, Andrew V. Stout, New York; Wm. T. Graham, Greenwich, Conn.; Reg. Halladay, Cresskill, N.J.

The International Nickel Company of Canada, Limited, operates mines in the Sudbury district; smelters at Copper Cliff and Coniston; hydro-electric plants at Turbine, Wabageshik, and Nairn Falls; refineries at Port Colborne, Ont., Acton, London, England, and Clydach, Wales; rolling mills at Birmingham, England, and Huntingdon, W. Va., U.S.A.; a colliery at Pontardawe, Wales; and a foundry at Bayonne, N.J., U.S.A. 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, 1929:—

This report deals jointly with the affairs of the International Nickel Company of Canada, Limited, and all of its subsidiaries, which now include the Mond Nickel Company, Limited. The financial statements submitted herewith reflect the various changes in capital structure incident to the inclusion of the Mond properties and other assets, and accordingly are not strictly comparable with those of last year.

Net earnings for the calendar year ended December 31, 1929, were $22,235,996.87 as compared with $12,399,317.42 for the previous year. This increase in net earnings is attributable not only to the inclusion of Mond's earnings but also to a substantial growth in the consumption of your company's products.

As a result of the plans of exchange of stock of your company for stock of the former International Nickel Company (New Jersey) and stock of the Mond Nickel Company, Limited, $27,627,825.00 of 7 per cent. cumulative preferred stock and 13,758,208 shares of common stock without par value are issued or are to be issuable upon completion of the exchanges.

CONSOLIDATED GENERAL BALANCE SHEET, DECEMBER 31, 1929

ASSETS

PROPERTY ACCOUNT:	Dec. 31, 1929	Dec. 31, 1928
Property owned and operated as at December 31, 1928, together with properties acquired with the Mond Nickel Company, Limited	$134,988,485.38	$68,456,428.31
Addition during year 1929	21,175,351.76	7,816,102.10
	$156,163,837.14	$76,272,530.41
DEDUCT RESERVES:		
Depreciation of plants	$14,492,003.23	$11,852,063.46
Depletion	5,373,476.31	4,560,025.19
	$19,865,479.54	$16,412,088.65
	$136,298,357.60	$59,860,441.76
SUNDRY INVESTMENTS	2,910,339.13	2,058,896.67
	$139,208,696.73	$61,919,338.43
CURRENT ASSETS:		
Inventories of metals and supplies at cost or market, whichever is lower	$17,109,312.18	$7,278,429.46
Accounts and bills receivable	8,487,682.26	4,622,873.89
Government securities	745,675.00	2,730,100.00
Call and time loans	13,962,900.00	17,600,000.00
Cash	2,432,433.32	1,848,666.69
	$42,738,002.76	$34,080,070.04
	$181,946,699.49	$95,999,408.47

LIABILITIES

CAPITAL STOCK:	Dec. 31, 1929	Dec. 31, 1928
7 per cent. cumulative preferred	$27,627,825.00	$8,912,500.00
Common stock, no par value, 13,758,208 shares	57,360,541.67	46,909,200.00
	$84,988,366.67	$55,821,700.00
DEBENTURE STOCK OF BRITISH SUBSIDIARIES:		
5 per cent. first mortgage debenture stock	$1,822,500.00	
5½ per cent. mortgage debenture stock	4,938,119.64	
6¼ per cent. mortgage debentures	866,052.00	
	$7,626,671.64	
Ten-year serial 5 per cent. purchase money notes	$1,500,000.00	$1,800,000.00
CURRENT LIABILITIES:		
Accounts payable and pay rolls	$6,101,324.77	$2,245,733.59
Taxes accrued	3,921,366.03	1,214,893.45
Reserved for preferred dividend payable February 1, 1930	483,472.94	155,968.75
	$10,506,163.74	$3,616,595.79

LIABILITIES—*Continued*

FUNDS AND RESERVES:		
Insurance and contingent	$2,837,763.96	$1,245,603.55
Retirement system	1,100,032.81	345,689.20
	$3,937,796.77	$1,591,292.75
SURPLUS:		
Capital surplus represented by surpluses of subsidiaries at acquisition	$48,428,730.57	$16,030,641.57
Earned surplus	24,958,970.10	17,139,178.36
	$73,387,700.67	$33,169,819.93
	$181,946,699.49	$95,999,408.47

CONSOLIDATED GENERAL PROFIT AND LOSS STATEMENT

(For twelve months ended December 31, 1929)

	Dec. 31, 1929 (12 months)	Dec. 31, 1928 (12 months)
EARNINGS OF ALL PROPERTIES after deducting manufacturing, selling expense, ordinary repairs and maintenance	$29,353,072.97	$16,076,595.52
OTHER INCOME	1,800,587.48	629,999.05
TOTAL INCOME	$31,153,660.45	$16,706,594.57
DEDUCT:		
General office expense	$1,846,316.18	$967,478.56
Reserved for income and franchise taxes (estimated provision)	2,682,394.99	1,188,678.59
	$4,528,711.17	$2,156,157.15
NET OPERATING INCOME	$26,624,949.28	$14,550,437.42
DEDUCT:		
Interest paid and accrued	$448,066.48	.....
Provision for retirement system	886,051.07	$556,765.02
Provision for depreciation and depletion	3,054,834.86	1,594,354.98
	$4,388,952.41	$2,151,120.00
NET PROFIT FOR THE YEAR	$22,235,996.87	$12,399,317.42
DIVIDENDS:		
Preferred	2,040,501.23	557,034.25
Common	12,375,703.90	4,331,095.25
BALANCE TO SURPLUS	$7,819,791.74	$7,511,187.92

QUARTERLY CONSOLIDATED GENERAL PROFIT AND LOSS STATEMENT

(For twelve months ended December 31, 1929)

	1st quarter Mar. 31, 1929	2nd quarter June 30, 1929	3rd quarter Sept. 30, 1929	4th quarter Dec. 31, 1929
EARNINGS OF ALL PROPERTIES after deducting manufacturing, selling expense, ordinary repairs and maintenance	$7,391,660.85	$7,291,861.49	$7,446,226.11	$7,223,324.52
OTHER INCOME	469,047.98	536,207.25	537,465.54	257,866.71
TOTAL INCOME	$7,860,708.83	$7,828,068.74	$7,983,691.65	$7,481,191.23
DEDUCT:				
General office expense	$527,728.79	$474,197.01	$376,720.12	$467,670.26
Reserved for income and franchise taxes (estimated provision)	748,698.05	678,229.70	821,765.22	433,702.02
NET OPERATING INCOME	$6,584,281.99	$6,675,642.03	$6,785,206.31	$6,579,818.95

CONSOLIDATED GENERAL PROFIT AND LOSS STATEMENT—*Continued*

DEDUCT:				
Interest paid and accrued....	$104,251.56	$103,454.08	$130,930.30	$109,430.54
Provision for retirement system.....	151,190.66	191,507.09	260,524.27	282,829.05
Depreciation and depletion...	738,648.47	732,696.09	766,174.16	817,316.14
NET PROFIT.....	$5,590,191.30	$5,647,984.77	$5,627,577.58	$5,370,243.22
DIVIDENDS:				
Preferred.....	589,876.11	484,064.00	484,069.75	482,491.37
Common.....	2,749,146.80	2,750,116.40	3,438,069.10	3,438,371.60
BALANCE TO SURPLUS.....	$2,251,168.39	$2,413,804.37	$1,705,438.73	$1,449,380.25

Canadian Properties

The properties of the Mond Nickel Company, Limited, in Canada were acquired by your company directly and are as follows: Garson, Levack, and Frood Extension mines, together with lands and mineral claims in the Sudbury area, a smelter at Coniston, and hydro-electric plants at Wabageshik and Nairn Falls.

During the year 1,991,910 short tons of ore were mined, of which 1,177,323 tons were mined at Creighton. 368,686 tons at Levack, 246,049 tons at Garson, and 199,852 tons at Frood.

The smelters at Copper Cliff and Coniston ran at capacity throughout 1929 and produced 132,030 short tons of bessemer matte. Of this total the Copper Cliff plant furnished 91,613 tons and the Coniston plant 40,417 tons.

At the Port Colborne refinery, production of refined nickel was kept in close balance with consumption. Three additional electrolytic units were installed during 1929, and this refinery now has an annual capacity of 86,400,000 pounds of electrolytic nickel, 36,000,000 pounds of nickel in oxide, and 120,000,000 pounds of blister copper.

At the Coniston works a new sintering plant has been erected and placed in operation. This sintering plant, together with the installation of fast cranes and improved matte handling facilities in the smelter, will materially increase matte production.

A fire of unknown origin destroyed the headframe and rock-house at the Levack mine in December, 1929. This surface plant, formerly of timber, will be replaced by steel, and the mine will resume production by July, 1930. No shortage of nickel will result as your other mines can readily supply smelter requirements.

"Nitre cake," an essential flux used in the separation of copper and nickel, is an acid sodium sulphate heretofore available in quantity as a by-product from the manufacture of nitric acid. Manufacturers of nitric acid are adopting the atmospheric nitrogen fixation process with the result that the production of nitre cake is diminishing and its price rising. In order to insure a permanent supply of this material at a reasonable cost your company has acquired by lease a large deposit of sodium sulphate located in Saskatchewan and has contracted with the Horseshoe Lake Mining Company, Limited, to develop this property. The sodium sulphate will be delivered to a sulphuric acid plant now being constructed at Copper Cliff by Canadian Industries, Limited. Your company has entered into a long-term contract with Canadian Industries, Limited, under which sulphur gases from the new smelter will be sold to that company for the manufacture of sulphuric acid primarily for the conversion of Horseshoe Lake sodium sulphate into nitre cake in quantities sufficient to meet refinery requirements.

As announced during the past year your company, jointly with the American Metal Company of Canada, Limited, and Consolidated Mining and Smelting Company of Canada, Limited, is erecting an electrolytic copper refinery at Copper Cliff, Ont. The initial capacity of this works, which will be the largest of its kind in the British Empire, will be 120,000 short tons per annum and the capital expenditure involves approximately eight million dollars. Your company has acquired a 40 per cent. interest in this undertaking. Rapid progress has been made, and this plant should be refining copper from the Frood mine by the autumn of 1930. The company organized to carry on this business is known as Ontario Refining Company, Limited.

Since the last report was issued, the Frood surface plant has been completed and put into successful operation. There are now 2,000 men employed at this mine, and underground development is progressing rapidly. During the year ended December 31, 1929, 48,877 lineal feet of drifts, crosscuts, raises, winzes, and box-holes were completed and a ventilating shaft raised 1,583 feet. This vast amount of work, aggregating nearly ten miles, brings the total underground development, since work was started in September, 1926, to a total of 64,291 lineal feet, or over twelve miles. Communications have been established between the Frood mine and the Frood Extension mine (the ore body being continuous) on the 2,000-, 2,400-, and 2,800-foot levels, and connections will soon be completed on the 2,200- and 2,600-foot levels.

The proven ore in this deposit now amounts to 134,673,000 tons, of which 43,562,000 tons is high-grade ore below the 1,400-foot level. Extension sampling shows that the ore body thus far developed grows progressively richer in copper as depth is attained. This was indicated by assays on ore taken from crosscuts, results of which were submitted in the report of December 31, 1928. The average grade of proven ore below the 1,400-foot level runs: nickel, 2.39 per cent.; copper, 3.62 per cent.; a total of 6.01 per cent. It is of interest to note that over

10,000,000 tons of high-grade ore were added to the Frood reserves as a result of development work in the lower levels completed during the year 1929.

Recent work on the 2,800-foot level is showing much greater widths and evidence of extensions along the strike both to the north and to the south and promises further substantial additions to the Frood high-grade reserves. No special effort is being made to block out more ore, as this situation will unfold as mining operations proceed.

Monthly output reached 37,600 tons in December, 1929, about two-thirds of which came from development work, and will increase month by month during 1930 as new stopes are brought to the producing stage. It is your management's objective to prepare this mine to furnish at least 4,500 tons daily by midsummer of 1930 and to bring up the output to 6,000 tons daily by January 1, 1931.

Progress on the new smelter and concentrator, plans for which were mentioned in the last report, has been rapid. All of the reverberatory smelting-plant steel was erected and the plant closed in during 1929. Foundations are completed and steel is being erected on the concentrator plant, which will have a capacity of 8,000 tons per day. There will be 35,700 tons of structural steel in these two structures and their auxiliary buildings. The ore bins, having a capacity of 10,000 tons, have been completed, as has also the screening and crushing plant, having a daily capacity of 8,000 tons.

The smelter stack, 510 feet high, inside diameter 45 feet, is finished and a coal grinding plant, having a daily capacity of 700 tons of ground coal, is 80 per cent. completed.

Smelter equipment, consisting of five 1,000-ton reverberatory furnaces, thirty 10-hearth Herreshoff roasters, and eight 13- by 35-foot matte converters, is being installed and, barring unexpected interruptions, this plant will be blown in during the summer of 1930. When completed this smelter will have a daily capacity for 5,000 tons of concentrates from the new concentrator or a like tonnage of direct smelting ore and should, from the standpoint of flexibility and cost of production, compare favourably with any similar plant now in operation.

Ore Reserves

Your company now has proven ore reserves of 202,620,000 short tons. This tonnage includes Frood mine low-grade, 91,111,000 tons; Frood high-grade, 43,562,000 tons; Creighton mine, 5,503,000 tons; Levack mine, 19,062,000 tons; Garson mine, 3,193,000 tons; Murray mine, 22,490,000 tons; Stobie mine, 13,712,000 tons; Crean Hill mine, 3,028,000 tons; other mines, 959,000 tons.

Without taking into consideration the possibility of lateral extensions and probable ore below 3,000 feet, the Frood high-grade ore, together with the reserves in the other mines now being worked (Creighton, Levack, and Garson), indicates a life at the present annual rate of nickel consumption of twenty-five years. Beyond this period the vast reserves in other mines and in the upper levels of the Frood, with future inevitable improvements in mining methods and metallurgical processes, guarantee low-cost nickel production over a long period of time and fully justify a continuation of your company's aggressive sales development policy.

It was stated in the last annual report to stockholders that precious metal values in Frood ore would be determined by smelting average samples of ore obtained from development work and analysing the resultant bessemer matte, this method being more accurate than the usual method of analysing ore samples. Results obtained in this way indicate that bessemer matte made from Frood ore mined below the 1,600-foot level will net a return in precious metal values of approximately $50 per ton.

Obviously the amount of income from this source will depend upon the marketability of the platinum metals, for which the demand is at present limited. Your management has had its research and development departments actively engaged for some time past with a view to extending the uses for platinum metals and thus avoiding surplus production otherwise probable when the prospective output of the Frood mine is considered.

Outlook

During 1929 your company procured the greatest volume of business in its history, notwithstanding that sale of nickel for the manufacture of ordnance and armour plate were negligible.

The world's consumption of primary nickel in all forms reached a total of 136,000,000 pounds, exceeding the corresponding figure for 1928 by 16 per cent. and the peak of the work period by 29 per cent.

With the inclusion of the Mond Nickel Company, Limited, the scope of your company's activities has been materially expanded. Research and sales staffs have been reorganized, and your company's proved sales policy now inaugurated by Mond in Great Britain and Continental Europe is already showing appreciable results.

Plant betterments and the installation of additional mining and smelting facilities in Canada, Great Britain, and the United States are progressing satisfactorily. The major projects in this programme, entailing a further expenditure of approximately $12,000,000, are scheduled for completion during the ensuing year and will make provision for a total annual output of 180,000,000 pounds of nickel. In pursuance of your company's policy of providing for an adequate supply of metal to meet rapidly increasing demand, expenditures of this character aggregating $37,500,000 have been made since 1924.

The increased output of copper in 1929 compared with 1928 was largely due to Frood ore extracted as stopes were opened in this mine. Copper production will show a further large

increase as the Frood mine comes into operation this year coincident with the completion of the electrolytic refinery of the Ontario Refinery Company, Limited, at Copper Cliff, Ont.

Each of the principal uses of nickel gained ground during 1929, and it is most gratifying that sales of no important type of nickel steel or nickel alloy are lagging.

In the automotive industry large quantities of nickel were consumed and high percentage nickel steels are now standard materials used in the manufacture of tractors, trucks, and busses. Similar steels are also specified for at least 90 per cent. of modern aeroplane engines.

The use of nickel steel is rapidly progressing in locomotive construction. Many railroads are using or are now experimenting with nickel steel and nickel cast-iron for such purposes as boiler shells, tubes, forgings, stay-bolts, frames, cylinders, and other castings. This field is a most promising outlet for a large tonnage of nickel.

Stainless steels and irons containing 8 to 12 per cent. of nickel are rapidly coming into prominence. Although a recent development, your company's sales of nickel for this requirement have increased over 400 per cent. during the past year. There is every reason to believe that the manufacture of stainless steel is in its initial stage and will ultimately become one of the principal outlets for nickel. Large quantities of this alloy will be used for automobile radiators, lamps, and trim in 1930. Some fifteen steel companies in America and Europe are now making and selling this product.

The use of nickel in cast iron and in cast steel has expanded satisfactorily. Several of the high nickel content irons, such as corrosion- and growth-resisting iron, high strength iron and hard chilled iron, are being vigorously developed for a great variety of applications. Sales of nickel to foundries increased 50 per cent. in 1929, and continued progress may be expected.

Magnetic nickel iron alloys, used principally in radio transformers and telephone coils, are being considered for power distribution transformers, a much wider field of application. The consumption of these alloys increased 100 per cent. in 1929, and there is every prospect for another large advance in 1930.

The demand continues to expand for nickel-chromium and nickel-chromium-iron heat-resisting alloys for equipment and structures operated at high temperatures, such as electrical heaters and stoves, metallurgical furnaces, chemical retorts, and heat regenerators. Some twenty manufacturers are now engaged in the production, development, and sale of these materials.

Consumption of nickel for electro-plating has materially increased, due not only to the expansion of the use of nickel plating, particularly in the automotive industry, but also to the gradual adoption of heavier nickel deposits. While many articles are now finished with chromium plate, this finish is usually applied on a foundation of heavy nickel-plate, as in the case of automobile trim.

Sales of mill products from the Huntingdon and Birmingham plants were well in excess of last year, and there is a growing demand for rolled nickel alloys such as copper-nickel, German silver, chromium-nickel, and iron-nickel. Sales of pure rolled nickel have rapidly expanded, and increased consumption is indicated for such diversified purposes as radio tubes, caustic evaporators, oil-well strainers, dairy apparatus, and plating anodes.

Monel metal sales have continued to expand for both new and established uses. Modern design has facilitated its adoption for architectural decoration in buildings such as banks, offices, and hotels. A comprehensive campaign has been undertaken to popularize Monel metal for domestic appliances, such as kitchen and pantry sinks, table tops, and washing machines. Through wide publicity the merits of this alloy are now generally recognized in many countries where distributors have been selected by your company. A survey is at present under way with a view to stimulating the consumption of Monel metal in China and Japan.

The business your company will secure during 1930 depends largely on activity prevailing in other lines of industry. Your company has an advantage in having a world market for a diversity of products which makes for continuity of operations and stability of earnings. Nickel is now essential to industry, and applications of a permanent character will continue to multiply. Copper and precious metals, heretofore valuable by-products, will shortly become more important sources of revenue to your company. All factors considered, your management believes that the outlook is promising for sustained progress during 1930.

The International Nickel Company of Canada, Limited, employed an average force of 4,586 men in the Sudbury district during 1929, divided as follows:—

Creighton	864
Frood	1,324
Garson	342
Levack	382
Copper Cliff	1,040
Coniston	634
Total	4,586

During 1929 the following superintendents were in charge of the various mines of the company: superintendent of mines, Oliver Hall; Creighton

mine, R. D. Parker; Frood mine, G. L. Helmrich, succeeded J. P. Hussey and A. D. Carmichael, with F. J. Eager as assistant; Garson mine, W. J. Mumford, succeeded A. L. Sharp; Levack mine, A. L. Sharp, succeeded F. J. Eager.

McVittie-Graham Mines, Limited

In the spring of 1929 control of this company passed to interests comprised of the British Metals Corporation, N. A. Timmins interests, and F. M. Connell.

The officers and directors of the company are: F. M. Connell, president; R. E. Stavert, vice-president; Geo. E. Leighton, J. I. Rankin, and Roy D. Hearn, directors.

The executive offices are at 132 St. James Street West, Montreal. W. E. Segsworth is general manager.

The following is from the report of the general manager for the year ending December 31, 1929:—

Moose Lake.—The shaft was completed to 265 feet, a station cut at 250 feet, and crosscuts run 58 feet west and 59 feet east. From the west crosscut a drift was run 237 feet north, and from the east crosscut a drift was run 229 feet south.

From these drifts, which were parallel to the ore zone, twelve horizontal diamond-drill holes were run across the formation through the contact. The total number of feet drilled was 1,593.

In addition to this underground work, the surface outcrops were trenched and sampled and a magnetic survey made along the norite-granite contact. The result of this work was the disclosure of four lenses of ore. These lenses were spread over a distance of 1,800 feet, and the magnetic survey did not show any connecting bodies intervening.

Work was discontinued on the Moose Lake property at the end of July. Deep diamond-drilling was commenced again in December, and by the end of the year the first hole had reached a depth of 264 feet and had not reached its objective.

Totten-Howland Option.—The geological mapping of this property was carefully gone over and the drill cores relogged. As a result of this work, diamond-drill hole No. 6 was deepened from 1,467 feet to 1,902 feet, with no result.

On the other properties under option, the most important of which were the Ella Lake and the Clear Lake properties, magnetic surveys and surface trenches were run, but this work did not disclose any showing large enough to continue work under the option terms.

Examination of Holdings.—All the properties owned by the company were carefully examined, especially along the norite contact; and where conditions appeared favourable, magnetic or electric surveys were run. None of the properties yielded any discovery worthy of active development at this time. Detailed maps and reports on each of these properties are on file.

Examination of Properties Submitted.—Twenty-two outside properties were examined with a view to taking up options. Of these, two were considered worthy of further attention, and negotiations are still in progress on the most promising.

Prospecting.—In July, eleven claims were staked in Maclennan township on the east rim of the Sudbury basin. An endeavour was made to locate ore on these claims, both by magnetometer and by electrical survey, but as nothing was found the claims were abandoned.

Sudbury Offsets, Limited

This company is capitalized at 5,000,000 shares of $1 par value. The officers and directors are: C. T. Young, president; D. W. Lang, vice-president; S. J. Defoe, secretary-treasurer; Frank Dennie, G. H. Sedgewick, and Geo. Glendinning, directors. The head office is at 1004 Bank of Hamilton Building, Toronto.

Sudbury Offsets, Limited, own and have been developing 46 claims in Foy township, district of Sudbury, on the north rim of the basin. The company reports a total of 8,610 feet of diamond-drilling done during 1929, together with trenching, stripping, and the establishment of roads.

SILVER

Agaunico Cobalt Mines, Limited

The Agaunico Cobalt Mines, Limited, operated the property in Bucke township, district of Timiskaming, throughout the year.

The officers of the company are as follows: D. L. Jemmett, president; H. Jemmett, secretary. The directors are: D. L. Jemmett, Jas. L. Ross, Jas. L. Ross, Jr., and E. M. Carruthers.

During the year the following underground work was done:—

	Feet
Exploration	97
Developing	88
Raising	23

Shipments of cobalt ore, having a value of $43,609.11, were made to the Deloro smelter and to Germany.

J. M. C. Dunlop was resident manager, employing an average of 29 men.

Blair Gowganda Silver Mines, Limited

The Blair Gowganda Silver Mines, Limited, has a capitalization of $1,000,000, divided into 500,000 shares of common stock of $1 par value and 5,000 shares of preferred stock, par value $100. The officers of the company are: W. J. Blair, president; T. H. Plunkett, vice-president; Miss J. Dodd, secretary. The directors are: W. J. Blair, Geo. H. Sedgewick, E. L. Thompson, W. W. Hall, C. B. Ulrich, and F. A. Turnquist.

The following work was done from June 6 to November 20, 1929: sinking, 49 feet; drifting, 250 feet; and crosscutting, 110 feet. An average force of 12 men was employed. M. D. Kennedy was manager. The mine is in Nicol township, district of Timiskaming. The head office is at Barrie, Ont.

Arthur Brocklebank

Arthur Brocklebank operated the Kerr Lake mine in Coleman township, district of Timiskaming, under lease, during 1929.

Shipments of ore to the smelter at Deloro totalled 65.38 tons, having a value of $57,269 in silver and $1,993 in cobalt. Bullion valued at $5,029 was shipped.

Ten men were employed.

C. E. Cain and Associates

In 1929, C. E. Cain, Wesley Preston, and W. D. Taylor bought the Beaver mine in Coleman township, district of Timiskaming, from the Northern Canada Mining Corporation.

All work on the property was done by the owners. Shipments of ore having a value of $1,810 were made.

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.

Angus D. Campbell is mine manager, and 120 men are 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, 1930:—

PRODUCTION

Concentrates shipped, or ready for shipment, dry tons	301.04	
Ounces, per ton	2,761.45	
Total fine ounces silver recovered	831,307.00	
Total pounds cobalt recovered	37,834	

REVENUE

Total ounces paid for	768,094.24	
Average price obtained per ounce	$0.4966	
Revenue from sale of silver		$381,440.12
Total pounds cobalt sold	32,656	
Revenue from sale of cobalt		5,033.23
Total revenue		$386,473.35

PRODUCTION SINCE COMMENCEMENT OF OPERATIONS

Period	Months	Tons milled	Ounces per ton recovered	Gross production, ounces	Gross value, silver and cobalt
Feb. 1, '22, to June 30, '22	5	Sorting	.....	40,000	$28,000.00
July 1, '22, to June 30, '23	12	Sorting	.....	62,811	41,146.80
July 1, '23, to June 30, '24	12	7,607	46.03	350,147	229,656.95
July 1, '24, to June 30, '25	12	30,273	30.62	927,088	637,712.10
July 1, '25, to June 30, '26	12	34,425	29.03	999,234	683,601.48
July 1, '26, to Mar. 31, '27	9	29,136	26.18	762,861	426,928.53
Apr. 1, '27, to Mar. 31, '28	12	40,250	21.32	858,044	486,186.47
Apr. 1, '28, to Mar. 31, '29	12	43,186	22.04	951,718	546,937.28
Apr. 1, '29, to Mar. 31, '30	12	45,302	18.35	831,307	383,766.97
Total	.....	230,179	.....	5,783,210	$3,463,936.58

SUMMARY OF DEVELOPMENT (No. 3 SHAFT)

	Feet
Drifts	5,542.3
Crosscuts	3,798.3
Raises	1,539.6
Winzes	4.5
Total	10,884.7

This work was done in 182 working places on the 11 mine levels. The total footage now completed at No. 3 shaft is 58,450 feet, or over 11½ miles, with a production of 100 ounces of silver per foot.

SOURCES OF ORE FROM MINE

	Tons	Grade, ounces	Total, ounces
Development	5,615	8.4	47,144
Stopes	39,687	21.3	845,615
Total	45,302	19.7	892,759

WASTE ROCK

	Tons
To surface	18,355
To filled stopes	9,776
Total	73,433

MILLING

	Tons	Ounces per ton	Total, ounces
Ore treated from mine	45,302	.....	.....
Silver recovered	.....	18.35	831,307[1]
Silver in tailings	.....	1.36	61,452
Total	.....	19.71	892,759

[1]Smelter returns.

CONCENTRATES PRODUCED

	Pounds	Ounces
Metallics	.....	2,660
Jigs	164,018	316,859
Sands	302,668	483,728
Slimes	56,847	15,533

OPERATING COSTS

	Total cost	Cost per ton	Cost per ounce
Development	$132,867.27	$2.933	$0.160
Mining	64,299.80	1.419	.077
Tramming and hoisting	28,545.89	.630	.034
Milling	50,754.72	1.120	.061
Shipping	8,212.37	.181	.010
Smelting and refining	14,710.05	.327	.018
General expenses, mine	16,355.55	.361	.020
Corporate legal transfer and administration, Toronto office expenses	15,911.68	.351	.019
General maintenance	3,058.74	.067	.004
Insurance and miscellaneous	5,618.19	.124	.007
Total	$340,334.26	$7.513	$0.409

MILLING COSTS

	Labour	Supplies	Power	Total	Cost per ton
Conveying to mill	$3,075.86	$604.75	$200.38	$3,880.99	$0.086
Crushing	2,192.17	1,657.39	1,574.00	5,423.56	.120
Jigging	1,412.00	1,207.23	1,252.69	3,871.92	.085
Ball-milling	5,422.88	5,281.10	4,688.57	15,392.55	.340
Tabling	5,112.82	547.52	2,134.05	7,794.39	.172
Drying and bagging	2.29	151.90	803.75	957.94	.021
Water supply	432.82	41.09	639.52	1,113.43	.025
Heating	517.11	1,190.77	.....	1,707.88	.038
Tailings disposal	3.52	60.79	.....	64.31	.001
Repairs and maintenance	4,467.20	417.88	.....	4,885.08	.108
Supervision and assaying	5,066.09	460.85	135.73	5,662.67	.123
Total	$27,704.76	$11,621.27	$11,428.69	$50,754.72	.....
Cost per ton	$0.611	$0.256	$0.253	.....	$1.120

Development

An extensive programme of exploration and development was carried out during the first three quarters of the year, 9,340 feet of crosscutting and drifting and 1,540 feet of raising being done. During the last three months of the year, the price of silver having dropped abruptly, development expenditures were cut and the work confined to the most favourable areas. Some minor ore shoots were developed during the year. No ore was found on the deep 850-foot level. These erratic ore bodies require exploration of as many favourable chances as possible at a minimum of cost, favourable results in some areas paying for unfavourable results in other areas and also yielding a profit on the whole. The present low price of silver reduces the number of favourable chances, since three ounces of silver now sell for the price previously received for two ounces. Ore must therefore grade 50 per cent. higher in silver to be worth as much as formerly. Nevertheless, bonanza silver ore bodies, such as have been known in this locality and others which may yet be found, can be worked at a profit.

Capitol Mines

The Capitol Silver Mines, adjacent to your property, having been taken over, exploration there has been commenced. An electrically driven plant, consisting of an 1,100 cubic foot air compressor, double-drum electric hoist, electric pump, and drilling equipment was put in at the Capitol shaft on claim H.S. 351. The capital cost of this equipment and connecting electric power lines was $25,000. The shaft has now been pumped out and crosscutting started on the 800-foot level. The first part of the crosscutting will be in the Keewatin formation, in which has been found rich silver veins at Cobalt and South Lorrain. The crosscut will be driven into an area of the underlying diabase sill where the chances of finding payable silver veins are excellent.

New Plant and Equipment

In addition to the equipment purchased for the Capitol shaft, an expenditure of $2,177 for plant and equipment was made at the main workings. This, however, paid for itself in lower operating costs during the year. The Diesel engine power plant in use before the present electric power was secured was sold.

Milling

The mill handled an extra half month's tonnage during the year, although the total costs of milling were lowered. The grade of ore milled was lower than during the previous year.

General

Total operating costs were again reduced, but due to the lower grade of ore and to the very low price of silver during the last part of the year, profits were less than those of the previous year. A substantial profit was, however, made. The maintenance of milling and profits depends on the results of development, which continues on a reduced scale at the main workings, and on the results of the Capitol shaft exploration, which is being actively extended to a very favourable area.

F. L. Chitty

The Badger mine in Coleman township, district of Timiskaming, was operated under lease by F. L. Chitty.

High-grade ore, containing 219 ounces of silver, was shipped to Deloro.

E. H. Clemens

E. H. Clemens operated the Coniagas mine in Coleman township, district of Timiskaming, under lease throughout the year, employing 12 men.

Fifty-four tons of ore were mined, and a shipment of 53.57 tons, containing 309,674 ounces of silver, was made.

Cobalt Contact Mines, Limited

The Cobalt Contact Mines, Limited, operated their properties in Bucke township, district of Timiskaming, with a force of 20 men during the year. 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 development for the year comprised: 585 feet of drifting, 155 feet of crosscutting, and 120 feet of raising. The work was all done on the 300-foot level. During the year 143.12 tons of ore was shipped containing

66,194 ounces of silver and 21,988 pounds of cobalt. Also 1,419 tons of mill rock were shipped to the Cobalt Reduction Company. This rock contained 33,848 ounces of silver, making a total production of 100,042 ounces.

Cobalt Kittson Mines, Limited

The Cobalt Kittson Mines, Limited, has an authorized capital of $5,000,000 in shares of $1 par value. The officers are: J. H. Paré, president; W. H. Mitchell, secretary-treasurer. The directors are: David Champaux, Wilfrid Duclos, A. Nadeau, P. Dubuc, and A. J. Pidgeon. The head office is at 70 St. Paul Street, Quebec, Que.

The property in Kittson township, district of Timiskaming, was operated continuously during 1929, a working force of 10 men underground and 15 on the surface being employed.

Development work consisted of: 178 feet of shaft-sinking, 326 feet of crosscutting, 371 feet of drifting on the 450-foot level, and 60 feet of drifting on the 598-foot level. A storehouse, stable, and power-house were built.

A. Nadeau was in charge of operations until June 1, 1929, and was succeeded by A. J. Pidgeon.

Friday Mines, Limited

Friday Mines, Limited, operated their property in the township of South Lorrain, district of Timiskaming, from February to December, 1929, with a force of 10 men. The officers and directors of the company are: J. R. Sproat, managing director; R. C. Vokes, G. A. Beirkamp, C. H. Gray, and W. H. Schaffer. The head office of the company is at Timagami, Ont.

The development work for 1929 was as follows: a two-compartment shaft was sunk 156 feet; and 201 feet of drifting and 54 feet of cross-cutting was done on the 80-foot level.

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: F. H. Hamilton, president; W. H. Stafford, vice-president; L. Ehrlich, John H. Black, R. T. Shillington, E. Turk, and A. S. Hamilton, directors.

W. J. Dobbins is manager, and 96 men are employed at the mine in South Lorrain township, district of Timiskaming.

The manager's report for the fiscal year ending February 28, 1929, is as follows:—

Summary of Underground Operations

During the year, the following underground development has been carried out:—

	Feet	Cost per foot
Drifting and crosscutting	9,233.5	$13.54
Raising	1,546	16.03

Some 16,032 tons of ore was hoisted. Of this amount, 14,770 tons was taken from the stopes; the remainder came from development.

Results of Development

As indicated by the foregoing figures, a large amount of crosscutting, drifting, and raising has been performed during the year on the upper contact. This was carried out in order that all possibilities in that area might be exhausted. As a result of this work, several small shoots of ore were opened up, which while in no case large, yet in total were sufficient to carry on production.

There is still some work to be performed in this section with possibilities of some further ore still remaining.

In August, 1928, by arrangement with the Mining Corporation of Canada, Limited, exploration of the lower contact of the diabase sill was commenced through the workings of the adjoining Frontier property at the 1,400-foot level. This development has been continuous since that date, and small patches of silver have been found from time to time.

While these occurrences have been decidedly encouraging in that they give proof of mineralization, no ore body of commercial size had been developed at the close of the fiscal year.

Mill Statistics

During the year, 13,147 tons of ore was milled. Abbreviated statistics are as follows:—

Ore milled	13,147 tons
Heads, average	27.7 ounces
Tails, average	3.9 ounces
Extraction, average	85.8 per cent.
Average running time	85.1 per cent.

Production

Production for the year (based on actual smelter returns) was as follows:—

	Pounds, net	Silver, ounces	Cobalt, pounds
Picked ore	225,532	367,487.46	47,289
Concentrates	766,993	317,509.54	53,600
Total	992,525	684,997	100,889

The corresponding figures for the silver and cobalt produced during the previous year were 994,582.75 ounces and 92,962 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
Total	13,249,714.4	9,146,714.43	1,131,264.88
Fiscal year, 1928-29	992,525	684,997	100,889
Total production to February 28, 1929	14,242,239.4	9,831,711.43	1,232,153.88

COST OF PRODUCTION

(Based on 13,228 tons of ore treated, producing 684,997 ounces of silver)

	Total cost	Cost per ton	Cost per ounce
Development	$150,707.94	$11.39	$0.220
Ore extraction	68,379.13	5.17	.100
Ore sorting	7,610.02	.58	.011
Milling	27,291.04	2.06	.040
Shipping and marketing	34,954.42	2.64	.051
Administration	27,852.87	2.11	.041
General maintenance	14,245.12	1.08	.021
Head office expense	9,331.30	.71	.013
Corporate expense	21,292.75	1.60	.031
Taxes	480.00	.04	.001
Total	$362,144.59	$27.38	$0.529

Ore Reserves

While no calculation of ore reserves has been attempted, there still remains a sufficient amount of high-grade and mill rock in the mine to maintain the present rate of production for a few months.

J. H. McLeod and C. W. Price

J. H. McLeod and C. W. Price operated the Foster mine in Coleman township, district of Timiskaming, under lease, throughout 1929.

Ore and bullion having a value of $4,236 were shipped. The cobalt content of the ore was valued at $1,376.

Three men were employed.

George Martin

The Crown Reserve mine in Coleman township, district of Timiskaming, was leased to George Martin.

Ore and metallics valued at $6,878 were shipped to the Nipissing mill.

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; W. R. P. Parker and G. M. Clark, vice-presidents; E. H. Rose, J. P. Watson, A. B. Stodart, C. E. Trafford, directors. M. F. Fairlie is managing engineer, and G. C. Ames is secretary-treasurer.

The average number of men employed at Cobalt was 150, of whom 40 men were employed in the mill of the Cobalt Reduction Company, a subsidiary of the corporation. The working force in South Lorrain at H. R. 64 averaged 30 men.

The year's operation resulted in a net profit of $478,497.07. Two dividends of $207,506.25 were declared. The production from the Cobalt mines of the corporation was greater than in 1928, but the total production was less, owing to the cessation of operations at the Frontier mine, South Lorrain. Total production was 985,249 ounces in 1929, against 1,132,603 ounces in 1928. In the Cobalt mines the estimated ore reserves were 22,000 tons containing 500,000 ounces of silver.

The following is taken from the managing engineer's report for the year 1929:—

Production

Silver production for the year was almost entirely confined to the Cobalt properties; exhaustion of the ore bodies at the Frontier and Crompton mines at South Lorrain having compelled discontinuance of work early in the year.

As a result, total production declined from 1,313,958 ounces to 985,249 ounces, although an increase from 918,266 ounces to 970,954 ounces was attained at Cobalt.

Continuously declining prices for silver throughout the year compelled the stopping of production on a number of veins, in order that the grade of mill ore might be maintained at a profitable level.

	Tons treated	Ounces produced
Cobalt properties	47,823	970,954
South Lorrain properties	75	14,295
Total	47,898	985,249

Included in the above production, the following tonnages were disposed of, without treatment at the local plant of the corporation: 17.62 tons of high-grade silver ore, containing 126,758.87 ounces; and 115.80 tons of low-silver high-cobalt ore, containing 15,757.92 ounces.

There was a decrease in the production of cobalt ore, the total weight of cobalt metal paid for being 21,413 pounds, as compared with 112,655 pounds in the previous year. This does not include cobalt metal contained in concentrates.

The details of tonnage treated, production, etc., from mill ore in 1929 are given in the table below:—

Tons of mill ore treated	47,753
Assay value, ounces per ton	20.57
Ounces contained	982,136.41
Ounces returned by Reduction Company	820,360.17
Percentage returned under contract	83.58

Past Production.—The table below gives the production by years from the mines of the corporation. The aggregate amounted to 47,001,234 fine ounces at December 31, 1929.

PRODUCTION IN OUNCES FINE SILVER TO DECEMBER 31, 1929

	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
Total	41,594,750	5,406,484	47,001,234

Mining Operations

Cobalt.—As in the past few years, the greater portion of mill tonnage was supplied from the Cobalt Lake property, lesser amounts coming from the McKinley-Darragh, Townsite, City of Cobalt, and Buffalo.

Extraction of ore on the lower levels of the Cobalt Lake and in the outlying sections of the other mines was finally completed, and mining operations latterly have been confined largely to upper levels.

Recent work on the Buffalo and Nancy Helen properties has resulted in mill-grade ore being developed, although the tonnage is limited.

While a small amount of high-grade silver ore was produced, there is little hope of this being continued and a further drop in the price of silver will make profitable operation on mill-grade ore difficult.

South Lorrain.—The following shipments of ore represent the production of the Frontier and Crompton properties for the year: 56 tons of mill ore with head assay of 15.20 ounces and silver content of 851.20 ounces; 18.82 tons of cobalt ore, assaying 75.98 ounces and containing 1,429.97 ounces; 0.21 tons of high-grade ore, containing 2,453.10 ounces of silver. In addition, 9,688.03 ounces were included in the year's production, being adjustment of smelter returns on shipments outstanding at the end of 1928.

The silver content of all classes of ore from the Frontier and Crompton properties was 14,422.30 ounces, as compared with 405,596.23 ounces for the previous year.

Practically no work was done at these properties during the year, following the final extraction of ore in the previous year. A somewhat improved demand for cobalt ore, together with higher quotations on this metal, will permit the mining of some remaining ore of this type. It is quite likely that a small tonnage of high-grade silver ore will be produced incidentally in carrying on this work. Operations will be limited, and no exploration work will be attempted.

Work is still being done by the corporation, under contract with the Keeley Silver Mines, in exploration of the lower levels of the latter property.

Fire destroyed the Frontier compressor house and three compressors, with loss fully covered by insurance.

On claim H.R. 64, the centre of a group controlled by the corporation, extensive exploration was done. Sinking was completed to 420 feet and a level established at 406 feet. At this horizon, near the sedimentary-Keewatin contact, drifting, crosscutting, and diamond-drilling were done. Calcite veins, one of them carrying cobalt ore, were proved to exist, but commercial silver values were not developed and work was discontinued for the present.

Sudbury.—In this district, a large area, totalling nearly 10,000 acres and consisting of groups of claims located at intervals around the outer edge of the norite intrusive, is held by the Mincor Exploration and Development Company, Limited, a subsidiary of the Mining Corporation of Canada, Limited. During the year preliminary geological mapping and prospecting was completed on all claims. Several promising areas have already been indicated, the importance of which will be determined by diamond-drilling, now in progress.

Patricia District.—Claims staked for the corporation in the Shonia and Pickle Lake areas, as well as east of Lake Nipigon, did not justify development and were allowed to lapse.

Northern Ontario.—Prospecting parties, in the employ of the corporation and working in selected areas failed to discover anything of importance in the northern sections of this province.

Ore Reserves

At the Cobalt properties, approximately 22,000 tons of ore remain in reserve with silver content of approximately 500,000 ounces. With the price of silver below 45 cents per ounce, it is quite possible that part of the above tonnage cannot be extracted profitably.

COBALT REDUCTION COMPANY, LIMITED

Concentrating Plant.—This plant ran 363 days during the year. The stamps ran 312,989 out of a possible 318,467 stamp-hours, or 98.28 per cent. of the possible running time. The tonnage of mill ore treated in the low-grade plant was 50,933 against 57,969 tons in 1928. This tonnage consisted of:—

	Tons
Silver ore from the mines of the Mining Corporation of Canada, Limited	47,753
Silver ore purchased from sundry shippers	2,770
Total silver ore	50,523
Cobalt ore from sundry shippers (concentrate returned)	410
Total	50,933

Comparative details of concentration treatment for 1929 and 1928 follow:—

	1929	1928
Tons treated	50,523.00	57,969.00
Average assay	22.01	21.06
Ounces contained	1,111,917.95	1,220,992.25
Tons concentrate produced	381.24	424.68
Average assay	1,608.86	1,651.30
Ounces contained	613,363.28	701,273.76
Percentage of extraction by table concentration	55.16	57.43

Flotation Plant.—All the slime produced by crushing and grinding, and the table tailing (after regrinding in tube mills), was treated by flotation.

Details of tonnage, extraction, etc., are given below:—

	1929	1928
Tons of slime treated	50,141.69	57,544.05
Average assay	9.94	9.03
Ounces contained	498,554.67	519,718.49
Tons of flotation concentrate produced	558.00	745.28
Average assay	700.73	586.18
Ounces contained	391,009.00	436,867.00
Percentage of extraction	78.43	84.06

SUMMARY OF MILLING OPERATIONS

	1929		1928	
	Total	Extraction	Total	Extraction
		per cent.		per cent.
Tons of ore milled	50,523.00	.....	57,969.00	.....
Average assay	22.01	.....	21.06	.....
Ounces contained	1,111,917.95	.....	1,220,992.25	.....
Table concentrate produced, ounces	613,363.28	55.16	701,273.76	57.43
Flotation concentrate produced, ounces	391,009.00	35.17	436,867.00	35.78
Total ounces produced	1,004,372.28	90.33	1,138,140.76	93.21

General Costs.—The total cost of operations was $187,782.29 against $211,490.63 in 1928. The cost of marketing the table and flotation concentrate produced, including freight, smelter treatment and refining charges, value of smelter deduction, etc., is included under "Operation" in the table below and amounted to $58,451.79 in 1929, or $1.157 cents per ton of ore treated.

TOTAL COST OF OPERATION

	Labour	Material	Other	Total	Per ton
Administration and general	$6,541.25	$741.34	$4,813.74	$12,096.33	$0.237
Operation	48,339.79	29,052.69	90,753.72	168,146.20	3.302
Head office	.....	.....	7,539.76	7,539.76	.148
Total cost of operation	$54,881.04	$29,794.03	$103,107.22	$187,782.29	$3.687

Earnings.—The gross earnings were made up of customs charges to the Mining Corporation of Canada, Limited, and subsidiaries and treatment charges on purchased ores, etc.

The operating profit was:—

By earnings	$223,915.85
Less total cost	187,782.29
Profit at plant	$36,133.56

There were no capital expenditures during the year.

Net Profit.—The net profit was:—

By profit at plant	$36,133.56
Written off plant	34,436.68
Total	$1,696.88

The above amount was paid out in dividends to the Mining Corporation of Canada, Limited.

Morrison Mines, Limited

Morrison Mines, Limited, operated their property during the six months ending December 31, 1929, in the township of Nicol, district of Timiskaming, with a force of 12 men. The officers and directors of the company are: Horace F. Strong, president and managing director; Lt.-Col. Jas. Cunningham, secretary-treasurer; Joseph Montgomery, vice-president; H. D. Fripp and T. F. Ahearn, directors.

The managing director's report for the year ending December 31, 1929, is as follows:—

On July 2, preparatory work was commenced at the mine, and by July 11 the water was removed down to and including the 300-foot level. Since that date active exploration has been maintained constantly and the following work accomplished:—

	Drifting	Cross-cutting	Shaft-sinking	Raising	Sumps
	feet	feet	feet	feet	feet
175-foot	230	70	.....	5	.....
300-foot	.....	.....	125	.....	10
425-foot	124	128	.....	.....	.....
Total	354	198	125	5	10

In the 230 feet of drifting on the 175-foot level, silver was encountered for a length of 65 feet with one section 15 feet in length which would approximate 25 ounces grade over a 4-foot stope width.

The shaft was scaled from top to bottom and sunk from the 300-foot level to a depth of 425 feet. On the 300-foot level, 10 feet of water sump was cut to permit sinking.

While deepening the shaft a vein was encountered dipping into the shaft from the north side at a depth of about 380 feet. This vein had a width of one inch where exposed in the crosscut on the 300-foot level. At the bottom of the shaft it is showing at the south side with a width of 2 inches. This vein showed silver in several places, but cannot be classified as ore.

Crosscutting to the northwest a distance of 90 feet cut a vein which, it is reasonable to assume, is the downward continuation of a vein or veins exposed on the upper levels, and which made good mill ore with a little high-grade on the winze level approximately 55 feet higher up. When cut on the 425-foot level this vein showed high-grade ore in the floor and to a height of 4 feet above the floor. Drifting to the east showed this shoot to extend for 28 feet in the floor and 5 feet in the back at the east end. This shoot should average 2 inches of 3,000-ounce ore. A cross-vein running north carries ore for 12 feet or more. Drifting to the west showed lean ground for 20 feet followed by a shoot 10 feet long in back and 15 feet in floor. This was followed by 10 feet of lean ground but with high-grade in the face, as of January 1.

Since January 1 and up to date of January 15, further development has made high-grade, and you are fairly safe in accepting a total length of 80 feet, out of 150 feet of drifting on the 425-foot level, which should average 50 ounces per ton over a stope width of 4 feet.

All plant and equipment have been maintained in excellent condition, advantage being taken of the Christmas shut-down to overhaul the compressor and hoist. Power interruptions,

while frequent in the summer, were not of long duration and, on account of so many transformer losses in the Gowganda camp by fire caused by lightning, we adopted the precaution of shutting down and pulling the line switches during severe thunderstorms. All Government requirements such as Workmen's Compensation returns, supplying of statistics, cable tests, etc., have been rigidly attended to at the proper times.

All expenses at the property have been kept down to the lowest possible point commensurate with competent work, and considering the modest scale of this work I believe you will consider the efficiency ratio quite high. All charges at the mine to the end of December total $20,588.89, which includes supplies on hand in excess of $1,200. These charges have all been met, with the exception of current accounts, totalling about $1,000.

With the satisfactory developments now making on the 425-foot level, it is greatly to be hoped that finances can be arranged to continue this development, carry the shaft to 500 feet, and develop at that horizon. Notwithstanding the fact that the silver market is the worst in history, I believe that your property can be made to produce a satisfactory return on investment.

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, 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 1929 was $813,164.27, and the net income of the operating company was $164,176.41. During the year $360,000 was paid in dividends, making a total of $29,400,000, or $24.50 a share. The operating company's surplus at the end of the year was $3,492,437.10.

The average number of men employed at the property at Cobalt, Coleman township, district of Timiskaming, was 190 men.

The general manager reports as follows for the year 1929:—

Summary of Results

The production of silver for the year was 1,545,000 ounces, a decrease of 364,000 ounces from 1928. The cost per ounce was 37.81 cents, a reduction of 4.44 cents. The ounce production was 81 per cent. of the amount produced in the previous year.

The net value of bullion, ore, and residue shipped was $813,000, a decrease of $354,000, due partly to the fall in the price of silver. The tons of ore treated at the mill were 18,000 less than in 1928; the head assay was 35.38 ounces per ton, an increase of 4.7 ounces.

Notwithstanding a decrease of $222,000 in operating expenses, the operating profit shows a decrease of $190,000, due in part to the decline in the price of silver.

The price of silver was the most discouraging feature of the year. A constantly falling market, starting at 57.5 cents in January and ending at 46.5 cents in December, with an average of 52.99 cents for the year, was 5.19 cents lower than the average price of 58.18 cents in 1928. The variation during the year was 11 cents, and the seriousness of the decrease is reflected in the operating profit. Surplus also was affected by this decrease to the extent of $125,000, due to the inventory of December 31, 1929, being valued at the low closing price for the year. Further price recessions were made in 1930, a new all-time low of 39.625 cents being recorded on March 4.

Operating results were better than anticipated at the beginning of the year, particularly ounces produced and decreased cost of production. The low price of silver, however, practically wiped out the advantages accruing from these results.

Operations at Cobalt continued in the usual manner, work being carried on at several shafts. The most important new development was encountered at shaft No. 73, where further work on an old vein developed an extension which produced a large proportion of the year's production and directly accounted for the increased head assay of the ore treated at the mill. It has every appearance of repeating its performance during 1930. Favourable developments were also obtained at other shafts, particularly shafts Nos. 12 and 63. As a whole, however, production continued to be derived from a number of small and generally low-grade veins situated in widely

separated parts of the property. Ore reserves are estimated at 13,000 tons, containing 500,000 ounces, a decrease of 4,000 tons and 96,000 ounces.

SHIPMENTS IN 1929

	Tons	Silver, fine ounces	Net value
Silver bullion	46.928	1,367,062.96	$722,721.32
Residue and ore	945.841	64,109.67	90,798.15
Total shipments	992.769	1,431,172.63	$813,519.47
Less custom bullion	.024	685.28	355.20
Shipments of Nipissing product	992.745	1,430,487.35	$813,164.27

PRODUCTION IN 1929

	Silver, fine ounces	Gross value	Net value
Shipments in 1929	1,430,487.35	$818,953.25	$813,164.27
On hand at mine, December 31, 1929	1,140,353.11	726,518.58	717,223.06
Total	2,570,840.46	$1,545,471.83	$1,530,387.33
On hand at mine, December 31, 1928	1,025,693.30	797,046.63	784,709.97
Nipissing production	1,545,147.16	$748,425.20	$745,677.36

SUMMARY OF PRODUCTION

	Total	Per cent.
Gross value of production	$748,425.20	100.00
Total cost of production	584,248.79	78.06
Profit on operations at Cobalt	$164,176.41	21.94

SOURCES OF PRODUCTION

	Tons
Shaft No. 19	9,601
Shaft No. 49	10,059
Shaft No. 63	16,917
Shaft No. 73	8,687
Shaft No. 92	457
Total	45,721

The various products treated in the high grade plant were:—

HIGH-GRADE ORE TREATMENT

	Tons	Assay	Ounces contained
Concentrate	555	1,820	1,010,029
By-products	24	2,693	64,638
Total	579	1,856	1,074,667

The refinery treated precipitate and custom bullion containing 1,424,974 fine ounces. Shipments of bullion amounted to 1,367,063 fine ounces; shipments of residue amounted to 836 tons.

LOW-GRADE MILL

	Tons	Assay	Ounces contained
Ore treated	45,421	35.38	1,606,948
Recovered in products:			
Precipitate	20	26,038	520,753
Coarse concentrate	474	2,035	964,823
Fine concentrate	83	730	60,589
Total recovery	.....	.....	1,546,165

Average tailing, 1.35 ounces; recovery, 96.22 per cent. Twenty stamps ran 352 days, 17 hours, or 96.08 per cent. of possible running time. They crushed 128.78 tons per day, or 6.45 tons per stamp per day.

SUMMARY OF UNDERGROUND WORK

Shaft No.	Drifting	Crosscutting	Raising	Total	Stoping
	feet	feet	feet	feet	cu. yds.
19	1,120	662	99	1,881	3,075
49	331	183	45	559	2,062
63	794	1,118	148	2,060	4,695
73	92	203	33	328	2,546
92	.....	.....	.....	.....	410
Total	2,337	2,166	325	4,828	12,788

Diamond-drilling, 3,416 feet.

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 seven men are employed.

The development in 1929 included 3,667 feet of drifting and 16 feet of sinking, and 18,082 tons were broken in stopes. There were hoisted 26,920 tons of ore, containing 1,289,118 ounces of silver. There were shipped during the year 39 tons of high-grade ore and 320 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; W. A. O'Flynn is manager; and 160 men are employed.

Underground development for the year 1929 amounted to 6,623 feet of crosscutting and drifting, 369 feet of raising. There were 42,563 tons of ore stoped and 55,617 tons of ore hoisted, containing 2,051,162 ounces of silver. Concentrates shipped amounted to 1,620 tons.

Peterson Cobalt Mines, Limited

Peterson Cobalt Mines, Limited, has an authorized capital of $3,000,000 shares, divided into 100,000 shares of preferred and 2,900,000 of common. The officers and directors of the company are: W. A. Lamport, president; J. C. Haight, vice-president; P. M. Goff, secretary-treasurer. D. J. Russell

is engineer. The head office of the company is at 301 Royal Bank Building, Toronto.

During the year 3,682 feet of diamond-drilling was done, with an average crew of 7 men.

Sandoe and Moyle

The Temiskaming mine in Coleman township, district of Timiskaming, was leased to Richard Sandoe and H. Moyle. Three men were employed.

Ore containing $7,812 in silver and $1,961 in cobalt was shipped.

H. Sequin

The Cobalt Comet mine in Coleman township, district of Timiskaming, was operated under lease by H. Sequin.

Eleven and a half tons of ore, having a cobalt content valued at $731, was shipped.

John W. Shaw and Associates

John W. Shaw and associates leased the Trethewey, Chambers-Ferland, and Aladdin mines in Coleman township, district of Timiskaming.

Ore and metallics having a value of $5,268 in silver were shipped to Deloro.

W. H. Smith

The Hudson Bay mine in Coleman township, district of Timiskaming, was operated under lease by W. H. Smith.

From 32 tons of ore mined and shipped, values of $1,322 in silver and $457 in cobalt were obtained.

Thomas E. Trembath and Partner

La Rose mine in Coleman township, district of Timiskaming, was operated under lease by Thomas E. Trembath and partner during 1929.

Ore and bullion valued at $17,727 were shipped to Deloro. The cobalt content of the ore was valued at $606.

Three men were employed.

TALC

Canada Talc Company, Limited

The Asbestos Pulp Company, Limited, was reorganized in 1929 and incorporated as the Canada Talc Company. The mine and mill were operated continuously during the year.

The ore body on the 6th level, at a depth of about 400 feet, was opened up, and the total production was from this body between the 6th and 5th levels. The vein, which averages 15 feet in width, with a maximum of 66 feet, was opened for a length of 300 feet.

The officers of the company are: W. S. Morden, Toronto, president; E. S. James, Belleville, vice-president; Roy Taylor, Madoc, secretary and manager.

Geo. H. Gillespie Company, Limited

The Henderson talc mine and mill, near Madoc, in Hastings county, was operated throughout 1929. The talc was mined at a depth of 310 feet, between the 4th and 5th levels. The vein has a width of about 33 feet.

An average of 25 men was employed. George 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 1929:—

Furnace No.	Days in operation	Product
		tons
1	330	99,000
2	Idle all year	.....
3	335	224,000
4	109	54,500

The only change in the blast furnace section during the year was the installation of four Freyn pressure gas-burners at No. 3 furnace.

Jas. H. Bell is blast furnace superintendent.

Deloro Smelting and Refining Company, Limited

The plant at Deloro operated throughout the year. Smelting operations were curtailed to some extent, owing to the decreasing supply of ore available; but an increase in the production of "Stellite" was made.

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.

Steel Company of Canada, Limited

The Steel Company of Canada, Limited, at Hamilton operated the "A" furnace for 341 days during 1929, with a production of 100,466 tons; and "B" furnace for the entire year, with a production of 233,463 tons.

During the year an Ingersoll-Rand Turbo blower, of 55,000 c.f.m., and a Theissen gas-washer were installed.

The average number of men employed during the year was 140. R. A. Gillies is blast furnace superintendent.

MINING ACCIDENTS IN 1929

By

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

Accidents during 1929

During the year 1929 at the mines, metallurgical works, quarries, clay, sand, and gravel pits regulated by the Mining Act, there were 2,444 accidents to employees reported to the Department of Mines up to January 15, 1930. Fifty-five fatalities, arising out of forty-eight separate accidents, were recorded.

These returns represent a decrease of 115 in the total number of casualties and a decrease of 30 in the number of men killed over the record of the preceding year, 1928. It should be noted, however, that the number of fatalities in 1928 was abnormally high due to the death of 39 men in the Hollinger mine disaster of that year.

The report shows a fatality rate of 2.89 per thousand men employed, which is 0.13 per thousand lower than the average rate for the past twenty-five years.

There were 126 non-fatal accidents per thousand men employed, which shows a decrease of 15 per thousand men from the rate in 1928.

The percentage of non-fatal accidents followed by infection decreased from 10.7 per cent. in 1928 to 6.9 per cent. in 1929.

Fatal Accidents

A comparison of fatal accidents for the past five years is given in the following table:—

Distribution	1925	1926	1927	1928	1929
Mines, underground	30	20	19	31	33
Mines, surface	1	3	4	2	2
Metallurgical works	2	3	3	4	2
Quarries	7	3	4	2	3
Clay, sand, and gravel pits	2	3	3	4	8
Total	42	32	33	43	48

By months the fatal accidents occurred as follows:—

Month	No.	Men killed
January	5	5
February	4	4
March	0	0
April	3	5
May	4	4
June	4	4
July	5	5
August	3	4
September	5	5
October	3	3
November	3	4
December	9	12
Total	48	55

Classifying the fatalities according to industries gives the following:—

Gold mines	17
Nickel mines	19
Silver mines	4
Copper-lead-zinc mines	1
Gypsum mines	1
Metallurgical works	2
Quarries	3
Sand, gravel, and clay pits	8
Total	55

ANALYSIS OF FATALITIES AT MINES, 1925-29

Cause	1925	1926	1927	1928	1929
	per cent.	per cent.	per cent.	per cent.	per cent.
Fall of ground	19.35	17.39	26	6.6	14.3
Run of ore or rock	.....	.....	17.4	5.3	11.9
Shaft accidents	19.35	26.09	21.3	9.3	14.3
Explosives	25.8	43.48	4.3	12	28.6
Miscellaneous, underground	29.03	.....	8.69	64	28.6
Surface	6.45	13.04	21.7	2.6	2.3

TABLE OF FATAL ACCIDENTS IN MINES, METALLURGICAL WORKS, QUARRIES, AND GRAVEL, SAND, AND CLAY PITS, 1905-1929

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
1905	9	4,415	500	4,915	1.83
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

The comparative fatality rate per thousand men employed at mines, metallurgical works, quarries, clay, sand, and gravel pits is as follows:—

	Men employed	No. killed	Rate per thousand
Mines	12,507	42	3.35
Metallurgical works	3,817	2	.52
Quarries	1,820	3	1.65
Clay, sand, and gravel pits	850	8	9.41
Total	18,994	55	2.89

The occupation and nationality of the men killed at mines, metallurgical works, quarries, clay, sand, and gravel pits, are set out in the following table:—

Occupation	English-speaking	Pole	Ukrainian	Jugo-Slav	Finn	German	Lithuanian	Italian	Russian	Unknown	Total
Miner	6	1	2	1	6	....	1	1	....	....	18
Drill helper	1	1	1	2	....	....	....	....	....	....	5
Cage tender	....	....	....	....	....	1	....	....	....	....	1
Mucker	1	....	....	....	....	....	....	1	....	....	2
Timberman	....	....	....	....	2	....	....	....	....	....	2
Pumpman	....	....	....	....	....	....	....	1	....	....	1
Scaler	....	....	....	1	....	....	....	....	....	....	1
Trammer	....	1	....	....	....	....	....	....	....	....	1
Chute-blaster	....	....	....	1	....	....	....	....	....	....	1
Skip tender	....	....	....	....	....	....	....	....	1	....	1
Shaftman	1	....	....	1	2	....	....	....	....	....	4
Pipe fitter	1	....	....	....	....	....	....	....	....	....	1
Shift boss	....	....	....	....	....	....	....	1	....	....	1
Hoistman	1	....	....	....	....	....	....	1	....	....	2
Labourer	6	....	....	1	....	....	....	....	....	....	7
Crusherman	1	....	....	....	....	....	....	....	....	....	1
Locomotive fireman	1	....	....	....	....	....	....	....	....	....	1
Brakeman	1	....	....	....	....	....	....	....	....	....	1
Mechanic	1	....	....	....	....	....	....	....	....	....	1
Assistant superintendent	1	....	....	....	....	....	....	....	....	....	1
Truck driver	1	....	....	....	....	....	....	....	....	....	1
Farmer	....	....	....	....	....	....	....	....	....	1	1
Total	23	3	3	7	10	1	1	5	1	1	55

The ages of the men killed were as follows:—

17–20	21–25	26–30	31–35	36–40	41–45	46–50	Over 50	Total
1	8	17	14	6	5	2	2	55

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	.....	304	304
Rock or ore at chute	.....	129	129
Fall of persons	58	154	212
Falling objects	47	135	182
Fall of rock or ore from face, wall, or back	.....	106	106
Tramming	2	134	136
Crushed between two objects	30	104	134
Flying objects, sledging, etc	17	99	116
Nails or splinters	32	80	112
Drilling machines	.....	91	91
Hand tools	36	50	86
Strain while lifting	19	56	75
Machinery	37	10	47
Running into or striking against objects	7	37	44
Cage, skip, or bucket	.....	23	23
Explosives	3	17	20
Falling down shaft, winze, raise, or stope	.....	16	16
Burns	13	1	14
Electricity	10	.....	10
Gas	1	3	4
Explosion of carbide	4	3	7
Poisoning from cyanide, mercury, etc	2	.....	2
Unclassified	6	1	7
Total	324	1,553	1,877

The causes of non-fatal accidents at metallurgical works were:—

Falling objects	51	Machinery	8
Burned by slag, matte or scrap	26	Strain while lifting	5
Fall of persons	20	Nails or splinters	5
Transportation	13	Cranes, ladles, hooks	4
Crushed between two objects	12	Running into or striking against objects	4
Flying objects, sledging, etc	11	Electric	3
Burns	9	Gas	1
Hand tools	8	Total	180

The causes of non-fatal accidents at quarries were:—

Handling material	56	Machinery	10
Falling objects	30	Fall of rock	9
Fall of persons	28	Explosives	7
Flying objects, sledging, etc	20	Nails or splinters	6
Transportation	19	Burns	4
Strain while lifting	15	Hoists, derricks, elevators	2
Crushed between two objects	14	Unclassified	5
Hand tools	12	Total	237

The causes of non-fatal accidents at clay, sand, and gravel pits were:—

Falling objects	19	Flying objects	5
Fall of persons	17	Running into or striking against objects	5
Transportation	11	Hand tools	4
Machinery	9	Nails or splinters	3
Crushed between two objects	7	Burns	3
Fall of material	5	Electric	1
Strain while lifting	5	Unclassified	1
		Total	95

Infection

Records show that infection followed in 164 cases out of 2,389 non-fatal accidents in 1929.

Location	No. of accidents	Accidents followed by infection	Per cent. infection
Mines, underground	1,553	96	6.2
Mines, surface	324	35	10.8
Metallurgical works	180	7	3.9
Quarries	237	19	8
Clay, sand, and gravel pits	95	7	7.4
Total	2,389	164	6.9

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
Struck by rock from blast	9	9	1	1	10	10
Premature explosion	5	7	3	4	8	11
Delayed too long lighting fuse	2	2	2	3	4	5
Drilled into explosive	5	7	2	2	7	9
Returned to delayed blast	.....	.....	2	2	2	2
Handling explosives	3	4	1	1	4	5
Concussion from blast	1	1	.....	.....	1	1
Total	25	30	11	13	36	43

The following table shows the fatal accidents due to the use of electricity at mines, metallurgical works, and quarries during the past ten years:—

1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	Total
.....	2	.....	.....	1	3	.....	2	1	.....	9

The voltage of the circuits on which the accidents occurred was as follows:—

Volts	No. of accidents
220	1
550	7
2,200	1
Total	9

Classifying the accidents according to the industry shows the following:—

Mines, surface	4
Metallurgical works	3
Quarries	2
Total	9

The causes of fatal accidents due to electricity during the past ten years were as follows:—

Failure to open circuits before working on apparatus	4
Defective temporary installation	1
Defective wiring	2
Water leaking on apparatus and ground wire disconnected	1
Touched live line on pole and fell to ground	1
Total	9

The following table shows the non-fatal electric burns during the past ten years:—

1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
14	6	6	9	9	6	5	10	4	14

The causes of non-fatal electric burns during 1929 were:—

Arc when closing disconnecting switches	3
Opening disconnecting switches under load	2
Working on live circuit	2
Coming in contact with high-voltage circuit	2
Coming in contact with low-voltage circuit	2
Oil switch exploded	1
Compensator exploded	1
Closing disconnecting switch on short circuit	1
Total	14

Fire Caused by Electric Apparatus in 1929

A fire originated in the coils of a 150 h.p., 550-volt motor at the Levack mine of the International Nickel Company of Canada, Limited, at about 2.45 A.M., December 15.

The motor was driving a Symons crusher by a belt and was installed in a separate compartment, 9 feet square, with the roof 3 feet above the top of the motor. The building was constructed of corrugated iron, and the roof and walls were lined inside with wood. The floor was made entirely of concrete, with the wiring in conduit buried in the concrete.

The fire was confined to the insulation of the motor when first discovered and the motor was stopped by remote control. The smoke was too intense to permit entrance to the room, and there were no fire extinguishers close at hand. The flames from the motor ignited the roof and walls and spread rapidly to the crusher plant.

Four lives were lost in the shaft as a result of the fire, when four miners attempted to ride up in the bucket. The crusher plant, rock-house, and headframe were destroyed.

Prosecutions

The appeal by the Attorney-General for Ontario from the judgment of the Appellate Division of the Supreme Court of Ontario in the case of Rex *vs.* Baker was heard by the Supreme Court of Canada, February 5, 1929, Justices Duff, Mignault, Newcombe, Lamont, and Smith sitting on the appeal.

The decision of the Appeal Court, setting aside the findings of Police Magistrate McKessock, of Sudbury, was affirmed.

To give a brief summary of the previous proceedings in the case: Fred J. Baker, hoistman at No. 1 shaft, Frood mine, was charged before Magistrate McKessock with criminal negligence under Section 284 of the Criminal Code. The prosecution arose following an accident in the shaft when Baker overwound a skip on September 23, 1928.

The Police Magistrate found him guilty and sentenced him to a fine of $200 and costs or, in default, three months' imprisonment.

An appeal to the Supreme Court of Ontario resulted in the quashing of the magistrate's finding. The Supreme Court of Canada upheld the Ontario Court's judgment as outlined above.

Before Magistrate Atkinson, at South Porcupine, on February 21, E. Sirrila, a drill-runner at the Hollinger mine, was fined $10 and costs for a contravention of Regulation 25, Section 161, of the Mining Act, in that he "drilled within ten feet of a cut-off hole."

J. Kisil, a Pole, who had been in the employ of the International Nickel Company of Canada, Limited, at Creighton mine, was tried before Magistrate Thos. Stoddard, at Creighton, on October 31, on a charge that: "At the village of Creighton, in the district of Sudbury, on or about the 28th day of October, 1929, being under the influence of liquor, did go down to the 23rd level of the Creighton mine of the International Nickel Company of Canada, Limited, contrary to Subsection 219, of Section 161, of the Mining Act of Ontario, being part of Chapter 5 of the Revised Statutes of Ontario, 1927."

Magistrate Stoddard found the accused guilty and fined him $75 and costs, or three months in jail. Costs amounted to $35.50. Kisil elected to take the jail term rather than pay the fine.

Victor Lalonde was tried before Magistrate McKessock, at Sudbury, on November 1, in connection with a fatal injury to Kalle Hytanen. The accident occurred at the Frood mine of the International Nickel Company of Canada, Limited, on October 24.

The charge laid was that "Victor Lalonde, of the town of Sudbury, in the district of Sudbury, on or about the 24th day of October, 1929, did hoist one Kalle Hytanen in a skip used for hoisting material in a raise on the 2,000-foot level in the Frood mine of the International Nickel Company of Canada, contrary to Subsection (a), of Subsection 50, of Section 161 of the Mining Act."

Lalonde's own evidence given at the inquest was quite conclusive and he pleaded guilty to the charge. The straightforward way in which the accused gave his evidence at the inquest and the fact that he was of a type that the company officials considered worthy of re-employment, inclined the magistrate to leniency. Lalonde was sentenced to pay a fine of $20 and costs or one month in jail. He paid the fine. Costs amounted to $22.80.

Government Mine Rescue Station at Timmins

Pending legislation authorizing the erection of three central mine rescue stations in the Porcupine, Kirkland Lake, and Sudbury areas, an arrangement was effected by which a mine rescue station, in advance of such authority, was established in Timmins late in 1929 to afford a degree of protection until the whole scheme might become effective.

The arrangement provides that the station be financed through the Workmen's Compensation Board of Ontario out of assessments levied on the mines, while the equipment of the station, the selection of the personnel in charge of it, and all matters pertaining to the operation and maintenance of the station are under the control of the Chief Inspector of Mines.

This, in the main, follows the lines laid down in the proposed legislation covering the entire three stations, which are to be established in the province.

The Timmins station is housed in a tile building, 15 feet by 40 feet, erected as a lean-to to the municipal fire hall, and provides two rooms for storage of equipment and training purposes. The main room (15 feet by 28 feet) is used as a storage and lecture room and, in addition, contains the heating plant. While the second room (15 feet by 12 feet) is used as a



Interior view of Timmins mine rescue station, showing part of the rescue equipment.

"smoke room" in which training may be given in irrespirable atmosphere and is separated from the storage room by a gas-tight partition containing a long observation window through which the supervisor may observe at all times the action of the crew undergoing training in the smoke room.

In the main the rescue equipment carried at the station consists of the following:—

12 sets of McCaa, 2-hour type, self-contained oxygen breathing apparatus.
12 All Service gas masks.
24 M.S.A. self rescuers.
2 M.S.A. carbon monoxide detectors.
1 Pyrotannic acid carbon monoxide detector and air sampling accessories.
2 Wolf Flame safety lamps.
12 model "F" Edison electric cap lamps.

In case of an emergency there are sufficient supplies to operate the apparatus until additional supplies can be obtained by express.

It is proposed to commence training of mine crews in mine rescue, first aid, and mine recovery operations as soon as a standard course of training can be decided on and drawn up.

At the time of writing, arrangements have been effected through the courtesy of the United States Bureau of Mines for a team composed of the inspectors of the Department of Mines, the supervisor of the Timmins station, and a representative of the McIntyre Porcupine Mines to take the U.S. Bureau of Mines training course at the Pittsburgh station of the bureau.

On the completion of the course, a schedule for training Ontario miners will be drawn up and the actual training of mine teams commenced.



Rescue team wearing McCaa 2-hour breathing apparatus, Timmins mine rescue station.

Stench Test at Vipond Consolidated Mines, Limited

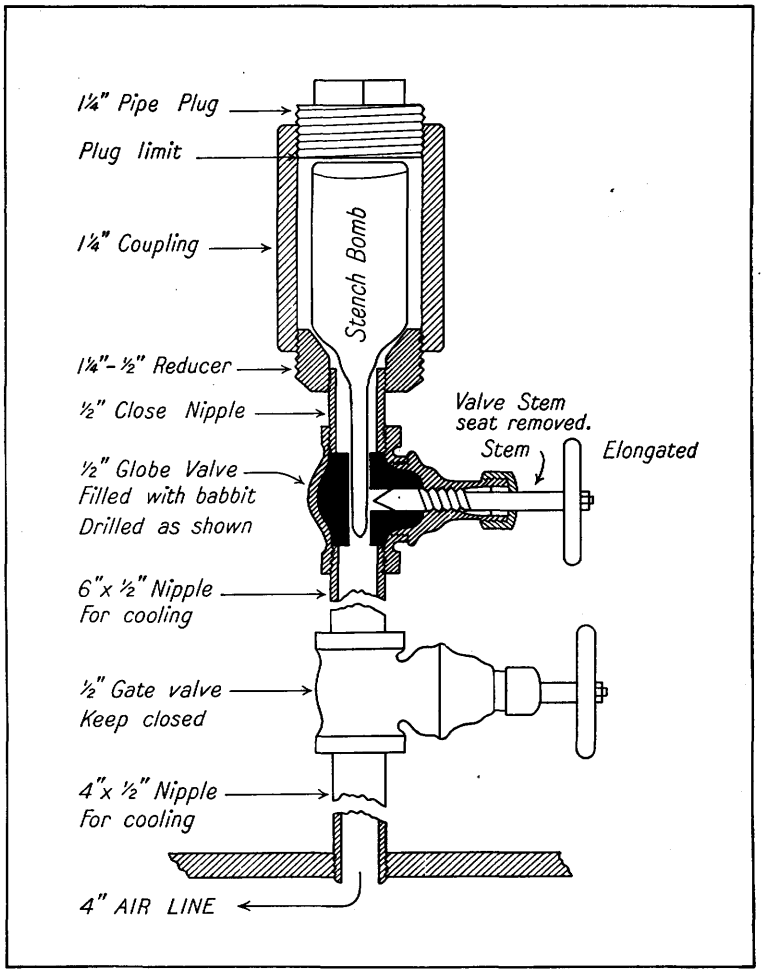
The introduction of the stench, ethyl mercaptan, into the air lines, as a signal to underground workmen to vacate the mine, was tried under working conditions at the Vipond mine, Timmins, and the results obtained demonstrate the effectiveness of this warning signal.

The apparatus used for the introduction of the stench is illustrated by the accompanying sketch. It will be noted that the apparatus is made from standard pipe fittings. The modification of the valve for breaking the stench bomb can be accomplished at small cost and with few tools.. Owing to the low boiling point of the ethyl mercaptan, it is essential that the pipe nipples used be of sufficient length to dissipate the heat from the air lines. The length shown in the sketch proved adequate with the apparatus installed forty feet from the compressors and on the mine side of the receivers, which point is essential. There are four of these injectors installed on two air mains and housed in a small box midway between the hoist-house and the shaft-house.

About two weeks before the test was made, a notice was posted to the effect that a trial of this warning signal would be made and asking the men

to become familiar with the smell. They were also asked to record the time of detection of the stench and then proceed to the shaft. A small quantity of ethyl mercaptan was placed in the shaft-house, where, by turning a valve, it could be let into the atmosphere.

At the time of the test there were approximately sixty men underground engaged at their usual work. The mine has about nine miles of underground workings and ventilation is by natural air currents, except for the compressed air, which amounts to 1,800 cubic feet of free air per minute.



Stench bomb container and control valves (half-size).

Four bombs were used, each containing 12 c.c. of ethyl mercaptan. They were broken at intervals of twenty seconds, one in each of the four injectors as illustrated. Four minutes after the first bomb was broken a flash for the cage was received from the 866-foot level. Forty-seven minutes after the introduction of the stench all the men were out of the mine. Two crews of scalers failed to get the warning, but these men were far removed from operating drills. One of these men was warned by other workmen and one failed to receive any kind of warning.

Two hours after the stench was introduced the next shift went to work, and the atmosphere underground was quite clear.

The experience demonstrated that the stench was effective and entirely harmless.

The quantity of ethyl mercaptan injected into the air lines was roughly 20 c.c. for every 1,000 cubic feet of free air compressed per minute. It would perhaps be wise to use more; something like 30 c.c. would be a better quantity. It is essential that the introduction of the stench be spread over at least one minute of time. This insures a good distribution of stench in the air passing through the line. The four inexpensive injectors as used in this test insure the placing of the required quantity in the line over a given period.

The following are some notes of interest on the experiment:—

Time of breaking first bomb.....1.47 p.m.
Time of breaking second bomb.....1.47.20 p.m.
Time of breaking third bomb.....1.47.40 p.m.
Time of breaking fourth bomb.....1.48 p.m.

RECORD OF MEN COMING TO SURFACE

Working place	Time surface reached	Remarks
	p.m.	
866-foot	1.53	Men at pump station; no drill working.
200-foot	1.56	Men drilling in No. 200-H stope; strong odour.
1,000-foot	2.01	Muckers at station; no drills.
733-foot	2.03	Scalers in No. 709 stope; no drills.
500-foot	2.07	Drift; got stench at 1.57 p.m.; stayed to blast.
866-foot	2.05	Machine men in No. 802 raise.
600-foot	2.09	Sublevel; machine men and scalers.
400-foot	2.13	Men from No. 514 stope and No. 402-B drift.
400-foot	2.14	No. 426 stope; machine running; strong odour.
733-foot	2.30	No. 707-B stope; machine running but odour not strong.

Vipond side muckers warned Vipond side scalers, who reached the surface at 2.34 P.M. Scalers in No. 604 stope failed to get a warning of any kind. At the old Vipond shaft collar the warning came through a leak in the air line at 1.55 P.M. The natural air currents brought the warning to this upcast shaft at 2.03 P.M.

The Department of Mines is indebted to the Vipond mine, and especially the manager, Robert E. Dye, for making this test under working conditions. It has proved that an adequate warning can be given underground directly to 95 per cent. of the workmen. It also gives a fair estimate of the quantity of ethyl mercaptan necessary under metal mine conditions, as based on compressed air only.

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(In pocket at back of report)

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Map No. 39*b*—Sturgeon Lake Area, Districts of Kenora and Thunder Bay. Scale, 2 miles to the inch.



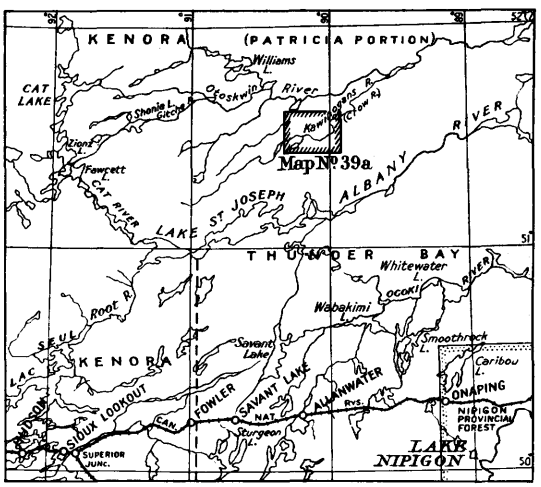
Airplane view of Pickle lake showing location of the Ontario Forestry Branch base and radio station (A), the Western Canada Airways base (B), the store (C), the N.A.M.E. base (D), and the Central Patricia Mines (E).

Pickle Lake-Crow River Area, District of Kenora (Patricia Portion)

By M. E. Hurst

INTRODUCTION

Between 1903 and 1905, W. McInnis,[1] of the Geological Survey of Canada, made a micrometer traverse of the Crow[2] river from Kapkichegimaga lake to its junction with the Otoskwin river. He reported that a belt of Keewatin rocks, 1 to 4 miles wide, was exposed along the course of the river for 17 miles east of Kapkichegimaga lake. Prospectors and exploration companies paid little attention to the mineral possibilities of this belt until the summer of 1928 when, with the adoption of airplane transportation, the area became readily accessible. Within a short time widespread interest was aroused by the announcement of attractive finds, and during the winter months prospectors staked hundreds of claims on



Key map showing location of the Pickle Lake–Crow River area. Scale, 60 miles to the inch.

either side of Crow river for 12 miles east of Pickle lake. In the summer of 1929 much of this ground was systematically explored and considerable development work was done on the known deposits.

Location

The Pickle Lake–Crow River area is in the District of Kenora (Patricia portion) of northwestern Ontario and lies about 125 miles northeast of Sioux Lookout and 85 miles north of Allanwater on the Canadian National railway. More specifically, this report deals with the territory around Pickle lake and that adjoining Crow river for a distance of about 12 miles east of the lake. A reconnaissance was also made of the Crow river between the west end of Kawinogans lake and Kapkichegimaga lake.

[1]Ont. Bur. Mines, Vol. XXI, pt. 2, 1912, pp. 112, 126.
[2]Also called Kawinogans, Ojibwayan for "no pickerel."

From 5 to 8 days are required to reach the area by canoe. The most travelled route goes from Hudson on the Canadian National railway to Perch Ripple at the northeast end of Lac Seul, up the Root river, and across to the west end of Lake St. Joseph. To this point there are 10 portages having a total length of $1\frac{1}{4}$ miles. Another route leaves the railroad a mile east of Savant Lake station, crosses into Savant lake, and follows the Savant and Pashkokogan rivers to Lake St. Joseph. If advantage is taken of the short cut between Pashkokogan lake and Pedlar Path bay of Lake St. Joseph, 12 portages totalling $3\frac{1}{8}$ miles will be necessary. Both routes continue northward from Doghole bay at the east end of Lake St. Joseph via Doghole, Annimwash, Kasagiminnis, Ochig, and Wimbabika lakes to Pickle lake. This stretch involves 8 portages totalling $2\frac{3}{4}$ miles. Longer and less convenient routes begin from the most westerly of the large bays on the north shore of Lake St. Joseph. These lead either to Kawinogans lake or to



Base and radio station, Ontario Forestry Branch, Pickle lake.

Kapkichegimaga lake, both of which drain into Crow river some distance west of the recent discoveries.

Airplanes operated by Western Canada Airways make the 85-mile trip from Allanwater on the Canadian National railway to Pickle lake in about one hour. During the summer of 1929 the following rates were charged:—

Allanwater to Pickle lake, per passenger	$55.00
express per pound	.25
Pickle lake to Allanwater, per passenger	27.00
express per pound	.12½

Supplies and equipment are transported by tractor-drawn sleds over a winter road, 110 miles long, that connects Savant Lake on the Canadian National railway with Central Patricia Mines on Crow river. The management of Central Patricia Mines, Limited, reports that transportation costs during the winter of 1929 amounted to $4\frac{5}{8}$ cents per pound. With continuous operation it is estimated that these costs could be reduced to $3\frac{3}{4}$ cents per pound.

During the summer of 1929 the Ontario Forestry Branch established a fire-rangers' base and a radio station on an island in Pickle lake. At present, since operations in the area have been temporarily discontinued, the nearest point at which supplies can be obtained is Osnaburgh House at the east end of Lake St. Joseph.

Topography and Drainage

The territory west of Pickle lake and particularly in the vicinity of Wimbabika, Kapkichegimaga, and Kawinogans lakes is fairly high and well drained. In places rock ridges border the lakes and, with the exception of the eastern half of Kawinogans lake, outcrops are plentiful along the shores.

To the east of Pickle lake the terrain is comparatively flat and consists largely of low-lying sand plains, spruce-covered muskeg, and open swamp. Here and there the level surface is broken by ridges of glacial drift and knolls of rock, which trend roughly northeast-southwest and seldom rise more than 50 feet above the surrounding lowlands. To the north of Crow river the high ground consists chiefly of glacial deposits which, except in a few places, completely cover the bed rock. In this section the broader ridges of drift consist of steeply sloping hills separated by abrupt, more or less circular depressions, a type of surface usually described as knob-and-kettle topography. On the south side of the river, the mantle of drift is less extensive and rock exposures, in the form of ridges and low knolls rising above



N.A.M.E. base, Pickle lake, September, 1929.

the muskeg, are fairly abundant. The average elevation of the area is about 1,200 feet.

The area is drained by Crow river, which rises just north of Lake St. Joseph and flows in a northeasterly direction until it unites with the Otoskwin river at Badesdawa lake to form the Kanuchuan river. The Kanuchuan river is a tributary of the Attawapiskat river, which empties into the west side of James bay opposite Akimiski island.

Between Kapkichegimaga lake and its junction with Pickle creek, Crow river, except for one intervening expanse (Hook lake), is narrow and swift. This stretch is marked by several small falls and shallow rapids which, at times, make 7 portages necessary. From the junction of Pickle creek to Kukuku rapids, a distance of about 9 miles, there are 5 small rapids or falls. Below Kukuku rapids the river varies in width from 1 to 3 chains and flows quietly and without appreciable drop for 14 miles to July falls, beyond which it empties into Badesdawa lake. From the east end of Kapkichegimaga lake to Badesdawa lake the territory adjoining the river is poorly drained and contains broad stretches of forest-covered muskeg and open swamp.

Inhabitants

A few families of Ojibway Indians gain a livelihood by trapping in the area during the winter months. They make no attempt at agriculture and

are dependent on hunting and fishing for subsistence. Their camps are located near the west end of Kapkichegimaga lake, on Pickle lake, and on Badesdawa lake. They spend much of the summer season travelling to and from posts on Lake St. Joseph where they trade their furs and obtain supplies for the following winter.

Natural Resources

Climate and Soil

The growing season in the area is comparatively short. The weather during the month of July was hot and dry, the thermometer rising to nearly 90° F. in the shade on several occasions, and vegetation on the higher ground was completely parched. Frosts occurred in June and again in the middle



July falls, Crow river.

of August. The only arable land in the area consists of small stretches of sand plain adjoining Crow river a short distance below its junction with Pickle creek.

Forests

Most of the area is well forested. The large stretches of muskeg support a fairly dense growth of spruce, much of it suitable for pulpwood. Tamarac is found in the wetter and more open swamps. Along the lake shores stunted cedars are plentiful. The high ground is covered by poplar, spruce, pine, and occasionally birch. On some of the drift ridges between Crow river and Tarp lake there are some fine stands of pine large enough for mine timbers. Jackpine is confined chiefly to the dry sand ridges and rocky slopes.

Fish and Game

Fish and game are remarkably scarce in the region and cannot be relied upon as a source of food supply. Pickerel and whitefish are caught occasionally in Wimbabika and Pickle lakes, but they do not seem to be abundant. Pike and pickerel can be obtained at times below the several falls on Crow river. The Indians catch sturgeon in Badesdawa lake.

Moose, deer, bears, and wolves are rarely seen. Caribou are reported to pass through the area during the winter. Apparently all the beavers have been trapped out as no fresh cuttings were seen. Of the small game, partridges and rabbits are most abundant, but even they are not plentiful.

Water Powers

With the possible exception of the falls at the outlet of Hook lake, there are no sites favourable for the development of hydro-electric power on Crow river. At Hook falls, with a drop of about 8 feet, only an inconsiderable amount of power could be developed owing to the small volume of the stream at this point.

The nearest power site of consequence is located on the Albany river 4 miles below Atikokiwam lake, a distance of about 26 miles south of Pickle lake. According to Government estimates[1] this site would provide a 36-foot head of water and has a capacity of 4,444 horse-power at ordinary minimum flow and 80 per cent. efficiency.

Scope of the Work

With the exception of a reconnaissance survey of the Crow river made between 1903 and 1905 by W. McInnis, of the Geological Survey of Canada, no previous geological work has been done in the area. In view of the possible importance of this new field and owing to the lack of geological information concerning it, the writer was commissioned by the Ontario Department of Mines to make a preliminary examination of the area and of the principal deposits. This work was done during the summer of 1929.

Pace and compass traverses were run north and south from Crow river at intervals across the staked portion of the Pickle Lake greenstone belt. The geological relationships in the vicinity of the showings and along the lines of several groups of surveyed claims were examined in greater detail. In addition, a reconnaissance was made of the shore geology along Crow river from Kawinogans lake on the west to Badesdawa lake on the east and about Wimbabika, Pickle, and Tarp lakes.

Acknowledgments

The writer was ably assisted by J. E. Thomson, C. G. Clarke, and G. Young, who rendered willing and efficient service throughout the field season. Mr. Thomson served as first assistant on the party and was responsible for much of the geological mapping. The writer wishes to express his appreciation of the information and hospitality tendered by officials of the various mining and prospecting companies working in the area and particularly to J. C. Kirkland, John McCallum, P. Hamilton, A. N. Davis, F. Grozelle, B. Jowsie, and F. Austin. The members of the party are indebted to pilots of the Provincial Air Service and to J. Guertin, deputy fire-ranger at Pickle lake, for their co-operation in the prompt delivery and care of provisions and equipment. In the preparation of this report, officials of Central Patricia Mines, Limited, and J. A. Reid, consulting engineer, very cordially furnished all information and maps dealing with the underground exploration of the property.

GENERAL GEOLOGY

Introduction

The consolidated rocks of the Pickle Lake–Crow River area are all pre-Cambrian in age. They consist chiefly of igneous rocks with only minor amounts of sediments. The principal geological feature of the area is the Pickle Lake belt of Keewatin greenstone. Another belt of greenstone, known as the Kawinogans Lake belt, is exposed near the west end of Kawinogans

[1]L. V. Rorke, List of Waterpowers in the Province of Ontario, Ont. Dept. Lands and Forests, 1925, p. 10.

lake. The belts extend like ribbons across a broad expanse of younger granite and gneiss. The general geology is summarized in the following table:—

Table of Formations

QUATERNARY	
PLEISTOCENE:	Boulder clay and fluvio-glacial deposits.
	Great unconformity
PRE-CAMBRIAN	
KEWEENAWAN(?):	Diabase dikes.
	Intrusive contact
ALGOMAN(?):	Granite and gneiss; granite porphyry and quartz porphyry.
	Intrusive contact
PRE-ALGOMAN:	Diorite and gabbro.
	Intrusive contact
KEEWATIN:	Greenstones, schists, iron formation, and some sediments.

The belts of Keewatin rocks are briefly described below. The extent of each, within the area examined, is shown on the accompanying sketch map. Owing to the prevalence of glacial drift and muskeg and the consequent scarcity of outcrops, the location of the granite-greenstone contacts, except in a few places, could not be accurately determined.

Pickle Lake Belt

This belt consists of massive greenstones, basic intrusives, schists, some sediments, and occasional bands of iron formation. It has been traced in a northeasterly direction from the west end of Wimbabika lake to July falls on Crow river, a distance of 28 miles. It has an average width of 4 miles and is bordered on the northwest and southeast by later intrusions of granite. In the vicinity of Wimbabika lake the belt narrows to less than a mile and appears to be cut off by granite just beyond the west end of the lake. A traverse run southeast from July falls indicated that the belt is at least $1\frac{1}{2}$ miles wide at this point and that it probably continues for some distance to the northeast.

The formations strike roughly northeast-southwest and dip, for the most part, at steep angles to the north or northwest. Considered as a whole, the belt appears to be the northern limb of an anticlinal structure, the axis of which lay some distance to the southeast. As a consequence of the folding movements to which the rocks have been subjected, much shearing and fracturing have taken place. Shearing has been localized chiefly along planes which have an east-west to northeast-southwest trend. Quite frequently such lines of structural weakness are most evident in the vicinity of the bands of iron formation. The greenstones, which are massive throughout most of the belt, have been rendered schistose along these planes of shearing. Near the granite contacts the schistosity is characterized by abrupt changes in strike and dip. The most prominent directions of fracturing (tension cracks) lie between north and northwest.

Kawinogans Lake Belt

This belt was first encountered on the shores of Kawinogans lake at a point about 13 miles southwest of the termination of the Pickle Lake belt. It lies on the line of strike of the Pickle Lake belt and may at one time have

formed a part of it. The two belts are now separated by a body of granite at least 8 miles wide. The Keewatin rocks are well exposed about the western half of Kawinogans lake, where they have a width of $2\frac{1}{4}$ miles, and are flanked on the north and south by granite. The belt was traced for about 6 miles. It continues to the southwest of Kawinogans lake and appears to be cut off by granite to the northeast. The rocks consist chiefly of massive greenstones, diorite or gabbro, and some schists. As no sediments or iron formation were noted along the lake shores it is probable that these rocks are present only in narrow, isolated bands similar to their occurence in the Pickle Lake belt. The schistosity of the greenstones strikes N. 60° E. and dips steeply to the north.

Keewatin

Volcanic Rocks

Volcanic rocks, similar to the Keewatin described from other parts of the Patricia portion of the district of Kenora, make up the bulk of the greenstone belts. They consist chiefly of andesitic and basaltic lavas,



Banded iron formation, claim Pa. 80,
Central Patricia Mines.

usually massive, but often sheared and altered to chlorite-carbonate schists. Occasionally they show an ellipsoidal or pillow structure and only rarely are they amygdaloidal. Acid lavas of rhyolitic composition occur in a few places. Volcanic breccia, forming a zone about 50 feet wide along flow contacts, was noted on claim Pa. 727 (Northern Aerial Minerals Exploration, Limited, East group). What is probably the same zone outcrops again to the northeast on claim Pa. 63 of the Albany River Mines.

In places the lavas are highly contorted and show evidence of the drag-folding that produced openings later filled by gash veins of quartz. Narrow bands of iron formation or other sediments occur here and there intercalated between the lava flows. Near the granite contacts the greenstones frequently show the effects of metamorphism and, in some instances, they have been converted to hornblende schist or amphibolite.

Iron Formation

Streaks, lenses, and bands of iron formation occur in various parts of the Pickle Lake greenstone belt. These bodies range in width from a few feet to 250 feet and can frequently be traced more or less continuously for several hundred feet along the strike. They appear to be intercalated between the Keewatin lava flows, and in places grade almost imperceptibly into the enclosing formations. The contacts between the greenstone and iron formation constitute lines of structural weakness. This is due to the

fact that the greenstones readily become schistose and tend to flow under pressure, whereas the harder and more resistant iron formation does not. In cases where shearing has been very intense, the bodies of iron formation are much fractured and often disrupted into segments, which are twisted from their original position and surrounded by schistose greenstone squeezed in from the sides. The principal deposits on the Central Patricia and N.A.M.E. properties are associated with bands of iron formation in which such fracture zones have developed and along which later mineralization has taken place.

The bodies of iron formation observed in the area are too low-grade to be of any value as a source of iron. Although in some sections the bands consist almost wholly of magnetite, such occurrences are not extensive enough to be of economic importance.

The iron formation consists of bands, ranging from a fraction of an inch to 2 inches in thickness, in which iron carbonate, silica, and magnetite



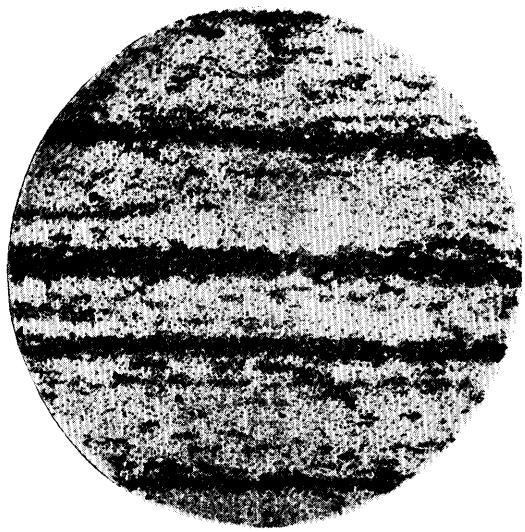
Band of iron formation (indicated by hammer) pinching out in schistose greenstone, claim Pa. 730, N.A.M.E. East group.

are present in varied proportions. The oxidation of the iron carbonate to limonite imparts a rusty appearance to the outcrops and frequently accentuates the banded structure. The silica occurs as a chalcedonic or flinty variety and never as jasper.

On an unweathered surface the iron formation may be light-grey, buff, greenish-brown, or black in colour. Usually it is made up of alternating light and dark grey layers. The light-coloured bands consist of finely laminated silica with only minor amounts of iron carbonate. The grey or brown layers contain much iron carbonate, some silica, and a little magnetite. In the dark-grey or black bands magnetite is abundant and usually predominates over the other constituents. In places, streaks and fragments of chloritic material from the greenstone walls are included in the iron formation near its margins.

Where later fracturing and mineralization have taken place, pyrrhotite and occasionally pyrite are found replacing the iron carbonate and filling minute cracks in the various bands. Oxidation of these sulphides is usually indicated by an extensive gossan and by the presence of a white sulphate coating the weathered surfaces.

Thin sections were made from drill cores and hand specimens representative of the bodies of iron formation which contain the principal ore zone on the Central Patricia property and the Howell vein on the N.A.M.E.



Thin section of highly siliceous iron formation in which the silica bands (light) are wider than the bands of iron carbonate (dark), Central Patricia Mines. (×51.)

East group. The microscope shows the iron formation to be composed of bands consisting chiefly of cryptocrystalline quartz and siderite, varying



Thin section of iron formation showing banded arrangement of magnetite grains (black) in iron carbonate (light), Central Patricia Mines. (×51.)

amounts of magnetite and pyrrhotite, and occasional streaks of chlorite. Some bands are made up entirely of small, sharp-cornered quartz grains which seem to be interlocked with one another rather than cemented together.

In other bands tiny, more or less angular particles of iron carbonate predominate. In most of the layers both quartz and siderite are intimately mixed together but in variable proportions. Some of the bands are composed almost wholly of magnetite in small, angular grains. Pyrrhotite occurs as patches, streaks, or grains replacing iron carbonate and chlorite or as veinlets traversing the various bands. It was obviously formed during a later period of mineralization and may possibly owe its origin, in part, to the interaction of hydrogen sulphide (H_2S) with the ferrous carbonate ($FeCO_3$) of the iron formation. Streaks of chlorite, which probably represent inclusions of schistose greenstone, are often associated with the carbonate bands.

The following analyses were obtained from samples of iron formation submitted to the Provincial Assay Office:—

	Sample No. 1	Sample No. 2
	per cent.	per cent.
SiO_2	38.35	32.13
Al_2O_3	nil	1.43
FeO	26.05	31.14
Fe_2O_3	2.60	9.60
CaO	4.68	2.28
MgO	3.42	2.17
Na_2O	.21	.08
K_2O	.18	.14
H_2O (—100° C.)	.01	.01
H_2O (+100° C.)	.32	.39
CO_2	23.00	18.98
TiO_2	.10	.14
MnO	.56	.13
P_2O_5	.11	.16
S	.45	2.09
Total	100.04	100.87
Specific gravity	3.055	3.488

Sample No. 1—Specimen of iron formation from trench No. 6 on the main ore zone, Central Patricia Mines.

Sample No. 2—Specimen of drill core from iron formation containing the Howell vein, N.A.M.E. East group.

Of the constituents determined in the above analyses, ferrous iron, lime, magnesia, and manganous oxide are believed to enter chiefly into the composition of the carbonate, which forms such an important part of the iron formation. The ferric iron and some of the ferrous iron are combined as magnetite. The silica occurs as a cryptocrystalline variety of quartz. As no minerals containing potash and soda were identified, these constituents are thought to be associated either with the silica or the carbonate. Oxide of titanium is probably contained in ilmenite and phosphorus pentoxide in apatite. Streaks of chlorite observed in thin sections of the core account for the presence of alumina in sample No. 2.

It is believed that the bands of iron formation represent chemical sediments deposited during certain brief periods of quiescence, which occurred in Keewatin time between successive outpourings of lava. These sediments probably accumulated in shallow depressions on the ancient flow surfaces or along shore lines existing at that time. The absence of silt and other detrital material in the iron formation suggests that deposition took place before the freshly erupted lavas were affected by weathering. Subsequent eruptions buried the iron-bearing sediments before complete oxidation was accomplished.

It is thought that the silica and ferrous carbonate were transported in solution and later precipitated under reducing conditions. Microscopic study of the iron formation suggests that the deposition of silica went on continuously, whereas the deposition of iron carbonate and magnetite took place periodically. In view of the absence of detrital material in the iron formation, it seems probable that the magnetite was not an original constituent of the greenstones set free by weathering but rather owes its origin to the oxidation of solutions rich in ferrous carbonate or other iron-bearing compounds. The writer is inclined to the belief that the silica-iron-carbonate solutions were given off by the lavas during or shortly after their eruption and to a subordinate extent only were derived from the weathering of these rocks.

Sediments

Sedimentary rocks form only a small part of the Pickle Lake greenstone belt. They occur in narrow bands lying conformably between the Keewatin volcanics and are considered to be of the same general age. No post-Keewatin or Timiskaming sediments were recognized in the area. The sedimentary bands, other than the iron formation already referred to, consist chiefly of quartzite and slate. The quartzite exhibits a gneissic structure due to the presence of dark-coloured constituents, of which garnet is the most conspicuous. A narrow band of gneissic quartzite, striking northeast-southwest, occurs in the vicinity of the workings on the Maloney property. What is probably the same band outcrops on the Mining Corporation claims, a mile distant, and at intervals still farther to the southwest.

Pre-Algoman

Bodies of coarse-grained basic igneous rocks, regarded as pre-Algoman in age, are widely associated with the Keewatin greenstones. These are thought to represent intrusions of diorite or gabbro which have, in many instances, been so sheared and altered as to be scarcely distinguishable from the adjoining volcanic rocks. In view of this similarity in appearance, and owing to the limited exposures, it was impossible in the time available to map these bodies separately.

Algoman(?)

Intrusions of granite flank the greenstone belts on the northwest and southeast. As no Timiskaming sediments were found in the area, the age of these intrusions could not be determined more precisely than post-Keewatin. To the west, in the Red Lake[1] and Woman Lake[2] sections of the Patricia portion of the district of Kenora, where rocks of Timiskaming age do occur, the intrusions of granite, which closely resemble those of the Pickle Lake–Crow River area, are considered to be of Algoman rather than of Laurentian age. In view of this similarity and because the batholithic invasions of granite were probably contemporaneous over much of northwestern Ontario, it is believed that the bodies of granite and quartz porphyry in the Pickle Lake–Crow River area are also Algoman in age.

The largest exposures of granite lie to the south and west of Pickle lake, on Wimbabika lake, and about the west end of Kapkichegimaga lake. With the exception of outcrops on the south shore of Tarp lake and below July falls, no exposures of granite were noted on the north side of Crow river east of Kapkichegimaga lake.

[1]E. L. Bruce and J. E. Hawley, Ont. Dept. Mines, Vol. XXXVI, pt. 3, 1927, pp. 26-47.
[2]E. L. Bruce, Ont. Dept. Mines, Vol. XXXVII, pt. 4, 1928, pp. 16-21.

The typical granite of the Pickle Lake–Crow River area is a grey, medium to coarse grained rock in which the principal ferromagnesian constituent is biotite. It is usually massive but may show a gneissic structure or a hybrid character near the greenstone contacts. Tongues of pink granite and pegmatite dikes cut the grey granite in places, particularly near the west end of Kapkichegimaga lake. The pegmatite dikes range from a few inches to 2 feet in width and consist of coarsely crystalline microcline along the margins, with quartz or occasionally pink aplite in the middle.

Bodies of quartz porphyry and granite porphyry, thought to be related in age to the main granite intrusions, occur on the Springer claims and on the property of the Albany River Mines. These rocks are characterized by conspicuous grains of quartz embedded in a fine to coarse groundmass consisting of feldspar and quartz with few dark constituents.

In other sections and principally to the north of the main showings on the Central Patricia property, there are narrow bodies of sheared quartz porphyry or quartz-sericite schist. As yet it has not been conclusively determined whether these rocks are acidic volcanics belonging to the Keewatin group or whether they represent later intrusions related to the Algoman granite. The fact that they are cut in places by large quartz veins, regarded as being of Algoman age, suggests that some of these acidic schists were derived from Keewatin lavas rather than from Algoman porphyries. A thin section was made of the sheared porphyry that lies to the north of the ore zone on the Central Patricia property. Under the microscope the rock is seen to consist of large grains of quartz embedded in a schistose matrix composed of sericite, carbonate, quartz, and chlorite.

Keweenawan(?)

Several diabase dikes were noted in the area. They intersect the Keewatin greenstones and are comparatively fresh and unsheared. As they resemble closely the Keweenawan diabase dikes of other areas, it is thought that they may be of the same age, although it was impossible to determine whether they are older or younger than the main granite (Algoman?) intrusions. The largest and most conspicuous dike runs northwest-southeast across the property of the Central Patricia Mines. Under the microscope this rock is seen to be composed of ophitically intergrown plagioclase and augite.

A lamprophyre dike that cuts across the Howell vein on the N.A.M.E. East group is thought to be of Keweenawan age. Thin sections of this rock show it to be composed chiefly of biotite, orthoclase, chlorite, and carbonate. It is probably an altered minette.

Pleistocene

Pleistocene glaciation has greatly modified the topography of the area. Glacial striae indicate that the ice sheet advanced in a southwesterly direction across this part of the Patricia portion of Kenora. In retreating to the northeast it left behind a mantle of drift, which underlies the swamps and covers much of the bed rock. The deposits consist, in part, of steep-sided ridges and drumloidal hills of boulder clay which, in some sections, give rise to a knob-and-kettle topography. Stretches of sand plain and occasional eskers, deposited by streams emerging from the retreating ice front, cover portions of the territory adjoining the Crow river. These deposits range from a few feet in thickness on the higher ground to 15 feet or more in the depressions.

ECONOMIC GEOLOGY

Evidence of mineralization has been noted at a number of points in the Pickle Lake–Crow River area. The deposits discovered so far consist of gold-bearing quartz veins or silicified zones carrying auriferous sulphides. The bands of iron formation are too low-grade to be of value as a source of iron.

Early reports from the area intimated that the iron formation was the principal ore carrier and that a unique type of gold deposit had been discovered. Subsequent exploration has shown that, while ore bodies may be contained in the iron formation, the gold values were introduced during a later period of mineralization. Unless such mineralization has taken place the iron formation is practically barren.

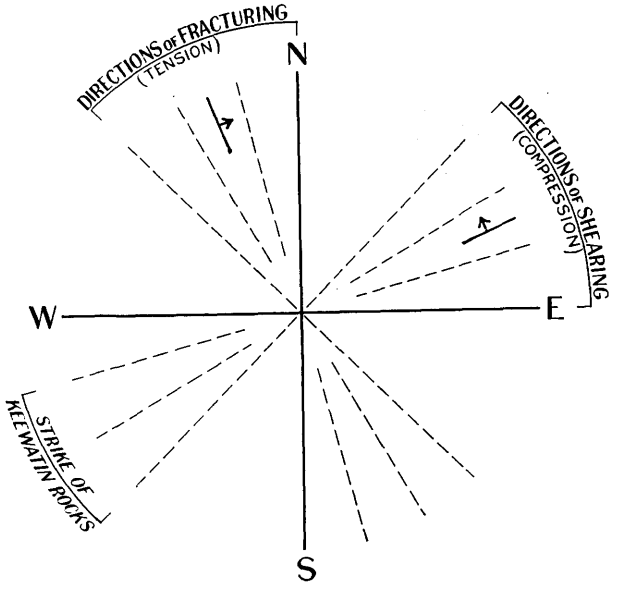


Diagram showing prominent directions of shearing and fracturing in the Pickle Lake greenstone belt.

The mineralization is associated with openings formed as a consequence of the folding and buckling of the Keewatin rocks. The folding movements involved both tension and compression. The compressive stresses were responsible for the development of shear zones, which trend N. 50° E. to east-west and dip north or northwest. These zones intersect at a low angle the greenstones and iron formation, which strike N. 50°-75° E. As the planes of shearing and the strike of the rocks are so nearly parallel, it is difficult to determine how much the rocks have been displaced or faulted by the shearing movements. The tensional strains, which appear to have become effective after the shearing, produced fractures that cut across the Keewatin rocks in directions ranging from north-south to N. 45° W. They dip usually to the east or northeast. As these fractures intersect the strike of the rocks, any relative displacement or faulting is more easily recognized. Underground exploration of the Central Patricia ore zone is said to indicate that the location and rake of the ore shoots have been determined by the intersection of the northwestward-striking planes of fracturing with the east-west planes of shearing. At the eastern extremity of the ore zone subsequent faulting along a northwest fracture has cut off the vein and displaced it, as indicated by the drag, to the south.

As the greenstones tend to flow and become schistose when sheared, the openings created are usually smaller and less continuous than those developed in the relatively hard and competent bands of iron formation. In the greenstones the veins frequently lie parallel to the schistosity and, as a consequence, they pinch and swell along the strike. Where drag-folding has occurred they are particularly irregular and contorted. The bands of iron formation tend to crack rather than flow in response to shearing movements and fractures once formed usually remain open. This explains why openings available for mineralization are often found to be more numerous and larger in the iron formation than in the greenstones. It is usual to find that veins and mineralized zones become narrower and more erratic on passing from iron formation into greenstone.



Thin section showing quartz veinlet (white) cutting iron formation, which is composed chiefly of iron carbonate (grey) and scattered grains of magnetite (black), Central Patricia Mines. (×51.)

Shearing and fracturing of the Keewatin rocks was followed by a period of mineralization, which is thought to have been genetically connected with the intrusions of granite (Algoman?). Quartz veins and associated sulphides were deposited in the fracture and shear zones. The quartz veins differ slightly in age but closely resemble one another in appearance. Some, probably the older ones, are gold-bearing and others are barren. The sulphides are associated with quartz in the vein filling or they occur as replacements of the wall rock. They consist chiefly of pyrrhotite, pyrite, arsenopyrite, and chalcopyrite. Pyrrhotite is particularly widespread in the mineralized portions of the iron formation, where it occurs as minute veinlets or as streaks and patches replacing iron carbonate. In addition to quartz, the vein filling frequently contains calcite, ankerite, chlorite, or tourmaline. Native gold is conspicuously present in some of the veins, notably the Howell vein on the N.A.M.E East group and a vein on claim Pa. 647 of the Springer group. At the Central Patricia property the gold values occur chiefly in the sulphides, especially arsenopyrite.

The most promising deposits so far discovered in the area occur on the Central Patricia property, on the N.A.M.E. East group, and on the Springer group. The shear zone on the Central Patricia property can be traced for about half a mile, but only portions of it are mineralized. It was thought

at first that the Central Patricia and N.A.M.E. showings occurred along the same "break," but subsequent work has indicated that there is no connection between the two deposits. The Howell vein on the N.A.M.E. property intersects a zone that has been exposed at intervals from the Springer group on the southwest to the Albany River Mines on the northeast, a distance of about 2½ miles. The showings on the Maloney and Mining Corporation claims, though a mile apart, appear to lie along the same band of sediments. Most of the other showings found in the area occur along smaller fracture zones and at widely separated points. Although much prospecting was done and many groups of claims were examined by mining and exploration companies during the summer of 1929, this work, for the most part, did not meet with encouraging results.



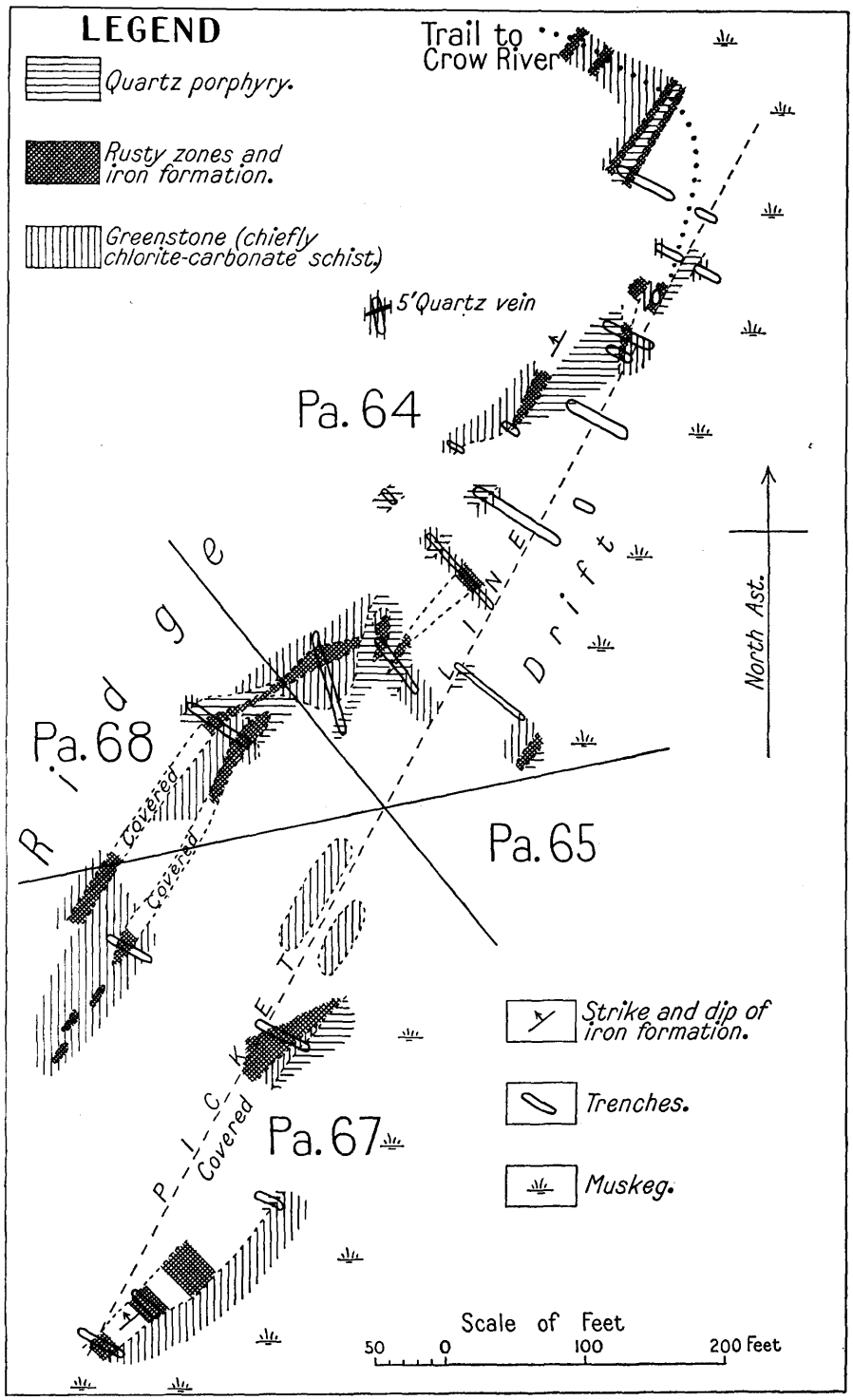
Thin section showing pyrrhotite (black) replacing a chloritic streak in banded iron formation, which is composed of iron carbonate (grey) and silica (white), Central Patricia Mines. (×16.)

Description of Properties

Albany River Mines, Limited

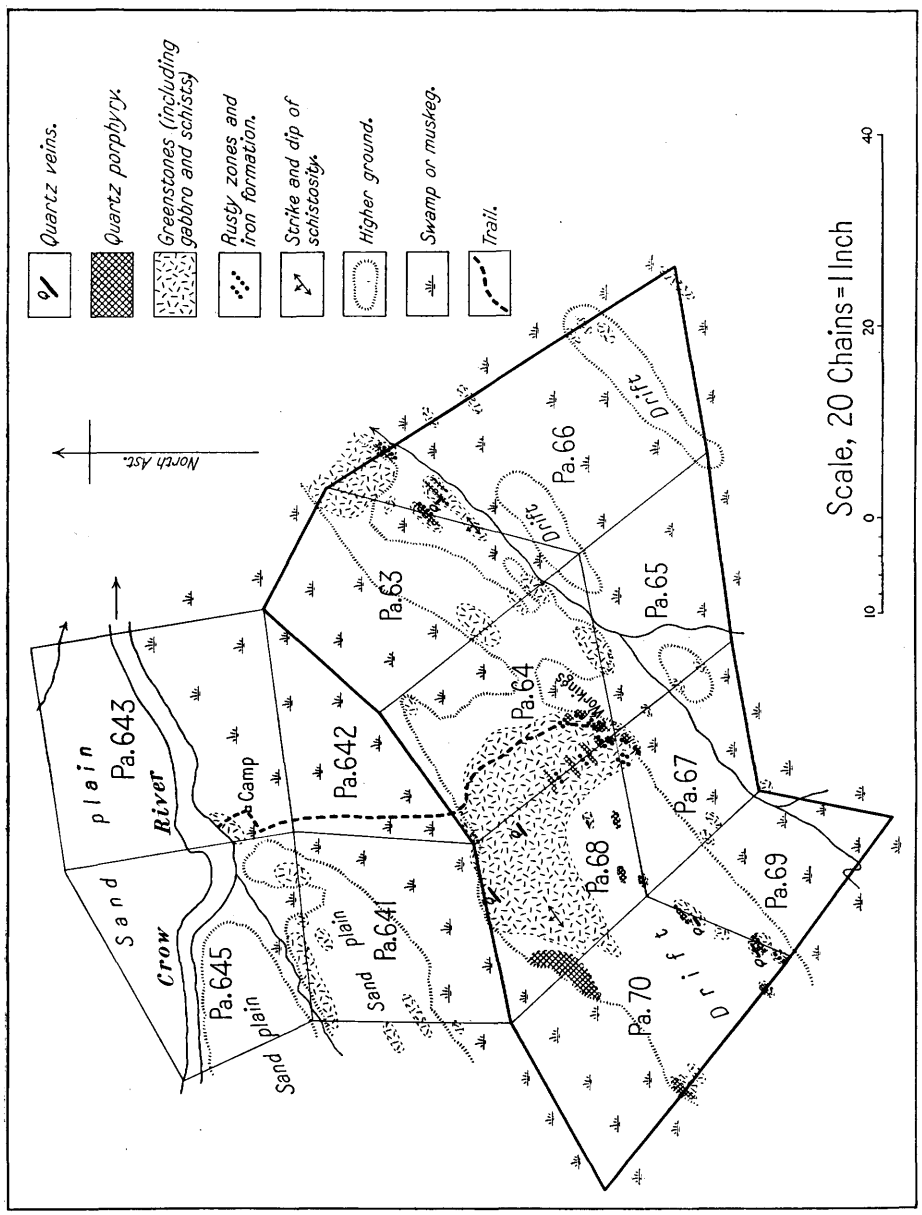
This property consists of 8 surveyed claims located to the southeast of Kukuku rapids on Crow river. These claims were the first recorded in the area. A trail, half a mile long, leads to the workings from a point on Crow river about half a mile below Kukuku rapids. During the summer of 1929 the ground was optioned to F. M. Connell and associates, and a programme of surface exploration was carried out under the direction of C. Matheson.

The geological relationships on this group of claims are shown on the sketch map on page 17. The principal showings occur along the base of a ridge which crosses claims Pa. 64, 67, and 68. The rocks in this vicinity consist of greenstones and several bands of iron formation which have been intruded by tongues of quartz porphyry. The greenstones are contorted and schistose, and the bands of iron formation are much fractured and disrupted. The quartz porphyry is light-grey in colour and contains conspicuous quartz grains embedded in a coarse matrix composed of feldspar, sericite, and chlorite. It seems probable that this zone of intrusion and and fracturing lies along the northeasterly continuation of the band of iron formation intersected by the Howell vein on the N.A.M.E. property.



GEOLOGICAL PLAN OF THE PRINCIPAL WORKINGS, ALBANY RIVER MINES.

The workings consist of trenches and rock cuts along the zone referred to above. The deposits occur at or near the contacts of quartz porphyry with greenstones or iron formation. For the most part, they are unconnected, erratic, and lacking in continuity. The mineralization consists of pyrite, pyrrhotite, and occasional veinlets of quartz and calcite. The sul-



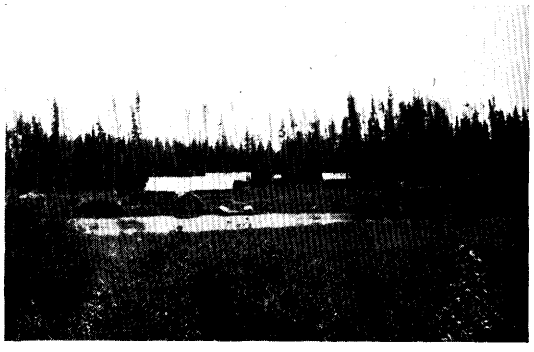
Geological sketch map of the Albany River Mines group of claims.

phides occur as veinlets cutting chlorite schist and iron formation or as solid masses, streaks, and disseminated grains replacing these rocks. Pyrite predominates in the greenstones; pyrrhotite in the iron formation. In places the iron formation consists almost wholly of magnetite over widths ranging up to 15 feet. It is reported that visible gold has been found in places and that attractive assays have been obtained from some of the showings.

Central Patricia Mines, Limited

The property of this company consists of 18 surveyed claims lying about 2 miles northeast of Pickle lake and covering ground on both sides of Crow river. The camp and principal showings are located close to the south bank of the river.

During the summer of 1929 the main ore zone was explored by diamond-drilling, and considerable trenching was done on various parts of the property. This work was carried out under the direction of J. C. Kirkland. Following the appointment, in September, 1929, of W. E. Segsworth as general manager and A. J. Keist as mine superintendent, underground development of the deposit was begun. During February and March, 1930, a complete mining plant and supplies sufficient to carry on underground operations for nearly a year were transported from Savant Lake station to the property. By the end of June, a 3-compartment shaft had been sunk to a depth of 527 feet and lateral work begun at four levels. J. P. Millenbach was then appointed mine superintendent, and development work was continued until the property was closed down in September, 1930.

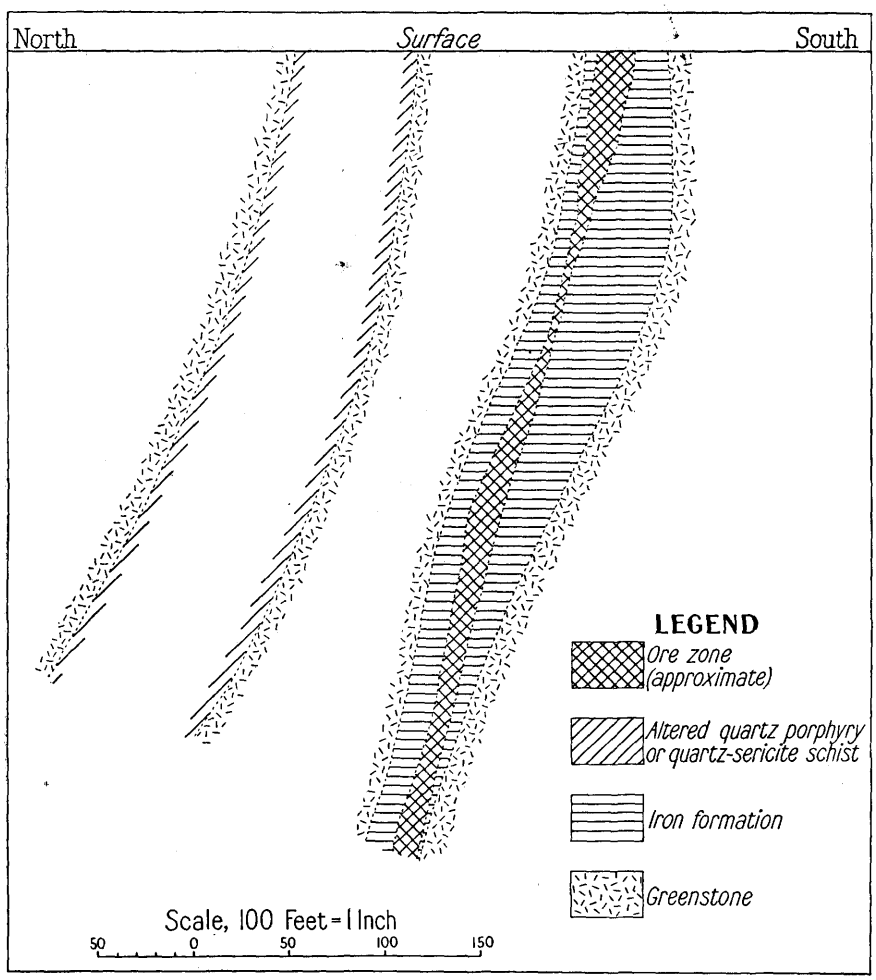


Camp at Central Patricia Mines, Crow River, August, 1929.

The geological relationships on this property are shown on the accompanying sketch map. The bed rock consists chiefly of Keewatin greenstones, schists, and occasional bands of iron formation. Sill-like bodies of altered quartz porphyry or quartz-sericite schist outcrop to the north of the principal ore zone and on both sides of Crow river. These appear to be conformable in strike and dip with the enclosing greenstones and they exhibit similar schistosity. Information available so far is insufficient to warrant a decision as to whether these bodies have been intruded as sills into the Keewatin rocks or whether they represent rhyolitic flows belonging to the same general period of volcanic eruption as the greenstones. It was at first believed that mineralization on the property was related to these tongues of altered porphyry, but no conclusive evidence pointing to such a relationship has been found so far. A prominent diabase dike, 100 to 300 feet wide, intersects the Keewatin rocks and crosses the property from northwest to southeast. Segments of the dike, exposed on either side of Crow river, appear to be slighly offset with regard to one another. Whether this is due to a bend in the course of the dike or to faulting has not been determined.

Patches of iron formation, quartz veins, and other evidence of mineralization have been found on various parts of the property. The most important deposit, and the one on which development work has been concentrated, is located just south of Crow river on claims Pa. 77 and Pa. 78.

This deposit occurs along a fracture zone intersecting a band of iron formation that lies within the Keewatin greenstones and trends slightly north of east. This band is not uniform in width or continuity but consists rather of several lenticular bodies. These do not lie exactly along the same line of strike but are slightly offset in relation to one another. They attain a width of 50 feet in places and each extends about 400 feet along the strike before being displaced or pinching out. Altogether, the iron formation has

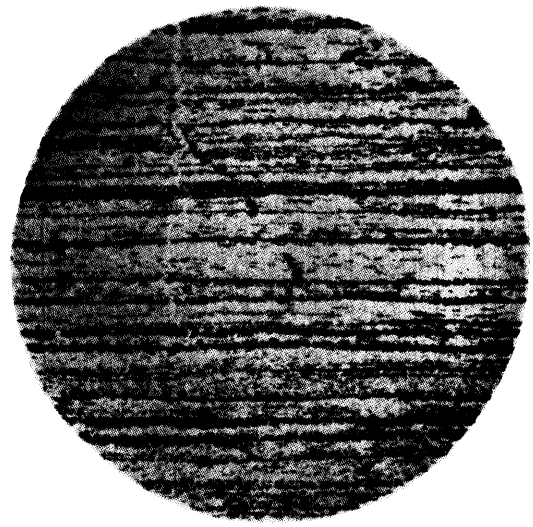


Structure section showing geological relationships across the principal ore zone, Central Patricia Mines.

been traced by trenching for about 1,800 feet. The zone of fracturing and mineralization runs approximately east-west and intersects the lenses of iron formation at a low angle. It is cut off or displaced by a fault at the east end; and at the west end, where it passes into the greenstones, there is a marked decrease in the mineralization.

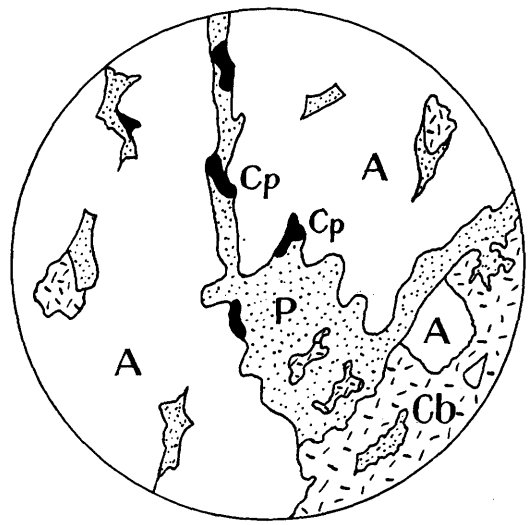
The relationships of the ore zone and of the various rock formations, as indicated by diamond-drilling, are shown on the accompanying structure section. The mineralized zone and the enclosing iron formation dip at an angle of 75 degrees to the north. The body of altered quartz porphyry

that lies about 100 feet north of the ore zone and runs parallel to it also dips to the north at about the same angle.



Thin section of finely laminated iron formation composed of iron carbonate (dark) and silica (light), Central Patricia Mines. (×16.)

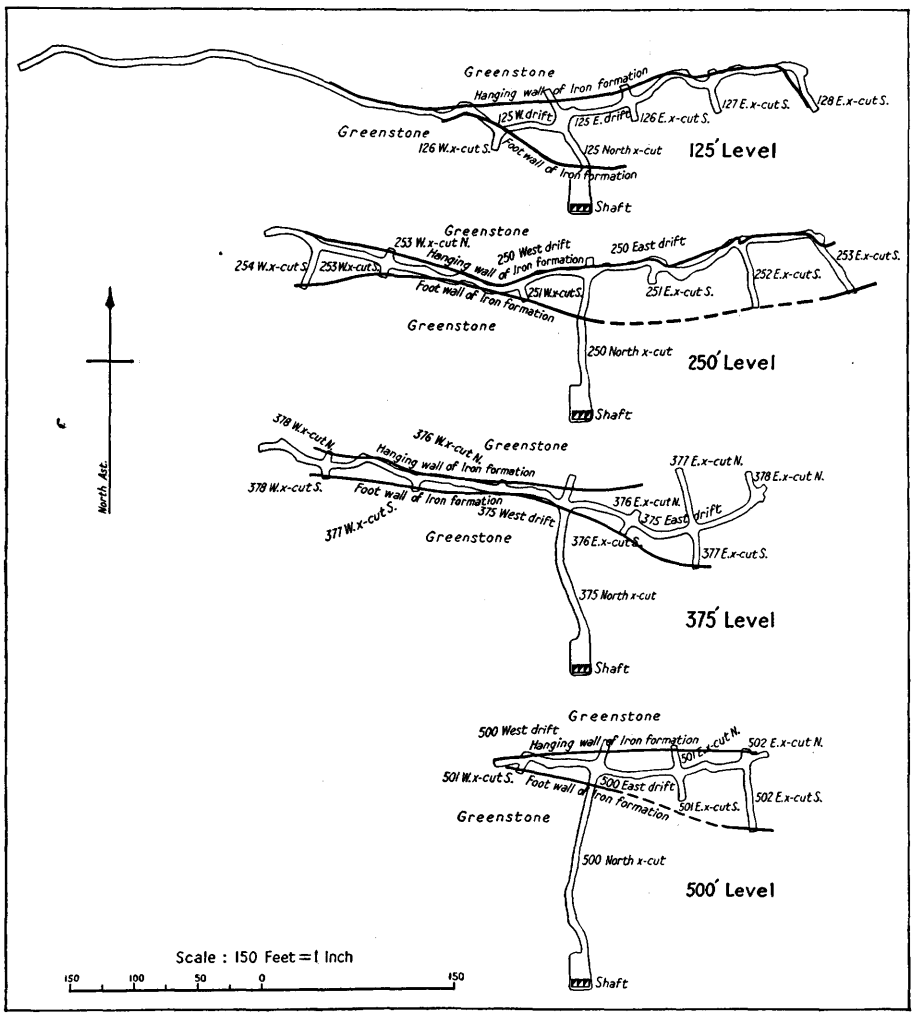
The fracturing of the iron formation provided innumerable cracks and crevices along which mineralizing solutions could subsequently penetrate. The chloritic and carbonate portions of the iron formation were impregnated



Drawing from a polished section of sulphide ore, Central Patricia Mines. The sulphides replace the chlorite and carbonate (Cb) of the iron formation. Arsenopyrite (A) is cut by a veinlet of pyrrhotite (P) and chalcopyrite (Cp).

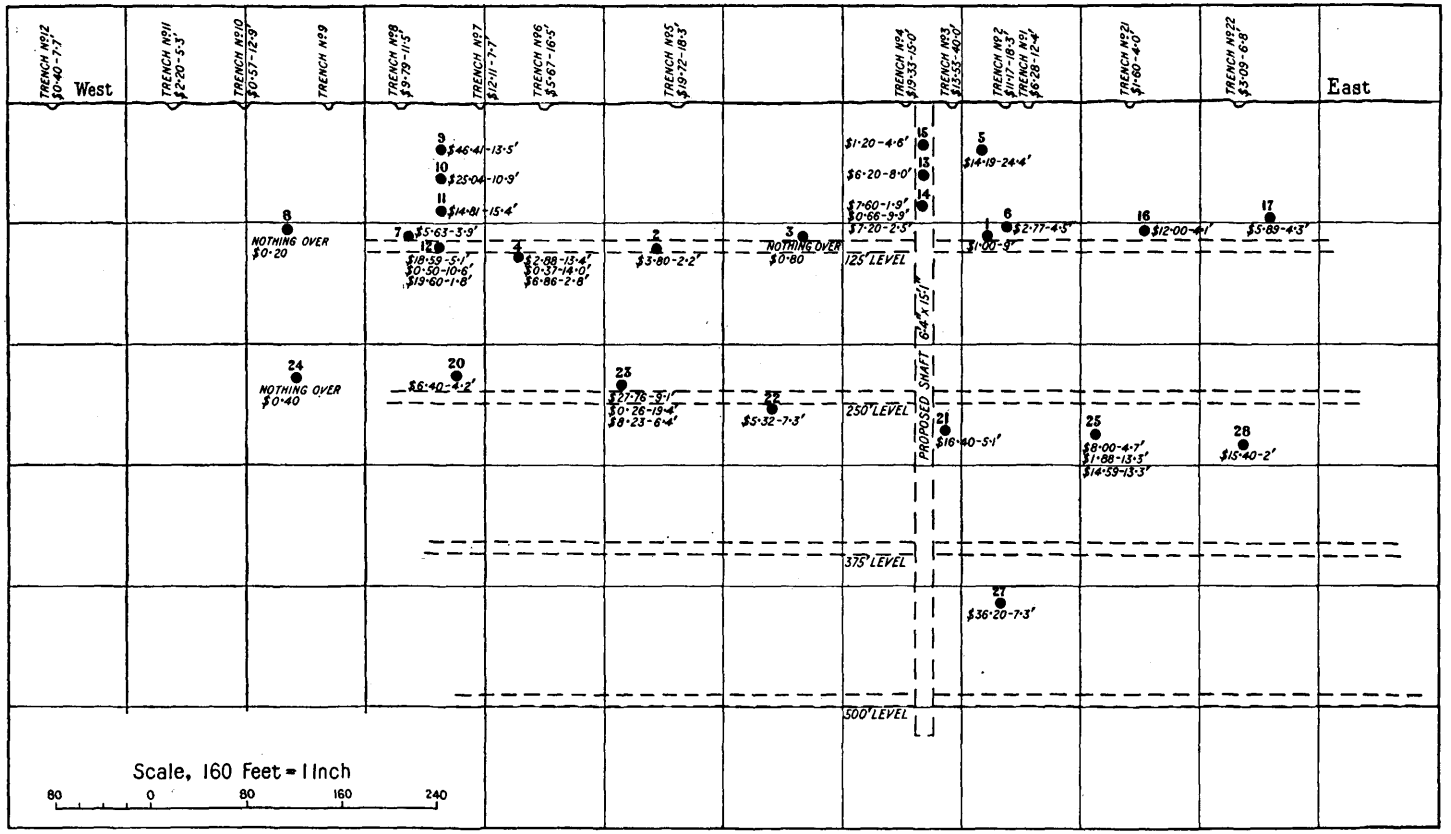
and partially replaced by pyrrhotite, pyrite, arsenopyrite, and chalcopyrite; and the open spaces were occupied by a network of quartz veinlets con-

taining varying quantities of the sulphides. No visible gold has been found so far in the deposit. The quartz and sulphides in specimens of ore taken from the surface workings were assayed separately at the Provincial Assay Office. The results indicate that the gold values are contained chiefly in the sulphides, particularly arsenopyrite, rather than in the quartz. As the mineralization is not confined between definite walls, the ore widths will be delimited largely by assay boundaries.



Plan showing underground workings, Central Patricia Mines.

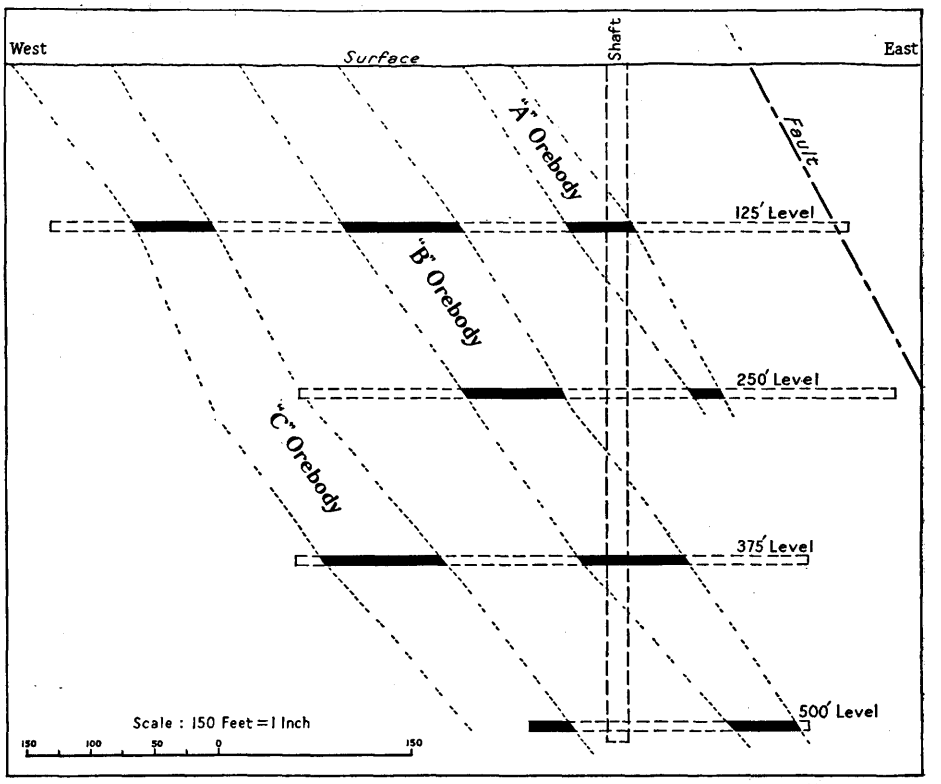
Prior to the commencement of underground development, the deposit was explored by diamond-drilling. Thirty holes, totalling about 6,000 feet, were put down at intervals along the ore zone. The assay returns obtained from the surface workings and from the drill-core intersections are shown on the accompanying plan and sections furnished by officials of the company. In a report issued by the company in December, 1929, W. E. Segsworth, general manager, states that the average of the surface sampling indicated an ore zone 557 feet long and 17.45 feet wide, running $12.57 in gold per ton.



Longitudinal section through the principal ore zone, Central Patricia Mines, showing diamond-drill intersections and assay values.

He also states that the average of the diamond-drill intersections at the 250-foot level indicated that the ore zone extends 680 feet with a width of 6.83 feet and gold values of $15.27 per ton. The deepest diamond-drill hole on the property at a depth of 430 feet intersected a horizontal width of 7.3 feet having an average value of $36.20 in gold per ton.

Underground exploration of the deposit was begun during the winter of 1929 and was continued until September 3, 1930. A vertical three-compartment shaft was sunk in the footwall of the ore zone to a depth of 527 feet, and lateral work, consisting of drifting and crosscutting, was done at four horizons: 125, 250, 375, and 500 feet. This work showed the gold



Longitudinal section of the ore zone, Central Patricia Mines, showing the ore bodies projected on a vertical plane.

values to occur in three fairly well defined shoots referred to below and in the longitudinal section on the opposite page as "A," "B," and "C." The following description of these ore shoots is taken from a report by J. A. Reid, consulting engineer for the company.

"A" shoot, the smallest and most easterly, is cut at the shaft crosscut on the 125-foot level. It has a maximum length on the first level of 52 feet but is only 15 to 20 feet long on the 250-foot level. Some indications of the shoot were found on the 375-foot level in the 377 east crosscut 25 feet north of the main drift.

"B" shoot has been explored on all four levels and its length is pretty well established. It lies 100 to 110 feet west of "A" shoot. Its greatest length, 92.5 feet, is on the 125-foot level and the shortest, 40 feet, on the 500-foot level. The average length as established by sampling is 69 feet.

"C" shoot has been completely traversed only on the 125- and 375-foot levels. It has not yet been reached on the 250-foot level and only partly explored and sampled on the 500-foot level. It lies 110 feet west of "B" shoot. It has the greatest length, 94 feet, on the 375-foot level and the estimated average length is 71 feet.

The ore bodies have a definite easterly rake varying from 59 degrees between the 125- and 250-foot levels to 46 degrees between the 375- and 500-foot levels, the average being 53 degrees.

On the 125-foot level, 184 feet east of the shaft crosscut, a strong fault zone was found, 12 feet wide, which strikes northwest and dips 60° N.E. This has cut off the iron formation and, from the evidence of the drag, displaced it an as yet undetermined distance to the south. If this fault be projected to the surface it will come up 120 feet east of the shaft or just east of No. 1 trench where the last important values were found in this direction. It appears not unlikely that this fault forms the eastern boundary of the ore zone.

The following estimates of the width, length, and assay value of each of the ore shoots exposed in the underground workings have been taken from a report prepared in September, 1930, by J. A. Reid, consulting engineer for the company. They are summarized in the table below:—

Shoot	Level	Channel samples			Car samples[1]			Remarks
		Value per ton	Width	Length	Value per ton	Width	Length	
			feet	feet		feet	feet	
A.....	125-foot	$14.74	3.6	51.5	$6.24	5	29	
	250-foot	16.62	3.4	21	8.13	5	13	
B.....	125-foot	$10.72	3.8	92.5	$9.61	5	54	The average for this shoot, taking into consideration both channel and car samples, is $13.92 per ton over a width of 5 feet and a length of 69 feet.
	250-foot	22.02	3.5	76	11.94	5	70	
	375-foot	21.07	4.8	82	14.78	5	86	
	500-foot	19.22	4.4	51	14.72	5	41	
C.....	125-foot	$26.50	3.6	60	$21.45	5	51	The ore body has not yet been reached on the 250-foot level. The average for this shoot, taking into consideration both channel and car samples, is $14.99 per ton over a width of 5 feet and a length of 71 feet.
	250-foot	.....	.....	.....	.....	.....	.....	
	375-foot	13.92	5.3	94	13.12	5	78	
	500-foot	12.22	4.4	35	6.70	5	22	

[1]These consist of grab samples taken from the cars of ore both underground and on the deck.

The following estimates of the value and tonnage of probable and possible ore indicated by surface and underground exploration up to September 18, 1930, are taken from a report of that date prepared by J. A. Reid, consulting engineer for the company:—

Probable Ore.—An average stope width of 5 feet is allowed. Shoot "A" is assumed to extend from the surface to the 250-foot level. It is too small in itself to have any important recoverable tonnage; nevertheless some ore can be secured close to the levels which might be supplemented by other quantities from various small showings, for which reason it is included in the estimate. "B" and "C" shoots are developed from the surface to the 500-foot level.

Shoot	Tons	Value per ton
"A".....	3,098	$8.81
"B".....	14,835	13.92
"C".....	15,222	14.99
Total.....	33,155	$13.71

Gross value, $454,555.05.

Possible Ore.—"B" and "C" shoots have, in all probability, a greater width than actually shown in the sampling over the drifts. "C" shoot has, in one place on the 375-foot level, 15.3 feet running $16.50 per ton. As, however, the drifts have not been slashed, only an approximate estimate can be given, which allows 40 per cent. more of possible ore on these two shoots, amounting to 12,000 tons of an average of say $12 per ton, worth $144,000.

The probable and possible ore amounts to 45,000 tons having a gross value of approximately $600,000.

Crow River Mines, Limited

This company controls several groups of claims in the area. Exploratory work has been largely concentrated on a group of 9 surveyed claims covering ground on both sides of Crow river just west of Kishkap falls. This group adjoins the N.A.M.E. East group on the north. Rock exposures, consisting chiefly of chlorite schist, iron formation, and sheared quartz porphyry, occur along a low ridge that trends in a northeasterly direction across claim Pa. 775. Rusty patches containing veinlets of quartz and ankerite, considerable pyrite, occasional bands of magnetite, and some chalcopyrite have been exposed by trenching at several points along this ridge.

Huronian Belt Company, Limited

The Huronian Belt Company, under the direction of F. Grozelle, explored a group of 18 claims, which cover ground on both sides of the Crow river and adjoin the N.A.M.E. West group on the north. The camp and most of the workings are on the north side of the river.

A low ridge of greenstone outcrops at intervals across the claims about 15 chains north of the river. At several points along this ridge, shear zones occupied by numerous parallel and intersecting veinlets of quartz have been exposed. A zone of this type occurs at the northeast corner of claim Pa. 802. It is 4 to 5 feet wide, strikes N. 75° E. (mag.), and has been uncovered for about 100 feet. The country rock consists of chlorite schist, into which quartz veinlets of different ages have been injected. The older veinlets occur as thin sheets lying parallel to the fissility of the schist and are composed of grey quartz, with some pyrite, arsenopyrite, and chalcopyrite. Considerable pyrite and carbonate are present in the adjoining wall rock. The younger veinlets intersect the schistosity and consist of white quartz, carbonate, and scattered patches of black tourmaline; there are no sulphides. Samples of each were submitted to the Provincial Assay Office. The results obtained for the older veinlets were: gold, none; silver, 0.30 ounces per ton. The younger veinlets gave: gold, none; silver, none.

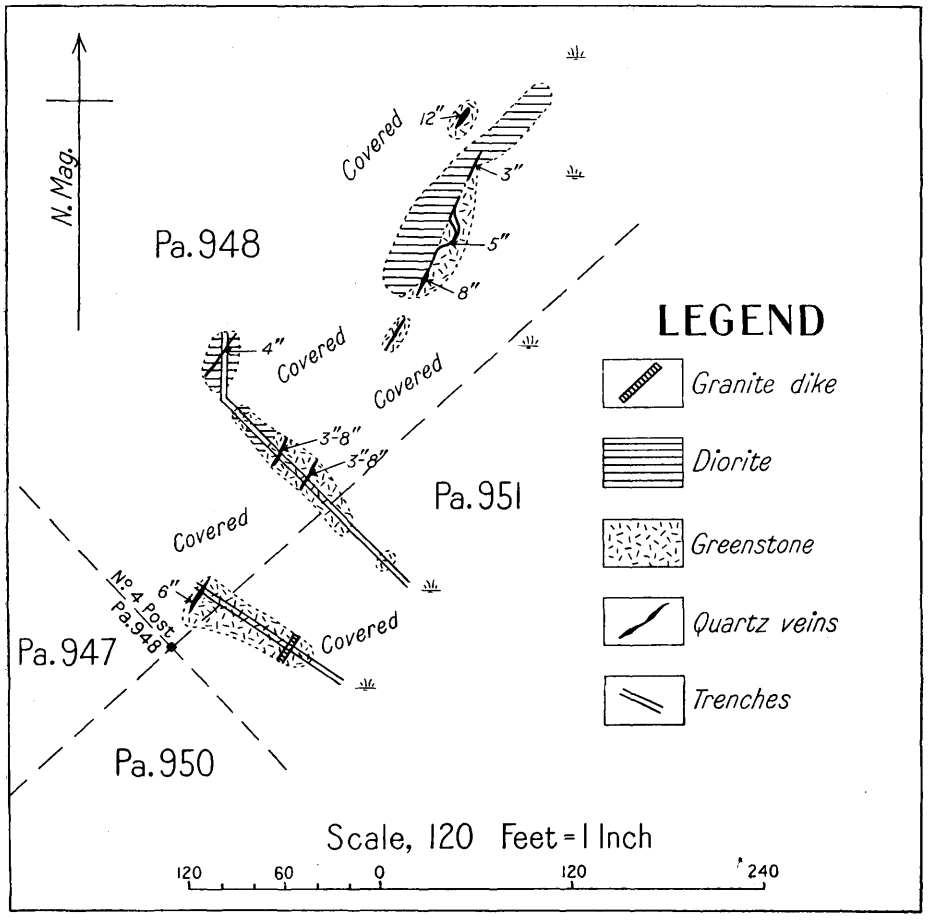
At several points on the claims narrow bands of iron formation have been uncovered. Near the northwest corner of claim Pa. 808, trenching through 6 to 8 feet of drift has exposed a rusty zone cut by gash veins of quartz containing pyrite and carbonate. On the south side of the river near the west boundary of claim Pa. 807, gash veins of quartz, containing some pyrite and chalcopyrite and stringers of calcite, cut a highly siliceous band of iron formation.

Another group of claims lying to the east of Crow river about 6 miles below Kukuku rapids was surveyed and partially explored. A trail leaves the east bank of Crow river about a mile below survey monument No. 24 and continues in a northeasterly direction to a small lake about 2½ miles distant. Large outcrops of greenstone and gabbro occur about the southwest end of the lake. Prospecting in this section uncovered several narrow bands of iron formation cut by occasional veinlets of quartz.

Maloney Claims

This group of unsurveyed claims lies about 10½ miles east of Pickle lake and 2 miles south of Crow river. A trail leading to the property departs from Crow river at a point about 1½ miles below Kukuku rapids. Most of the ground covered by the claims is muskeg.

The principal showing outcrops along the northwest slope of a low ridge of gneissic quartzite about 16 chains east of the camp. A large quartz vein, in places as much as 15 feet in width, has been exposed by stripping at three points in a distance of 250 feet. The vein lies between walls of sedimentary gneiss and extends in a direction parallel to the strike of the wall rocks, which is N. 45° E. (mag.). It dips at an angle of about 50° N.W. The quartz appears to be barren, but the walls and fragments of country rock



Geological plan of workings, Metcalfe property.

included in the vein are well mineralized with pyrite, pyrrhotite, and chalcopyrite. In a rock cut at the northeast end of the showing, a patch of nearly solid pyrrhotite, about 3 feet in width, has been exposed along the footwall. No information was available as to assay values obtained from the showing.

Metcalfe Claims

The Metcalfe group of claims lies about 2¼ miles north of Kukuku rapids on Crow river. From this point a winter trail leads north across a wide stretch of muskeg to the camp. Another trail begins from the head of the creek which joins Crow river at survey monument No. 25 and follows claim lines in a westerly direction to the workings.

The principal showings occur on the southeast slope of a low ridge near the south corner of claim Pa. 948. The deposit consists of several narrow quartz veins occupying parallel fractures in greenstone at or near its contact with a diorite dike. The veins strike N. 25° E. (mag.) and at one point extend into the diorite dike. One vein has been traced at intervals for about 300 feet and in that distance it ranges from a fraction of an inch to 8 inches in width. The vein filling consists chiefly of white quartz with occasional included fragments of chlorite schist from the walls. Pyrite is fairly abundant in the wall rock and occurs sparingly with chalcopyrite in the veins. It is reported that visible gold has been found in some of the veins. In places the chloritic schist in or near the veins has been recrystal-



Mining Corporation camp on the Manderstrom-Phelps group, August, 1929.

lized to form actinolite or garnet. The presence of a narrow dike of granite near the showing suggests that the deposit is not far distant from the main granite-greenstone contact to the north.

Mining Corporation of Canada, Limited

Exploratory work was concentrated on the Manderstrom-Phelps group of claims lying about 2½ miles south of Crow river and 9 miles east of Pickle lake. The trail leading to the property begins from a point on Crow river 1½ miles below Kukuku rapids. A log cabin and storehouse were erected 2 miles south of the river. The workings lie about half a mile south of the camp.

The showings occur along a low ridge of contorted gneissic quartzite and slate. These rocks probably represent the continuation of a similar band exposed on the Maloney property to the northeast. A body of granite lies less than half a mile to the southeast. Stripping and trenching have exposed a zone containing streaks of iron formation, narrow veins of grey quartz, and patches of sulphides. The quartz veinlets contain scattered needles of tourmaline and stringers of pyrrhotite, pyrite, and chalcopyrite. Most of the mineralization occurs in slaty portions of the zone which have been partially replaced by pyrrhotite.

Nipissing Mining Company, Limited

Assessment work and exploration were carried on by the Nipissing Mining Company, under the direction of F. Austin, on the Carruthers, Smith, and Eigenfeldt groups of claims which adjoin the N.A.M.E. East

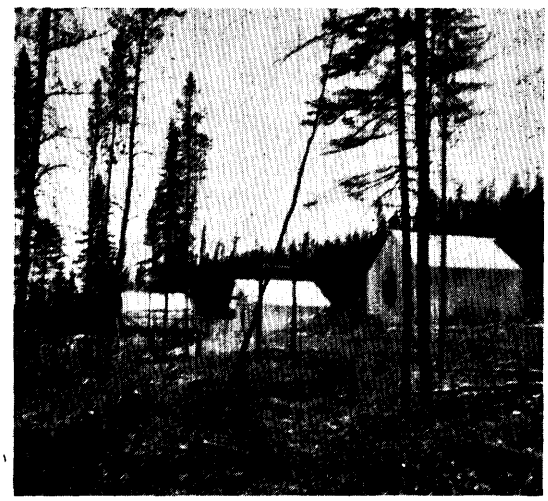
group on the south, east, and north, respectively. The Kinneally-Williams group, which adjoins the N.A.M.E. West group on the south, was also examined. While mineralization was noted at a number of points no deposits of importance were found.

Northern Aerial Minerals Exploration, Limited

The holdings of the Northern Aerial Minerals Exploration company consist of two groups of claims, usually referred to as the East group and the West group. Development work has been largely concentrated on the East group, where the most promising discoveries have been made. This work has been carried on under the direction of P. Hamilton, resident engineer.

East Group

This group includes 35 surveyed claims lying just south of Crow river and about 5 miles east of Pickle lake. A trail about 1½ miles long runs



Camp on the N.A.M.E. East group, Crow River, July, 1929.

from the head of N.A.M.E. rapids on Crow river to the camp, which is situated near the northeast corner of claim Pa. 730.

The accompanying sketch map shows the topography and most of the rock exposures on this group of claims. The bed rock consists chiefly of greenstones, bands of iron formation, and basic intrusives. The greenstones are mostly massive andesitic lavas which, when sheared, give rise to chlorite schist. Near the southwest corner of claim Pa. 727 brecciation was observed along flow contacts. Iron formation and rusty zones occur in streaks, lenses, and bands, ranging from a few feet to 250 feet in width. Bodies of schistose gabbro and diorite are associated with the greenstones. These are thought to represent later intrusions but, on account of their close resemblance to the greenstones and the scarcity of outcrops, no attempt was made to map them separately.

Mineralization has been found at a number of points on this group of claims. The principal discoveries are quartz veins, hereafter referred to as the Howell, Lake Shore, Riopelle, and Big Dome. The most attractive showing, and the one on which development work has been largely concentrated, is the Howell vein.

Howell.—This deposit lies along the northwest slope of a ridge on claims Pa. 746 and 747, and occupies a fracture zone which intersects a broad band of iron formation. The vein strikes N. 65° E. (astr.) and dips steeply to the northwest. It has been exposed by trenching for 250 feet,



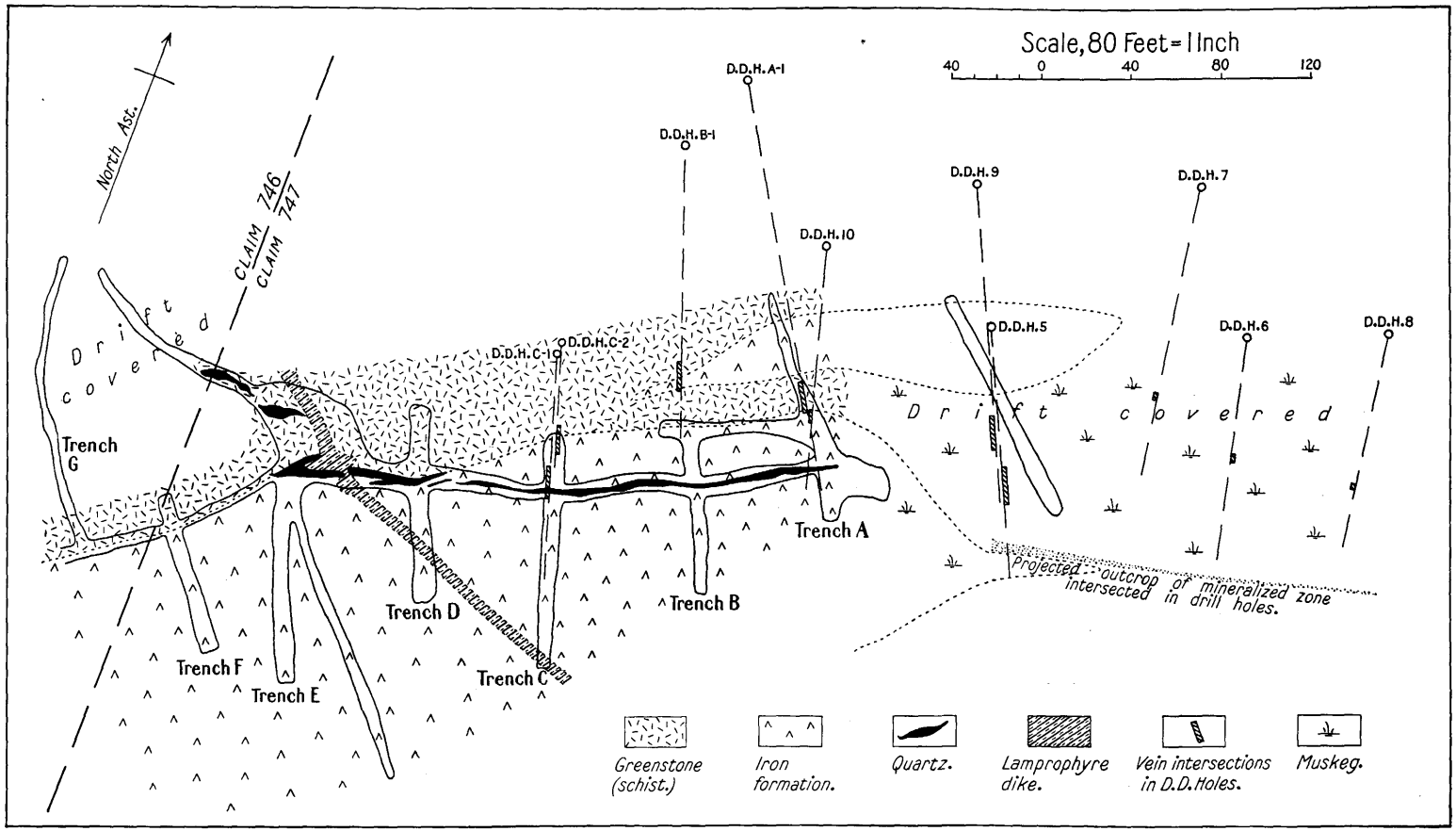
Thin section of iron formation showing rhythmic banding of iron carbonate (dark) and silica (light), N.A.M.E. East group. (×16.)

and throughout that distance the quartz filling has an average width of about 2½ feet. A lamprophyre (minette) dike, 4 feet wide, cuts across the vein near its west end. Toward the east the vein is covered by muskeg,



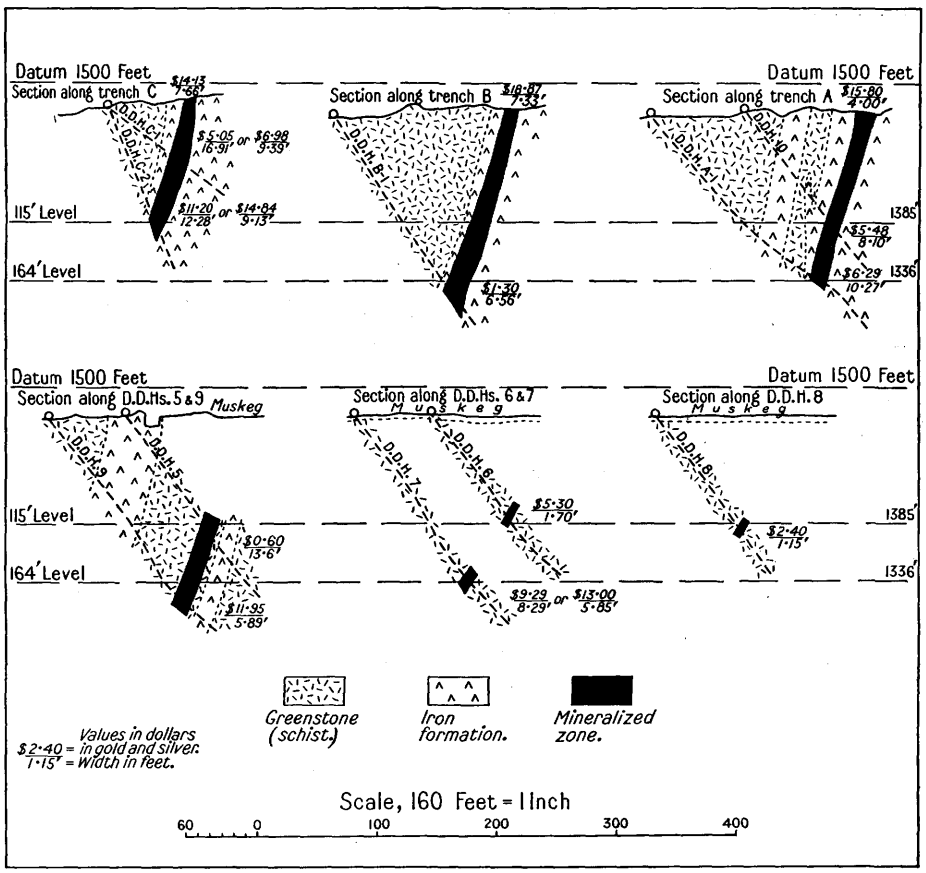
View looking west along the Howell vein, N.A.M.E. East group, July, 1929.

and toward the west it passes from iron formation into greenstone and splits up into stringers. Bulges and veinlets of quartz containing native gold occur in the greenstone at intervals for 600 feet along what is probably the westward continuation of the Howell "break."



GEOLOGICAL PLAN OF SURFACE WORKINGS AND DIAMOND-DRILLING, HOWELL VEIN, N.A.M.E. EAST GROUP.

The vein filling consists of white quartz containing visible gold, some chlorite and ankerite, and occasional grains of chalcopyrite. Pyrite, arsenopyrite, and ankerite occur here and there in the chloritic portions of the wall rock. In places the adjoining iron formation is traversed by veinlets of quartz, which extend outward from the main vein and, being auriferous, add considerably to the width of the ore zone.



Vertical sections across mineralized zone, Howell vein, N.A.M.E. East group.
(See plan on opposite page for location of sections.)

In the fall of 1929, a diamond-drill was taken to the property and 10 holes were put down along the course of the Howell vein. Toward the east, where the extension of the vein is covered by drift and muskeg, the drilling indicated that the band of iron formation containing the vein pinches out, that the vein passes from iron formation into greenstone, and that a mineralized zone continues eastward for at least 170 feet. This zone, projected to the surface, would outcrop about 40 feet south of the normal easterly extension of the Howell vein. Additional exploration will be necessary in order to determine whether the Howell ore body has been deflected sharply to the south or whether a separate parallel vein has been encountered in the east drill-holes. Development work to date has demonstrated that mineralization extends over a total length of 420 feet, of which 250 feet is exposed in the surface workings and 170 feet is indicated by drilling.

The following data, furnished by officials of the company, summarizes the extent and value of the mineralization indicated so far:—

	Mineralization		Average value in gold per ton
	Length exposed	Average width	
	feet	ft. in.	
SURFACE EXPLORATION:			
Howell vein	250	10 10	$12.50
Possible continuations of the Howell vein at:			
250 feet west	15	1 8	5.48
330 feet west	21	4 2	7.82
460 feet west	195	1 4½	22.34
DIAMOND-DRILLING:			
115-foot level	.....	7 8	7.11
164-foot level	.....	8 11	5.61
Consolidated average of surface exploration and diamond-drilling	420	9 2	$8.78

Lake Shore.—This vein lies just south of the lake on claim Pa. 705. One portion of the vein is parallel to the schistosity of the enclosing chlorite schist, and other sections occupy fractures crossing it. It has been uncovered at intervals for about 300 feet, and in that distance the quartz content ranges in width from a fraction of an inch to 3 feet. The vein filling consists chiefly of quartz with some ankerite, chlorite, and pyrite. It is reported that visible gold also occurs in the vein. In places the schist walls contain considerable pyrite and some chalcopyrite.

Riopelle.—These veins are located near the east boundary of claim Pa. 730. One occupies a cross fracture in drag-folded chlorite schist, strikes N. 45° W. (mag.), and dips steeply to the northeast. The other lies parallel to the schistosity of the greenstone, strikes N. 45° E. (mag.), and dips to the northwest. Both veins have been uncovered for about 120 feet. They range in width from a fraction of an inch to 3 feet, the average being about 5 inches. The vein filling consists of quartz and a little carbonate. Pyrite occurs here and there in the schistose portions of the wall rock.

Big Dome.—This vein lies near the west boundary of claim Pa. 706. It consists of contorted streaks and patches of quartz contained in drag-folded chlorite schist. It strikes N. 8° W. (mag.) and has been uncovered for about 150 feet. The wall rocks contain some pyrite, but the quartz filling appears to be barren.

West Group

This group consists of 27 surveyed claims which adjoin Central Patricia Mines on the east and the Springer group on the west. Most of this ground is covered by muskeg, and rock exposures are relatively scarce. A few patches of greenstone outcrop in the northwest and southwest sections of the property. The large diabase dike which crosses the Central Patricia property is well exposed on claims Pa. 680 and 687. No mineralization of importance has been found so far on this group.

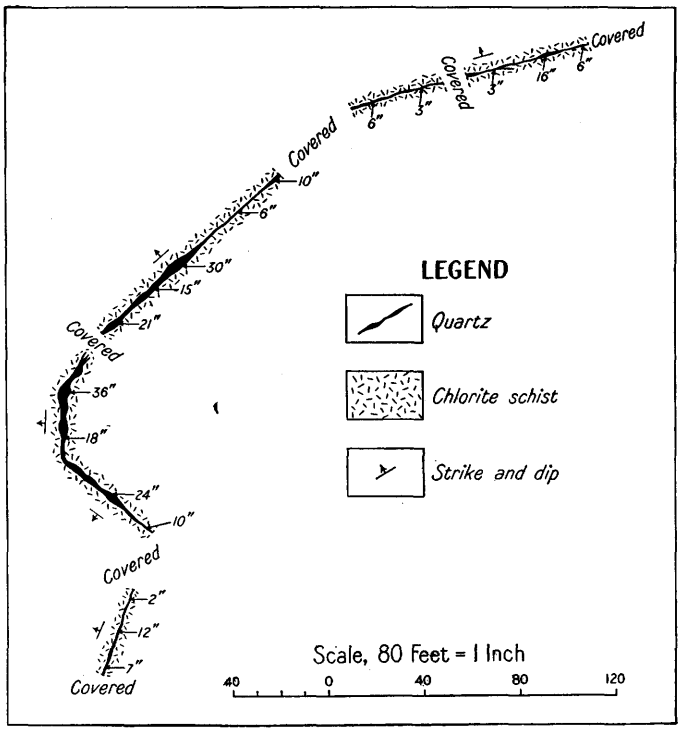
Paterson Exploration Company

Groups of claims located between Pickle creek and Crow river and along the south side of Pickle lake were examined by this organization under

the direction of W. H. Brookbank. Trenching and stripping were done in several places, but no mineralization of importance was uncovered.

Springer Claims

This group of 25 surveyed claims adjoins the N.A.M.E. West group on the east and the N.A.M.E. East group on the south. The camp lies about one and a half miles south of Crow river and is reached most easily from the main trail crossing the N.A.M.E. East group. A winter trail connects the property with Central Patricia Mines, 3 miles to the west. During the



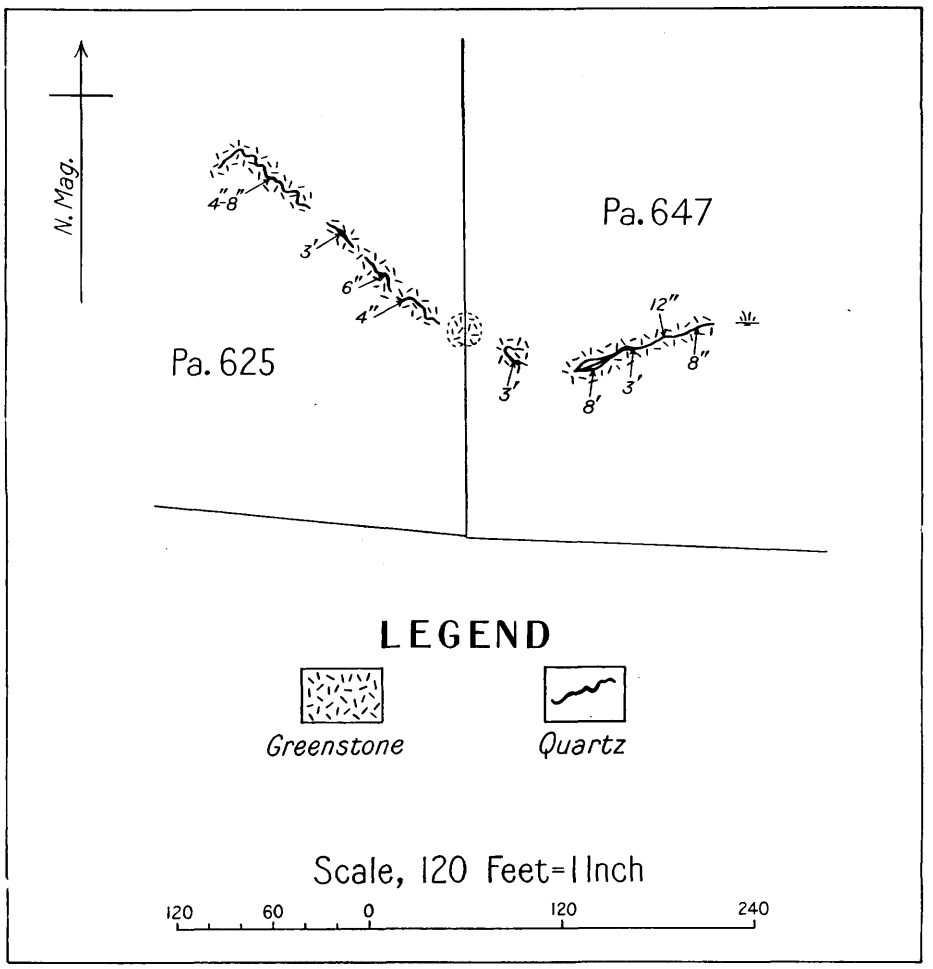
Geological plan of Lake Shore vein, claim Pa. 705, N.A.M.E. East group.

summer of 1929, this group was under option to F. M. Connell and associates. It has since been taken over by Central Patricia Mines, Limited. Extensive surface exploration was carried on under the direction of J. McCallum.

The western half of the property is largely covered by open muskeg. On the eastern claims numerous outcrops extend through the mantle of sand and glacial drift. The principal rock exposures are shown on the accompanying map. Keewatin greenstones and iron formation, basic intrusives, and granite porphyry occur on the property. The greenstones consist of massive andesite and basalt together with chlorite and hornblende schists. Bands and disrupted blocks of iron formation, representing the southwesterly continuation of similar bodies exposed on the N.A.M.E. East group, are contained in the greenstones. Basic intrusives consisting chiefly of diorite are associated with the greenstones. These rocks are more coarsely crystalline than the greenstones but resemble them so closely that it was impossible in the limited time to map each separately. Several large exposures of granite porphyry occur on claims Pa. 655 and 636. This rock is

light-grey in colour and contains conspicuous grains of quartz embedded in a rather coarse schistose matrix composed of feldspar and sericite. It is thought to represent an outlying or marginal phase of the main granite intrusions to the south.

Mineralization has been found at a number of points on this property. The most promising showing so far uncovered lies near the southwest corner of claim Pa. 647. It consists of a quartz vein containing conspicuous



Geological plan of gold-quartz veins on claims Pa. 625 and 647, Springer group.

amounts of native gold. The vein occupies a shear zone in schistose greenstone, strikes N. 75° E. (mag.), and dips 60° N.W. It ranges in width from 6 inches to 8 feet and has been traced for about 100 feet. The vein filling consists of quartz, scattered patches of black tourmaline, and occasional grains of pyrite and chalcopyrite. The green schist walls are only sparingly impregnated with sulphides. Near the west end of the vein where the green schist is highly drag-folded there is a cross-fracture which extends on to claim Pa. 625. This has been traced for 150 feet in a northwesterly direction. It is occupied by contorted veinlets of quartz ranging in width from 2 inches to 3 feet. It is reported that these veinlets also contain visible gold.

Native gold is reported to occur in a quartz vein near the south boundary of claim Pa. 629. This vein ranges in width from 6 inches to 3 feet and has been traced for about 200 feet. It occupies a cross-fracture in greenstone, strikes N. 45° W. (mag.), and dips 50° N.E. The vein filling consists of quartz, some calcite, and a little pyrite.

Another quartz vein intersects schistose greenstone near the northeast corner of claim Pa. 625. It ranges in width from 12 inches to 6 feet, strikes north-south, and has been traced for about 300 feet. At the north end it has been deflected toward the west along a flow or sill contact, and at the south end it splits up into stringers. The vein filling consists of white quartz, with some ankerite and traces of pyrite and chalcopyrite. No visible gold has been found, and most of the assay returns are reported to be low.

Rusty patches of iron formation containing stringers and disseminated grains of pyrite, pyrrhotite, and chalcopyrite occur on claims Pa. 655, 630, and 648. Some of these bodies undoubtedly represent the southwesterly continuation of similar exposures found on the N.A.M.E. East group. Quartz veinlets intersect these bands and fragments of iron formation in places, but the gold values are reported to be low.

Ventures Limited

This company examined and did assessment work on several widely separated groups of claims. One group adjoins the Crow river about 3 miles below Kukuku rapids, another lies to the north of N.A.M.E. rapids, and a third covers ground on either side of Pickle creek. This work was carried on under the direction of P. Soughers and A. G. Bellachey. No finds of importance were uncovered.

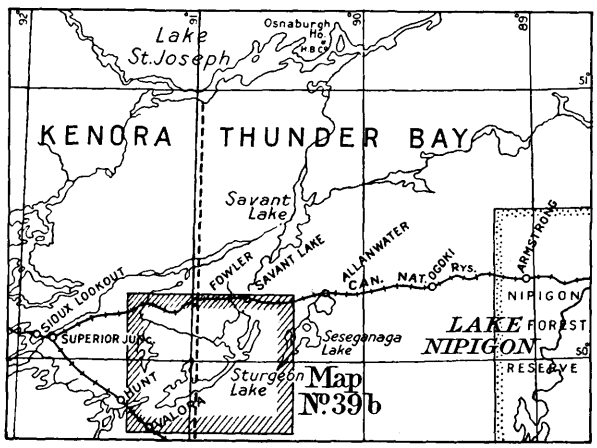
Sturgeon Lake Gold Area,
Districts of Kenora and Thunder Bay

By A. R. Graham

INTRODUCTION

During part of the field season of 1929, the writer conducted a geological survey of the Sturgeon Lake gold area. Sturgeon lake lies across the boundary between the districts of Kenora and Thunder Bay at about 50 degrees north latitude. The lake, which is about 45 miles long and from one to seven miles wide, is divided by a 12-mile narrows into two parts. The northeastern half is divided further into two large bays, known as North and Northeast arms.

Interest has been centred in the northeastern part of the lake where gold-bearing quartz veins were discovered in the year 1898. Mining has



Key map showing the position of the Sturgeon Lake area.
Scale, 50 miles to the inch.

been carried on intermittently since that time. Owing to the renewed interest in the gold deposits of the area, a further geological examination was thought advisable. Besides the reopening of several of the old properties, a number of recent discoveries of gold quartz veins have been under exploration during the years 1928 and 1929.

The southwestern part of the lake has never attracted much attention, though the formations found are favourable for the occurrence of gold quartz veins. During the long period of years since the first gold discovery, the northeastern part of the lake has been repeatedly examined and, no doubt, the most favourable prospects have been located. Prospectors contemplating a visit to the Sturgeon Lake area would be wise to pay special attention to the southern part of the area.

Access to the Area

The Canadian National Railways afford facilities for easy access to the Sturgeon Lake area. The northeastern part of the lake is reached from Savant Lake station on the transcontinental line of the Canadian National railway. A wagon road leads south from the station to the north end of the lake, a distance of three miles. The west end of the lake is reached

from Valora siding on the Port Arthur–Sioux Lookout branch of the Canadian National. A wagon road leads north to the west end of the lake, a distance of six miles. An alternate route to the west end of Sturgeon Lake starts at Watcomb station on the C.N.R. and goes through three small lakes with two short portages. Supplies may be purchased both at Savant Lake station and at Watcomb.

Field Work and Acknowledgments

Field work, which was commenced early in June, consisted of the geological mapping of the Sturgeon Lake basin. The lake itself, with the exception of the North arm, lies in a narrow belt of Keewatin rocks, and an attempt was made to define accurately the contacts of the Keewatin belt



Quartz-tourmaline vein in granite on the shore of Darkwater lake.

with the enclosing granite batholiths. A month was spent in a geological reconnaissance of the southwestern section of the area. During the second month, the writer visited the northeastern section, where detailed work was done on the mining properties in the vicinity of Couture lake, Northeast arm, Belmore bay, and King bay. Micrometer surveys were made at the St. Anthony and Davidson Carr mines, and pacing surveys were made along claim lines of the chief prospects. The final two weeks were spent in mapping the northeastern contact of the Keewatin volcanics and the granite gneiss in the vicinity of Vista, Seseganaga, and Vanessa lakes.

In conducting this work, able assistance was rendered in the field by W. F. White, A. Young, and D. P. Ross. The writer wishes to express his appreciation to prospectors and operators in the area for assistance rendered during the course of the work. Thanks are due especially to officials of the St. Anthony Gold Mines, Limited, and to R. Davidson.

Previous Geological Work

The geology of the Sturgeon Lake basin has been studied by a number of geologists at various times throughout a period of thirty years. References to the area are to be found in the following reports:—

W. McINNES, Geol. Surv. Can., Sum. Rept., 1899, pp. 118-120; ibid, 1901, pp. 90-92.
J. E. DAVISON, Ont. Bur. Mines, Report of the Survey and Exploration of Northern Ontario in 1900, pp. 230-249.
A. P. COLEMAN, Ont. Bur. Mines, Vol. XI, 1902, p. 148.
W. G. MILLER, Ont. Bur. Mines, Vol. XII, 1903, pp. 83-86.
W. H. COLLINS, Geol. Surv. Can., Rept. No. 1059, 1910, pp. 83-86.
E. S. MOORE, The Sturgeon Lake Gold Field, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, pp. 133-157.
T. L. GLEDHILL, Ont. Dept. Mines, Vol. XXXIII, pt. 6, 1924, pp. 18-39.

History and Development

Most of the facts in the following historical outline have been gleaned from former reports. Very few of the pioneers in this field now survive, and first-hand information concerning the early history is now difficult to acquire.

Gold was first discovered in 1898 by a prospector named Peter King. A small find was located on the shore of the southwest bay of Sturgeon lake. Prospectors attracted to the region journeyed to the northeast end of the lake, which became the centre of activity. In 1900, the first mining in the area was done at the Shore mine in King bay, where a shaft was put down 70 feet. The next year Jack Lake mine, the most important deposit in the area, now known as the St. Anthony mine, began operating. A number of other prospects were also developed at this time. Stamp mills were erected on four properties. Most of this work proved unprofitable, and many properties were abandoned a year or so afterwards. At the St. Anthony, mining continued, with periods of cessation, until 1918. The property was taken over by the present holders, St. Anthony Gold Mines, Limited, in 1921.

In 1928, with a revival of interest in the area, considerable staking and prospecting was done. The St. Anthony mine was reopened in November and operated until October, 1929. The Golden Centre Mining Company sank a 165-foot shaft on a prospect in the Northeast arm during the winter of 1928-29. Besides the individual work of claim-holders, extensive surface work on certain prospects was done last summer by several companies.

General Character of the Area

The area mapped is part of the Archean peneplain with its characteristic uniform topography. The entire region is glaciated and the lakes are, for the most part, erosion basins deepened by glacial action. The character of this denuded surface is dependent upon rock structure. The lakes in the Keewatin schists in the northeastern part of the area are typically linear in form, extending in the direction of the strike of the schists. Couture lake, Northeast arm of Sturgeon lake, Vanessa lake, and Beckington lake are representative of this type. In the granite gneisses, which are more resistant and free from lines of structural weakness, the lakes have irregular shore lines and a great number of islands.

The elevation of Sturgeon lake is 1,341 feet above sea-level, and the surrounding country never rises more than 200 feet above this elevation. The higher elevations are usually along the line of contact of the greenstone and granite. The hills south of Penassi lake and those east of Vanessa lake have formed along such a contact. There are few large areas of heavy glacial drift, and rock outcrops are numerous throughout the whole area. The region is abundantly supplied with lakes, and the waterways are excellent for canoeing, since portages are seldom over half a mile in length.

Water-power sites are available on the Sturgeon river. It has been reported that 700 horse-power could be developed at the rapids at the foot of Sturgeon lake.

GENERAL GEOLOGY

All the rocks in the area are of pre-Cambrian age. In the following table they are classified according to their relative ages, the oldest being at the bottom:—

ALGOMAN:	Granoporphyry, feldspar and quartz porphyry dikes. Younger granites, granodiorite, and syenite. Older granite gneiss and contact phases (biotite and hornblende gneiss), aplite and pegmatite dikes.
	Igneous contact
PRE-ALGOMAN INTRUSIVES:	Diorite, quartz diorite, porphyrite, diabase, gabbro, and amphibolite.
	Igneous contact
TIMISKAMING:	Conglomerate and greywacké.
	Erosion contact
KEEWATIN:	Rhyolite, volcanic tuff and breccia, agglomerate, sericite-carbonate schist, andesite, schistose basalt, basaltic pillow lava.

Keewatin

The Keewatin rocks of the area form a complex series of foliated extrusives. An attempt has been made in mapping to differentiate between the light-weathering acid volcanics and the basic greenstones.

Most of the Keewatin rocks exposed are basic volcanics. A wide belt of basaltic pillow lavas is found north and south of King bay and at the St. Anthony mine. The lavas are massive, and the pillow structure is still quite evident. Other basalts are sheared, for the most part, except where adjacent to granitic intrusions. In such localities, recrystallization has rendered them massive. Andesite flows outcrop along the west shore of Northeast arm. At the Bennett Pacaud property the main vein is enclosed in massive andesite.

A belt of acid flow and clastic rocks outcrops throughout the Northeast arm. A similar belt in the southwestern part of Sturgeon lake near the portage into Darkwater lake includes a series of rhyolite flows in which small quartz eyes have developed, giving the rock a porphyritic appearance. Areas of this acid lava have been crushed to form volcanic breccia. In certain outcrops angular rhyolite fragments are contained in a groundmass which, under the microscope, is seen to be composed of crushed material of the same composition. Fine-grained tuffs are interbedded with the rhyolites. In many cases this series has been changed completely into a rusty-weathering carbonate-sericite schist. Sulphides are found in the carbonate schist zones, and, in some cases, a little gold.

Timiskaming

Two belts of Timiskaming sediments are found in the Sturgeon Lake area. A series of interbedded conglomerate and greywacké occupies the centre of the Keewatin syncline in the southwestern part of the area. This band strikes approximately east and west, and the beds are now tilted into a vertical position. The maximum thickness of the series is about a quarter of a mile. Pebbles of granite, quartz porphyry, greenstone, and jasper are

found in the conglomerate. The greywacké under the microscope is seen to consist of large angular quartz fragments with a matrix of quartz and feldspar particles. Considerable carbonate is also present.



Agglomerate on the south shore of Sturgeon lake near the Kenora boundary line.

The following table shows the chemical composition of a sample of this greywacké. For purposes of comparison, an analysis of a greywacké from Kirkland Lake is included.

	Sample No. 1	Sample No. 2
	per cent.	per cent.
SiO_2	64.04	63.55
TiO_2	.16	.48
Al_2O_3	14.65	13.57
Fe_2O_3	1.07	1.31
FeO	4.93	4.01
MnO	.03	.....
CaO	3.69	3.78
MgO	1.81	2.50
Na_2O	4.84	5.00
K_2O	.69	2.51
H_2O	2.01	1.67
P_2O_5	.10	trace
CO_2	2.29	2.17
Total	100.31	100.55

Sample No. 1—Greywacké from the southwestern part of Sturgeon lake.
Sample No. 2—Composite sample of greywacké from the Lake Shore, Tough-Oakes, and Continental properties, Kirkland Lake. Analysis by L. V. Bell.[1]

[1]Ont. Dept. Mines, Vol. XXXVII, pt. 2, 1928, p. 20.

West of Cobb bay, this sedimentary belt has been altered by an intrusion of granite. Large quartz eyes have developed in a schistose groundmass, causing the greywacké to resemble quartz porphyry. Sheared pebbles are still evident in the metamorphosed conglomerate.

A second band of sediments outcrops on the north shore and on an island in East bay and can be followed southwest down the narrows where conglomerate is found on two islands and on points of the northwest shore. This band has been displaced by the intrusion of syenite along the southeast



Photomicrograph of greywacké from the southwestern part of Sturgeon lake. The white fragments are quartz. (× 20.)

shore of the narrows. On one of the small islands in the narrows, syenite dikes cut through the greywacké, indicating the younger age of this syenite mass.

Pre-Algoman Intrusives

A group of basic rocks of deep-seated origin have preceded the Algoman granites. Typically, they are represented by diorite and amphibolite, and are usually quite readily distinguished from Keewatin rocks of similar colour, owing to their coarse crystallization. Where granites come in contact with basaltic greenstones, however, a hybrid type of diorite occurs, which is very similar to these basic intrusions. Thus, in some cases, the rocks mapped as diorite on the accompanying map may be recrystallized greenstone.

A number of small bosses of diorite have intruded the acid volcanics in the Northeast arm. Under the microscope they are seen to be made up of kaolinized feldspars with the hornblende altered to chlorite. Carbonates have also been introduced into the diorite masses, as in the case of the volcanics into which they are intruded. Some phases of these diorites are porphyritic, and feldspar crystals have developed up to two inches in size. North of the Northeast arm and west of Richan lake, coarse amphibolites outcrop. Under the microscope, sections of this rock show radiating crys-

tals of amphibole with smaller amounts of interstitial feldspar. Altered gabbro outcrops on the route from Sturgeon to Squaw lake. Small bosses of diabase were noticed at the St. Anthony mine and also at the Shore mine in King bay. In the southwestern part of the area outcrops of these basic intrusives are not so common. Light-coloured diorites outcrop on some of the islands south of Granite bay. The diorites outcropping on the wagon road to Valora were found to contain considerable quartz, when sections were examined under the microscope. These quartz diorites might be contact phases of the granite in this vicinity.

No mineralization of economic importance seems to have accompanied the intrusion of these pre-Algoman basic plutonic rocks.

Algoman

The acid intrusives have been grouped together into one geological epoch, although there is considerable variation in the age of the different members. The large batholiths of granite gneiss are distinctly older than



Banded granite gneiss and biotite hornblende schist
on the shore of Seseganaga lake.

the fresh-looking bosses of granite, granodiorite, and syenite. Pegmatite and aplite dikes appear to have accompanied the intrusion of the older granite gneiss, whereas porphyries were intruded as a late phase of the younger granitic eruptions. The members of the younger period of intrusion are commonly more basic in composition than the older gneiss. The gold ore deposits are related to the intrusion of the younger members.

Older Granite Gneiss

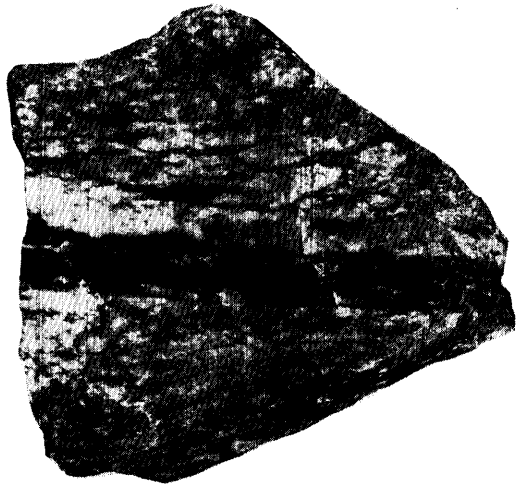
The configuration of the Keewatin volcanics makes three large areas of older granite gneiss distinguishable: (1) a northwestern area along the Sturgeon river, (2) an eastern area in the vicinity of Seseganaga lake, and (3) a southern area around Bell lake and Valora. The rocks of these areas are alike and all possess in common a gneissic character. The members of this complex are either plutonic intrusives or older rocks that have been included and have undergone partial assimilation. The common type is a biotite granite gneiss of light-grey or pink colour and medium texture. Hornblende granite gneiss is also found, although it is not common. Pegmatite and aplite dikes cut all the members of this complex.

The foreign materials, which represent foundered fragments of the Keewatin roof, are now altered to biotite and hornblende schists. These rocks outcrop over a large area around Seseganaga lake.

The alteration of the Keewatin formations is much more intense along contacts with the granite gneiss than with the younger granites. The structural features of the Keewatin are due largely to these older gneissic batholiths.

Younger Granite, Granodiorite, and Syenite

Following the intrusions of the granite batholiths, a number of elliptical-shaped bosses of granite, granodiorite, and syenite were intruded either as salients, projecting into the Keewatin formation along the axes of folds or along the contacts of the greenstones with the granite gneiss batholiths. In line with some salients bosses occur, which are completely surrounded by older formations, such as the syenite mass along the narrows of Sturgeon lake or the granite boss in Granite bay. Such elliptical-shaped intrusions



Specimen (natural size) showing small tourmaline vein in granite south of Beidelman bay.

have their longer axes parallel to the general strike of schistosity of the enclosing formations.

The granite salient south of Beidelman bay is the most acidic of these later intrusions. It is a pink quartzose granite, which in thin section is seen to consist largely of quartz with minor amounts of altered feldspar and small biotite shreds, some of which have been changed to chlorite. Along its north contact this granite becomes more basic and changes in colour from pink to light-green. Under the microscope the light-green phase is seen to consist of quartz, plagioclase, microcline altered to sericite, and a green hornblende in which nests of epidote crystals have developed. This granite mass has undergone metamorphism, due to the action of late pneumatolytic emanations accompanying its own intrusion. Small black tourmaline veins are numerous throughout the mass.

The feldspars have been changed to sericite, and the biotite to chlorite. Carbonates are common. A light-grey hornblende granite outcrops in Granite bay. Along its margin a pink syenitic phase has developed which is also common to the Penassi lake granite. Three separate areas composed entirely of syenite occur in the Sturgeon Lake area. The largest mass is along Vista lake; the other two areas are on Squaw lake and along the east

shore of the narrows. The Vista lake mass is a pink hornblende syenite, fairly uniform in colour and composition. Under the microscope, thin sections are seen to be composed of microperthite, microcline, orthoclase, large green hornblende crystals, and minor shreds of brown biotite. Accessory minerals are apatite, titanite, and magnetite. The Squaw lake mass is a coarse, grey mica syenite. Along the borders a pink phase has developed, and syenite dikes of similar appearance cut older formations in this vicinity. The syenite along the narrows varies greatly in colour, texture, and composition. The main mass is a coarse, grey augite syenite, but pink phases are common along the border. Light-coloured nephelite syenite is also found in small amounts. Under the microscope the nephelite syenite is seen to consist of microperthite, microcline, orthoclase, augite, nephelite, some biotite, cancrinite, and titanite.

From an economic point of view, the most important of these younger granite bodies is the granodiorite boss in the North arm. This boss has



Polished specimen of a granoporphyry dike from the south shore of King bay. (×2.)

intruded along the contact of the older gneiss and Keewatin formations; on the west, it grades imperceptibly into the older gneiss, remnants of which were found within the younger granite on the islands. Along its eastern border, the granodiorite has developed porphyritic phases. The Keewatin has undergone very little alteration along its contact with these porphyritic phases, and the contact is sharp. Where angular fragments of greenstone are included in the granite, as at the St. Anthony mine, little sign of alteration is evident. Under the microscope the granodiorite is seen to be composed of an acid plagioclase, orthoclase, microcline, quartz, brown biotite, green hornblende intergrown with the biotite shreds, small amounts of apatite, zircon, and magnetite.

Porphyritic Dikes

A large number of porphyry dikes accompanied the intrusion of the late granite bosses and are closely associated with the gold quartz veins. Several types are found in the vicinity of the granodiorite of the North arm. Coarse granoporphyry dikes have penetrated into pillow lavas along the south shore of King bay and on the peninsula north of the bay.

At the St. Anthony mine, several pipelike intrusions of a coarse quartz porphyry have cut both the granodiorite and the greenstone. A thin section of the contact of the granodiorite and quartz porphyry stock, which is found underground and on the surface at the St. Anthony mine, indicates that the hydrothermal alteration of the granodiorite to protogine granite is due in part to the hot solutions accompanying the intrusion of the quartz porphyry stock.

A number of quartz porphyry dikes outcrop southeast of Belmore bay. These porphyries have small quartz eyes in a fine-grained greenish matrix and are difficult to distinguish from some of the rhyolites in the Northeast arm. Quartz porphyries are also found near the granite south of Beidelman bay. In the vicinity of Cobb bay and Sixmile lake, numerous feldspar porphyry dikes were noticed by the writer. The large majority of porphyry dikes have come in simultaneously with or later than the younger granites.

ECONOMIC GEOLOGY

The main period of gold deposition came at the close of the Algoman. The bosses of younger granite and granodiorite caused local fracturing in the greenstone along the contacts. Porphyry dikes and gold quartz veins were intruded along these lines of weakness. Carbonates also accompanied the quartz. Large veins of ankerite were noticed at several points in the area. The greenstone wall rock bordering some quartz veins has been altered completely into banded sericite-carbonate schist. This carbonatization is also related to the introduction of gold, for gold values continue into these carbonate wall rocks.

The majority of the quartz veins occur in the greenstone, although some are found in the granite. The main vein at the St. Anthony mine is partly in the granite and partly in the greenstone. In the schist the veins tend to follow the rock cleavage, but in the granite they are very irregular, branching and reuniting to form a network. The veins along the granite contact have spectacular gold values but are irregular and uncertain. They have intruded into fissures formed by slight movements along the contact. The veins at some distance from the contact are more persistent in length and more uniform in values.

Quartz, siderite, calcite, and occasionally tourmaline, form the gangue minerals. The sulphides are pyrite, chalcopyrite, galena, zinc blende, and pyrrhotite. Galena and zinc blende are indicators of gold ore in the St. Anthony mine.

These two sulphides are found only in the contact veins around the North arm Sulphide bodies in East bay and King bay have low gold values in pyrite and pyrrhotite.

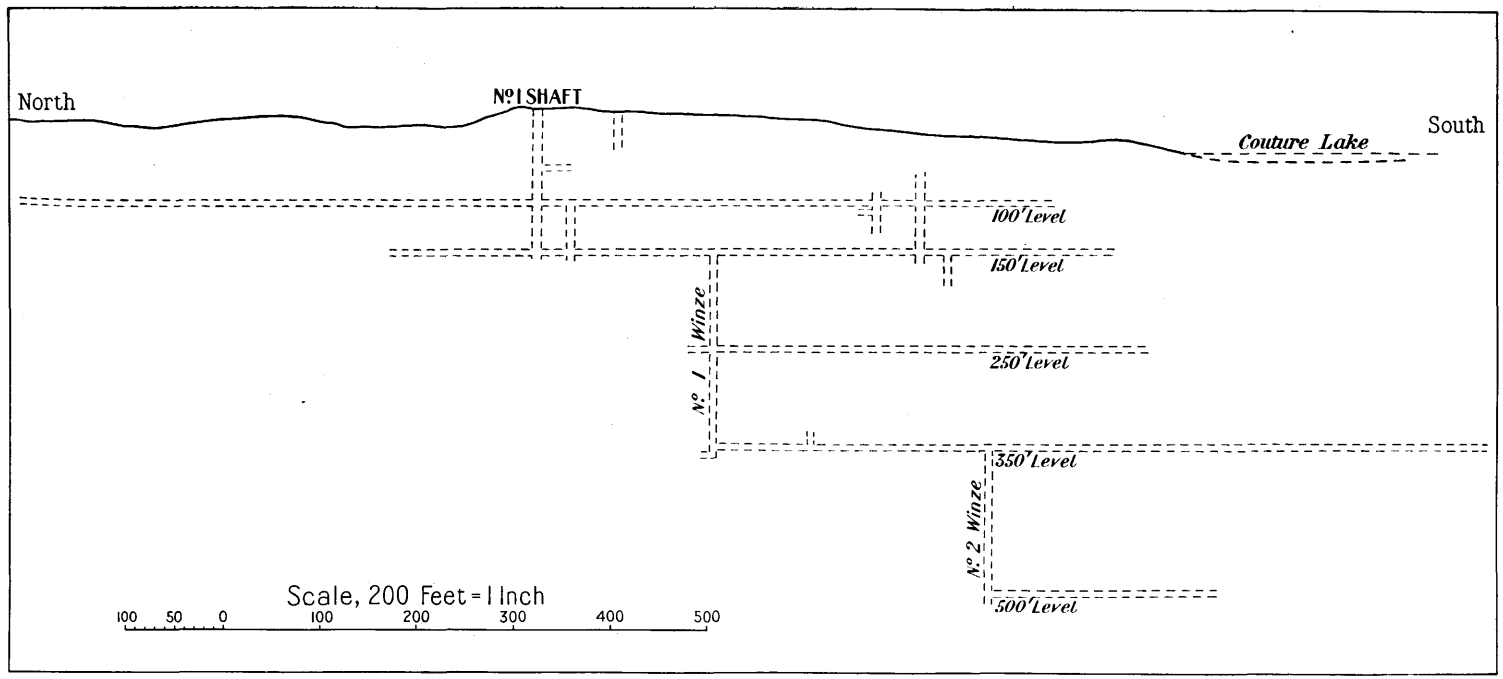
Description of Mines and Prospects

The writer visited only those properties on which work had been recently performed. Information on the old prospects, which have been abandoned, may be found in earlier reports on this area.

St. Anthony Mine

The St. Anthony mine, one of the earliest and most important discoveries in this region, is situated on claims B.G. 151 and 152 between the North arm and Couture lake. The mine has been operated at intervals by different owners since 1901.

The main ore body is a north-south fissure vein at the contact between Keewatin pillow lavas and a small dome of granodiorite, which is an offshoot from the granodiorite boss in the North arm. A coarse quartz porphyry



LONGITUDINAL SECTION OF UNDERGROUND DEVELOPMENT, ST. ANTHONY MINE.

stock has intruded along this same contact and has caused the alteration of the granodiorite to a protogine granite consisting almost entirely of quartz and sericite. The quartz veins that accompanied the intrusion of the porphyry stock have caused alteration along their walls. The northern portion of the main vein in the granite branches and reunites to form a stockwork. The wall rock has been altered to sericite schist. The southern portion of the vein in the greenstone tends to follow the rock cleavage. The wall rock



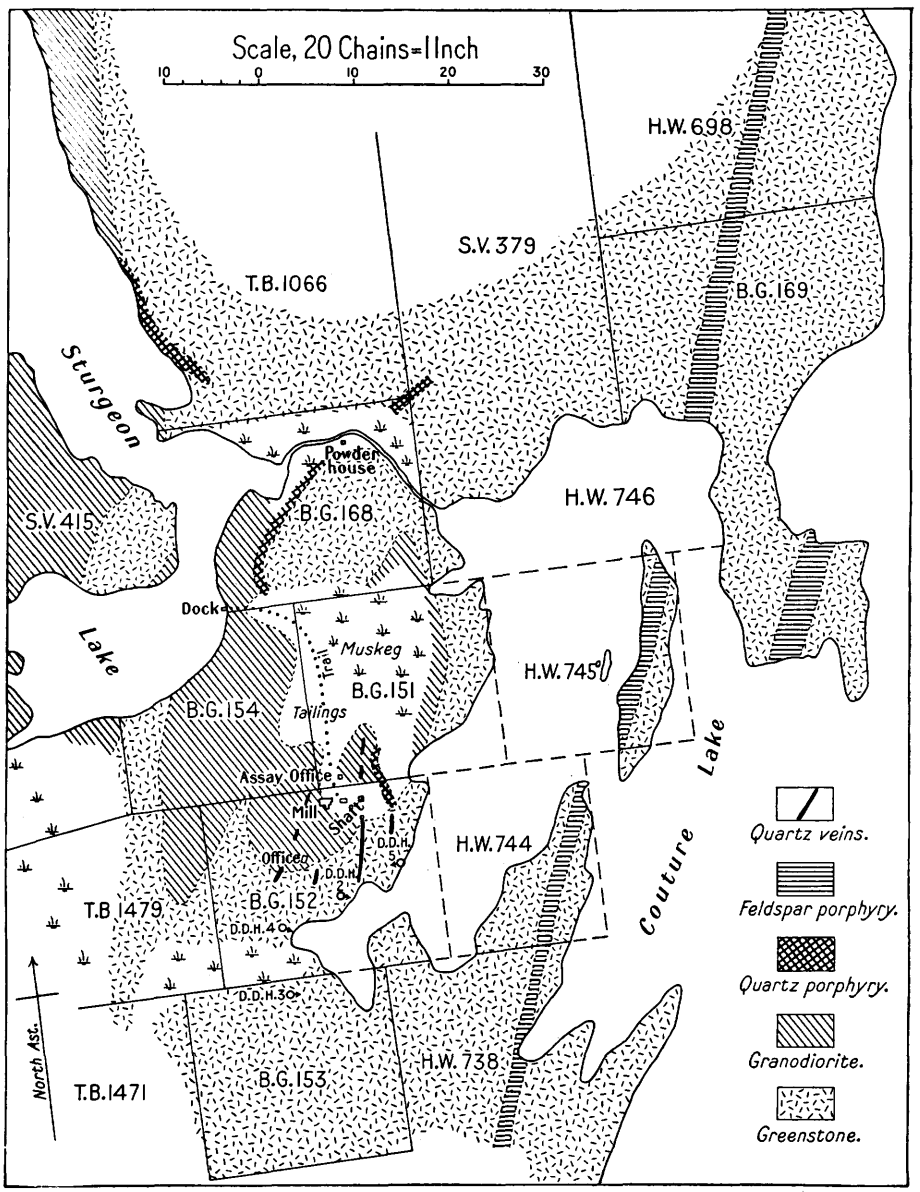
Photomicrograph of the polished surface of a quartz vein, St. Anthony mine, showing gold (Au) and galena (P) along fractures in quartz and pyrite (Py). (×100.)

has been altered to a banded carbonate sericite schist. The veins dip slightly to the west and the ore bodies rake to the southwest following the quartz porphyry stock.

The gangue minerals are quartz, calcite, and siderite. The sulphides are pyrite, chalcopyrite, galena, and sphalerite. Both galena and sphalerite are indicators of gold ore. The pyrite carries low gold values. In the granite most of the sulphides are confined within the veins; in the greenstone, the sulphides have penetrated into the wall rock, in which low gold values are found.

The main vein is 1,100 feet long on the surface, and the maximum width is 25 feet. Two other vein systems have been located on the surface, but the main vein is the only one on which underground work has been done.

The underground workings have been carried down 525 feet, and underground lateral work amounts to approximately 3,500 feet. There is a 10-stamp mill and amalgamation plant on the property.

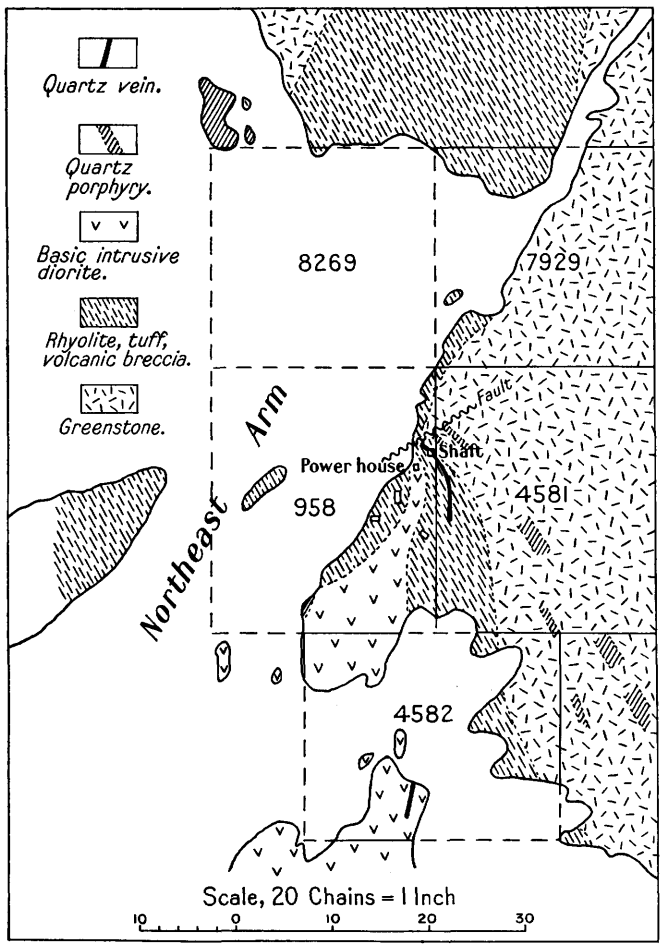


Geological sketch map of St. Anthony mine and vicinity.

During 1928-29, approximately 3,000 feet of diamond-drilling was done in exploration of the underground ore zone. The mine was reopened and drifting was done on two levels. The mill was operated for a short time during the summer. Work has been curtailed for the winter months.

Davidson Carr Mine

The Davidson Carr mine is situated on claims T.B. 958 and 4,581 at the north end of the Northeast arm. During the winter of 1928-29, the Golden Centre Mining Company carried out considerable exploration work on this property under option. An inclined shaft was put down 165 feet and 150 feet of underground lateral work completed. When the writer



Geological map of the Davidson Carr property.

visited the property, operations had ceased and the shaft was filling with water.

The main vein follows a drag fold at the contact between Keewatin greenstone and interbanded acid volcanic breccia, rhyolite, and tuff. Quartz porphyry dikes cut through the property. A slight fault occurs at the crest of the drag fold. Apparently the values are confined to the centre of the drag. The vein is 6 feet wide at the top of the shaft and has been traced for 600 feet on the surface. The width of the vein decreases at depth.

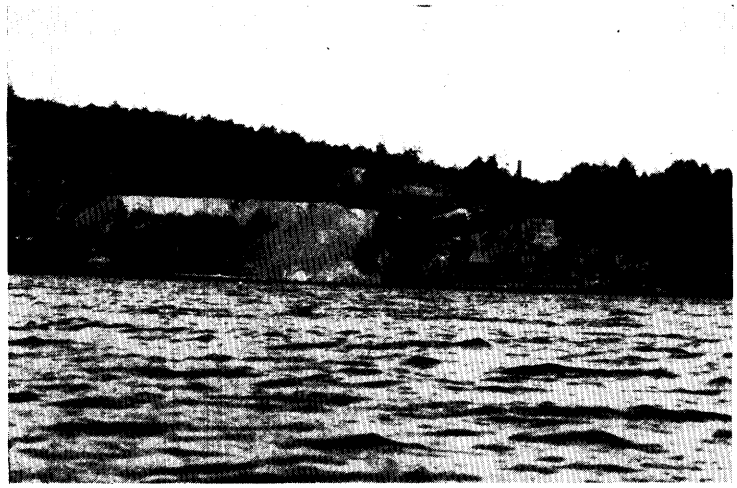
Bennett Pacaud Claims

The Bennett Pacaud interests are carrying on the development of a group of 5 claims, A.L. 771, 772, and S.V. 410-12, to the east of Couture lake.

Trenching has uncovered in andesite a quartz vein, 2 to 8 feet wide, carrying commercial-grade ore over a length of 600 feet. A carbonate zone in sericite schist, which can be followed for 1,000 feet, carries low gold values across 10 feet. It is the intention of the company to diamond-drill the main vein in order to test the continuance of values at depth.

Huronian Belt Claims

During the summer of 1928, the Huronian Belt Company performed systematic prospecting on a large group of claims along the granodiorite-Keewatin contact to the south of the St. Anthony mine. Their holdings



The Davidson Carr mine on the Northeast arm.

included the old Symmes property, claims B.G. 138 and 139. Although a number of quartz veins were discovered, they were small and irregular. Nothing of commercial interest was revealed, and the company did not continue the work during the season of 1929.

Davidson Jarvis Claims

The Davidson Jarvis group of fifteen claims is situated north of East bay. A number of quartz porphyry dikes penetrate schisted Keewatin acid and basic flows. Quartzites and conglomerate are also found on this property. Three gold-bearing quartz veins on claim H.W. 679 have widths from 4 to 8 feet and lengths from 600 to 1,000 feet. There are also two other smaller veins on claims A.L. 535 and H.W. 737.

Obonga Lake Chromite Area, District of Thunder Bay

By A. R. Graham

Introduction

Attention has recently been attracted to the Obonga Lake area, owing to the discovery of a chrome-bearing serpentine. The Obonga Lake area is situated in the district of Thunder Bay and lies to the south of the eastern continuation of Niven's 4th base line, surveyed by K. G. Ross, O.L.S., in

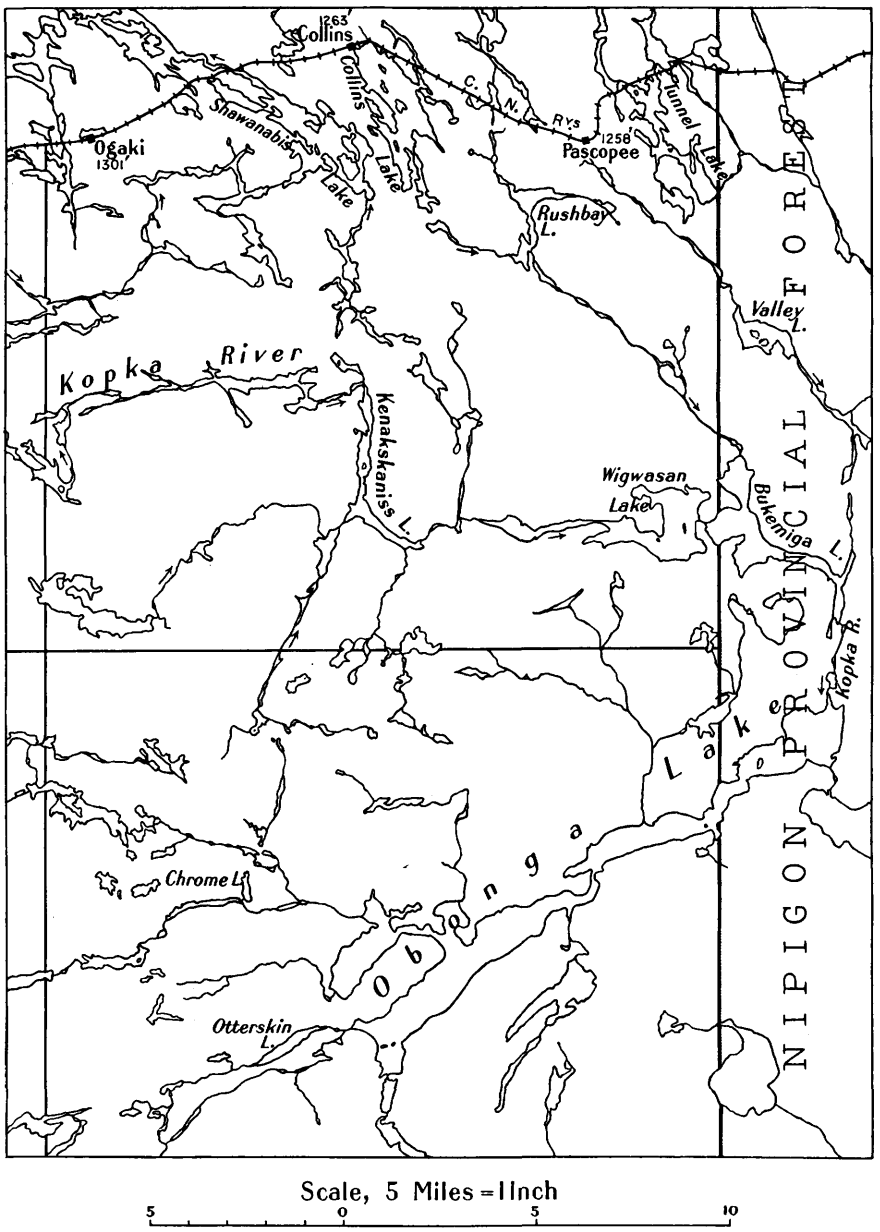


Chromite vein in serpentine.

1923, and to the west of the Nipigon Forest Reserve. The area may be reached by a canoe route of 26 miles south from Collins on the Canadian National railway. An optional route, with fewer portages, may be taken from Willet on the Canadian National railway by way of Lake Nipigon and the Kopka river, a distance of 58 miles.

A chromite deposit was discovered in the Obonga Lake area by W. Keefe and R. A. MacDonald in the fall of 1928. The deposit lies in a serpentine lens, situated along Wig creek, which flows into the northwest bay of Obonga

lake. The serpentine body was staked almost entirely by Keefe and MacDonald.



Map showing the position of Obonga lake, which is reached by a canoe route from Collins station. 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.

The development of the chromite deposit was undertaken by the Golden Centre Mining Company, who began active work on the property late in the fall of 1929. Owing to the proximity of the deposit to the Nipigon

Forest Reserve, work had to be curtailed during the summer owing to the fire hazard. At the time of the writer's visit to the property, early in September, 1929, only a small amount of surface exploration work had been performed. Since that time the company has completed a diamond-drilling programme, the results of which indicate better economic possibilities than the surface showings had revealed.[1]

Geological data on the Obonga Lake area are to be found in the "Report of the Survey and Exploration of Northern Ontario, 1900,"[2] and in a report by William McInnes,[3] of the Canadian Geological Survey. The first detailed map of the area is included in this report.

General Geology

All the rocks of the territory examined are pre-Cambrian. They may be classified as follows:—

KEWEENAWAN:	Remnants of Nipigon diabase sill and diabase dikes. Red dolomite.
	Unconformity
ALGOMAN(?):	Granite, granite gneiss, pegmatites.
	Intrusive contact
PRE-ALGOMAN(?):	Serpentine, talc carbonate schist.
	Intrusive contact
BASEMENT SCHISTS:	Keewatin greenstones, chlorite schists, gabbros, basic flows, pillow lavas, iron formation. Biotite and garnetiferous schists and gneisses.

Basement Schists

The basement schists that outcrop to the west of Obonga lake have been folded into a syncline about 15 miles long and 7 miles wide. The general strike of the schist belt is N. 70° E. At the east end, the schists have been covered by the Nipigon diabase sill. At the west extremity, approximately 7 miles west of Ross's 1922 meridian line, the granite outcrops.

Ancient schists and gneisses are found at the base of the greenstones. They form a well-defined band to the north of Wig creek. They strike at approximately 70 degrees and dip at 40 to 50 degrees under the Keewatin greenstone basin to the south. Along the Keewatin contact are found quartzose mica and garnetiferous schists, which alter towards the granite contact into biotite gneiss. There has been considerable assimilation of the schists along the contact of the Algoman granite batholith. The alteration, being transitional, the edges of this zone are indefinite, for the schists have been transformed so much by *lit par lit* injections and by the growth of large secondary feldspar crystals, that it is very difficult to differentiate between this older gneiss and the Algoman granite gneiss. No doubt these schists are of sedimentary origin and are identical with the Couchiching group in the Lake of the Woods area.

The greater portion of the synclinal area of basement schists is composed of Keewatin greenstones. The northern contact of the greenstones

[1] In the spring of 1930, a shaft was begun on the "E" zone, which lies near the eastern boundary of claim T.B. 8,814 and about 2,000 feet southeast of the "B" deposit. By October, 1930, this shaft had been completed to a depth of 350 feet; at the 100-foot level, crosscuts had been extended for 200 feet north and 320 feet south of the shaft, and some 200 feet of drifting had been done on this level. Preparations were being made to crosscut the serpentine body at the 225- and 350-foot levels.

[2] A. H. Smith, Ont. Bur. Mines, 1901, pp. 198-207.

[3] Geol. Surv. Can., Sum. Rept., 1902, pp. 208-213.

follows Wig creek southwestward from Obonga lake. The southern contact is found a mile south of Obonga lake. South of Wig creek are found chlorite schists and altered basic flow rocks, striking at N. 70° E. and dipping 60° S.E. Pillow lavas outcrop on the shore of the western bay of Obonga lake. At the western end of Otterskin lake, banded iron formation is found in altered tuff. The basic flows along Ross's 1922 meridian line have undergone recrystallization into amphibolite and gabbro. No mineralized quartz veins were encountered in the exploration of these greenstone schists.

Pre-Algoman (?) Intrusives

Throughout Northern Ontario, the Algoman period of granitic intrusions has been preceded by more basic phases of intrusion in the form of gabbros. pyroxenites, and peridotites. A large number of boss-like masses of peri-



Photomicrograph of talc carbonate schist. (Cross nicols, ×40.) T = talc. C = carbonate. S = serpentine.

dotite, in many cases altered to serpentine, have been reported in the past. In most of these peridotite intrusions, chromite has been an original constituent.

In the Obonga Lake area, a large serpentine lens has been found north of Wig creek. This altered peridotite body is elliptical in surface outline with a major axis of $3\frac{1}{2}$ miles and a minor axis of three-quarters of a mile. Originally intruded into the ancient sedimentary schists, the peridotite is now contained within the transition zone between these schlsts and the Algoman gneiss. While the schists were undergoing alteration into biotite gneiss through the action of siliceous emanations given off by the granite, the peridotite was also undergoing metamorphism by similar agents into serpentine and talc schist. Where the granite came in close proximity to the basic body, the alteration has been more intense, the peridotite changing at its border into talc carbonate schist.

At Chrome lake, in the vicinity of the chromite deposit, the weathered surface of the serpentine is, in general, black or rusty in colour, due to the development of iron oxide. The fresh surface is dark-green, with small

metallic chromite grains quite visible. The rock is soft and, as a result, the serpentine lens forms the low flat ground about the gneissic hills. Both Chrome lake and Puddy lake owe their origin to the erosion of the soft serpentine below the existing water table. At the east end of Puddy lake, red talc carbonate schists outcrop.

At the west end of Puddy lake, small brittle asbestos veins were noticed in a light-green serpentine. The serpentine in general has developed a platy fracture, causing it to break up into large thick scales. This fracture developed, no doubt, during the period of serpentinization of the peridotite.

In thin sections, the altered peridotite is shown to consist largely of interwoven scales of a colourless serpentine. Only in a few cases does the serpentine show the mesh structure typical of the alteration of olivine.



Columnar crystals of anthophyllite in serpentine.

Carbonates are observed in veinlets and aggregates, secondary to the serpentine. Long columnar crystals of anthophyllite have also developed in radiating groups.

Magnetite dust is disseminated universally throughout the serpentine, and magnetite veinlets replace the carbonates. The chromite is found in irregular or circular grains and in crystal form, perfect octahedrons being quite common. In some cases the chromite grains and crystals are disseminated; in others, the grains and crystals are arranged in thin stringers or in accumulations, a structure which has been called "synneusis" by certain authors. These last mentioned structures are contained usually in carbonate veinlets or in lenslike masses of interwoven penninite scales (as in the photomicrograph on page 59).

A small amount of talc is scattered throughout the serpentine. At the borders of the serpentine mass, the increase in the talc and carbonate content has been great enough to result in the formation of a talc carbonate schist. These minerals have formed later than the serpentine, for they penetrate through the latter in veinlets (see photomicrograph on page 54). All minerals are secondary, except the primary chromite crystals, which in many cases are fractured by the secondary minerals to produce a mitred structure (see photomicrograph on page 57).

The writer made the following analysis of a rock specimen from the centre of the serpentine mass:—

Chemical composition		Mineral composition	
	per cent.		per cent.
SiO_2	36.37	Serpentine	78.75
Al_2O_3	1.17	Penninite	10.66
Cr_2O_3	1.00	Magnesite	.17
Fe_2O_3	8.71	Magnetite	6.96
FeO	2.57	Chromite	1.35
CaO	....	Combined water	1.19
MgO	37.15		
Na_2O	.30	Total	99.08
K_2O	.19		
H_2O	12.77		
CO_2	.10		
Total	100.33		

The mineral composition has been calculated from the chemical analysis. It is apparent that this rock, now about 80 per cent. serpentine, was originally composed almost entirely of olivine.

Algoman(?)[1]

In the Obonga Lake area a large portion of the granite is covered by the Nipigon diabase sill. Apparently the granite forms a stable base on which the diabase may rest. Rock movements, being much more numerous in the schist areas, caused the greater fracturing of the overlying diabase, resulting in less resistance to subsequent erosion. To the north of the schist area, only two small areas of the granite remain uncovered by the diabase sill: the transition zone between the biotite schists and the granite, found to the north of Wig creek; and an area south of Ross's base line. The writer did not visit the granite area to the south of the schist belt.

In the transition zone, numerous pegmatite dikes and stocks cut through the older grey biotite gneiss. Small stocks of red biotite granite are found with the older rock masses included in it. In the area south of Ross's base line are found massive red granite and granite gneiss, with black biotite the most characteristic constituent. No porphyritic differentiates of the granite magma were noticed in the area.

Keweenawan

After a long period of erosion following the granite intrusion, Keweenawan dolomite was deposited on the denuded crystalline floor. A small remnant of this red dolomite was observed north of the first lake on Wig creek. White dolomite was found beneath high diabase cliffs at the west end of the fourth lake on Wig creek. This sedimentary deposition was interrupted by the extrusion of a great diabase sill. High diabase hills are found to the north and south of Obonga lake covering all preceding rock formations. The diabase sill also extends northwest from Obonga lake, overlying the granite batholith. Altogether, the diabase covers probably half of the Obonga Lake area.

The Keweenawan rocks are undisturbed, indicating little earth movement since their deposition. Subsequent geological records have been obliterated up to glacial times, the post-glacial debris now lying directly upon the worn diabase.

[1]The granites have been tentatively referred to the Algoman, although no sediments of Timiskaming age, with which to correlate them, were observed in this area.

Economic Geology

The chromite deposits of the Golden Centre Mining Company lie along the north contact of the serpentine lens north of Wig creek. They are associated, genetically, with the serpentine. Two types of deposits are found: (1) disseminated, (2) segregated.

In the disseminated form, chromite occurs as scattered grains, the size of a pinhead and smaller, through the serpentine. These deposits occur very often in proximity to the segregated bodies and, in this condition, form a transition from the chromite rock to the pure serpentine. Otherwise, they form pockety accumulations with a Cr_2O_3 content up to 17 per cent. A zone has been traced for 2,000 feet along the contact in which deposits of

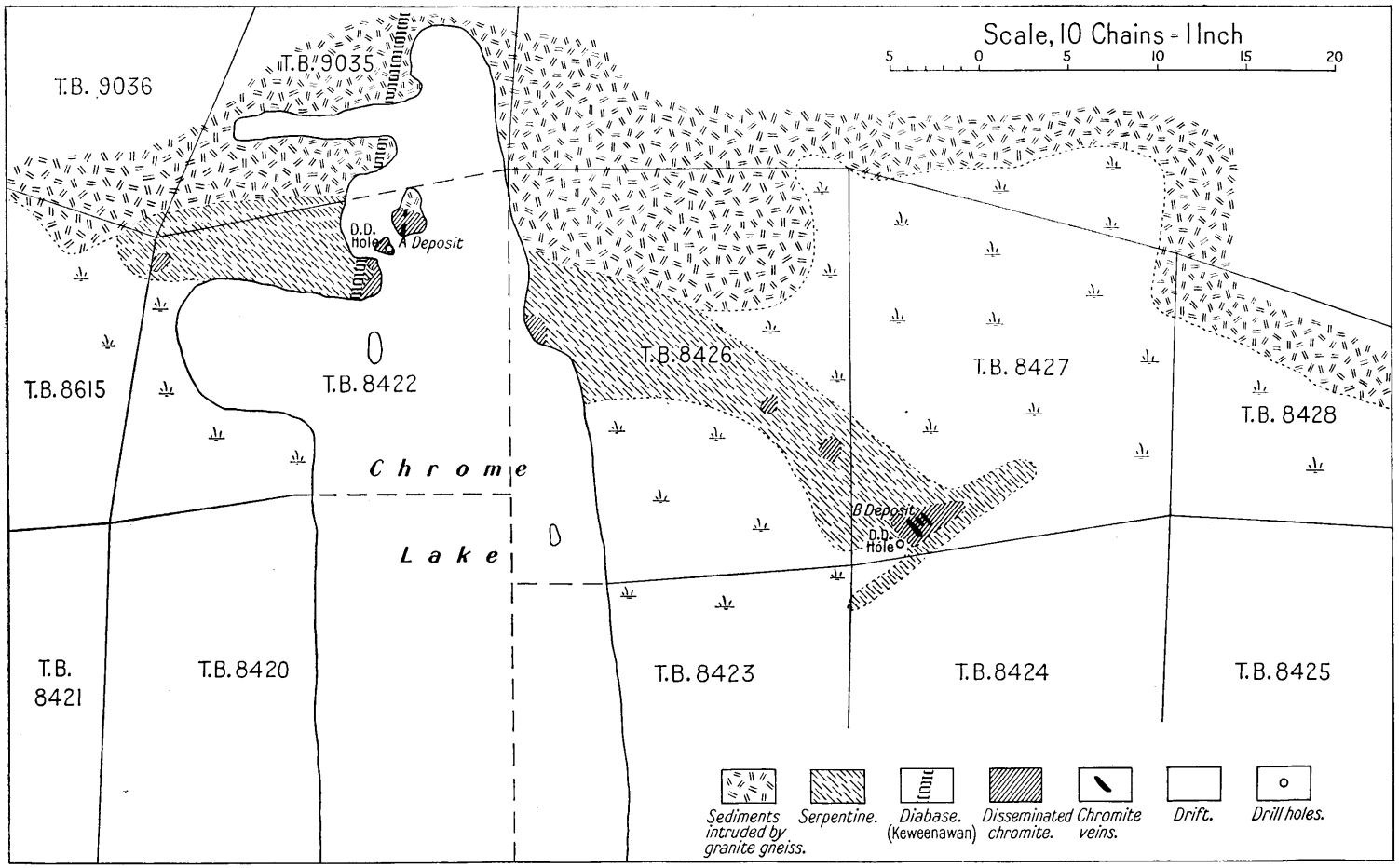


Primary chromite crystals, in a serpentine groundmass (S), fractured by secondary magnesite veinlets (M), producing a mitred structure. (One nicol, ×40.)

this type are quite numerous. Most of the serpentine contains a small percentage of chromite disseminated through the mass in a fine state of division. In the specimen of serpentine selected for chemical ana ysis, in which scattered grains of black metallic chromite were visible to the naked eye, the chromite forms 1.35 per cent. of the mineral composition.

The segregated deposits are in the form of irregular and vein-like bodies. They have been located at two points on the property (see sketch map on the following page). The "A" deposit is located on a small island at the north end of Chrome lake. Two irregular bodies have been found with widths up to 1½ feet and lengths of 10 to 20 feet. The Cr_2O_3 values average 27 per cent. At the "B" deposit, located on claim T.B. 8,427, a series of chromite veins has been found within the serpentine at some distance from the contact with the gneiss. The veins strike northwest-southeast and have dips of 20° to 40° S.W. Four veins with widths from 10 inches to 2 feet have been uncovered over a length of 60 feet. These veins average 34 per cent. Cr_2O_3, with a favourable ratio of iron to chromium.

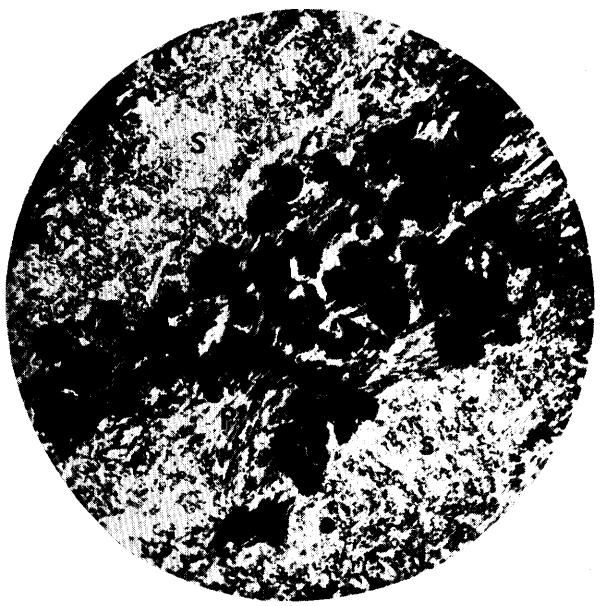
The chromite rock in these veins is black in colour and very fine grained in texture. With the naked eye, the individual chromite grains cannot be distinguished from the serpentine gangue. Numerous small fractures are



SKETCH MAP SHOWING THE GEOLOGY IN THE VICINITY OF THE CHROMITE DEPOSITS AT CHROME LAKE.

found through the chromite rock, and slickensides are common, indicating movement since the formation of the chromite veins. The pink chrome chlorite, kammererite, has developed along some fractures.

Although sharp contacts appear to exist with the serpentine wall rock, it has been concluded that the shearing of the serpentine, adjacent to the more competent chromite bodies, has accentuated the line of contact between the two. A thin section of the wall rock reveals the fact that the segregation of the chromite continues beyond the chromite body, but the accumulations of the chromite grains are not dense enough to form the chromite rock (see photomicrograph below). The chromite lodes are not true fissure-filling veins, but are accumulations of the chromite crystals in the primary peridotite magma. The altered peridotite lens dips flatly to the south, con-



Photomicrograph showing accumulations of chromite crystals enclosed in an interwoven mass of penninite scales (P) with serpentine (S) on either side. (Cross nicols, ×40.)

forming to the general dip of the schists and ancient gneiss. Chromium was an original constituent of the peridotite magma. Chromite, crystallizing early, settled to the base of this flat-lying intrusive by reason of its greater specific gravity. Thus, on the footwall, along the zone of the greatest width of the lens, the accumulation of the chromite has been sufficient to form these deposits. Along the narrower portions of the lens, sufficient chromium was not available for segregation to form chromite lodes.

In thin section, the chromite rock is seen to consist of small grains and crystals of chromite in a serpentine groundmass.

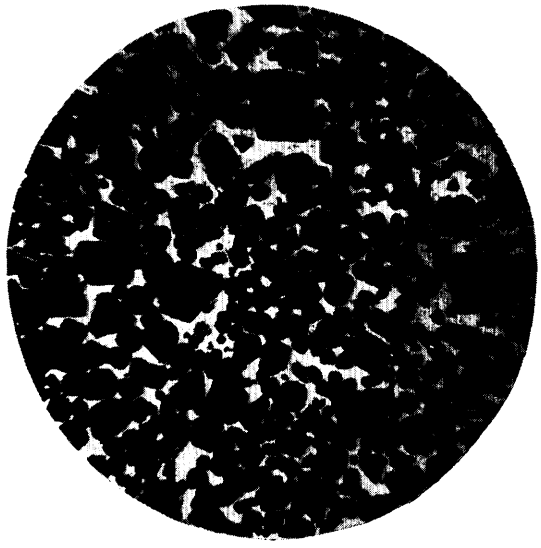
The grains and crystals range in size from one-tenth to one-fiftieth of a millimetre. To release individual grains for concentration would require fine grinding below 300 mesh. In this fine state, it is doubtful whether former methods of concentrating chromite ores by gravitation would be adequate. No doubt, a suitable flotation method could be devised for the separation of the chromite from the serpentine gangue.

In order to ascertain to what extent the Cr_2O_3 content could be increased by concentration, the writer separated out the chromite in a small specimen of the better grade of chromite rock from the "B" deposit. By the use of

heavy liquids and treatment with hydrochloric acid, a sample of chromite, 95 per cent. pure, was obtained. The chemical composition of this sample is as follows —

	Per cent.
SiO_2	2.50
TiO_2	.56
Al_2O_3	17.79
Cr_2O_3	42.30
FeO	27.69
CaO	nil
MgO	8.00
MnO	.49
NiO	nil
H_2O	.88
Total	100.21

All the chromite indicated at the time of the writer's visit to the property is below the commercial grade marketable at present. With con-



Photomicrograph of chromite rock showing the chromite crystals in a colourless serpentine groundmass. (One nicol, ×30.)

centration in view, the chromite rock will require fine grading and, as in the case of one sample of the better grade material investigated, with 100 per cent. concentration of the chromite, would yield a product with a Cr_2O_3 content of approximately 44 per cent. Low-grade chromite ores may be used directly for the manufacture of ferrochrome, if the metallic chromium-iron ratio does not fall below about two to one. The Obonga Lake deposits could be available directly for this use, if price discount for low Cr_2O_3 content was not excessive.

Since the deposit is not readily accessible, transportation difficulties will hinder its development, taking into consideration the present price at which Rhodesia and New Caledonia are supplying the American market with 50 per cent. ore. However, the increased consumption of chromium in America, due to the recent innovation of its use in the manufacture of rustless steel, a material of wide industrial application, will, no doubt, effect a better market condition. Deposits uncommercial at present will unquestionably be of considerable importance in the future.

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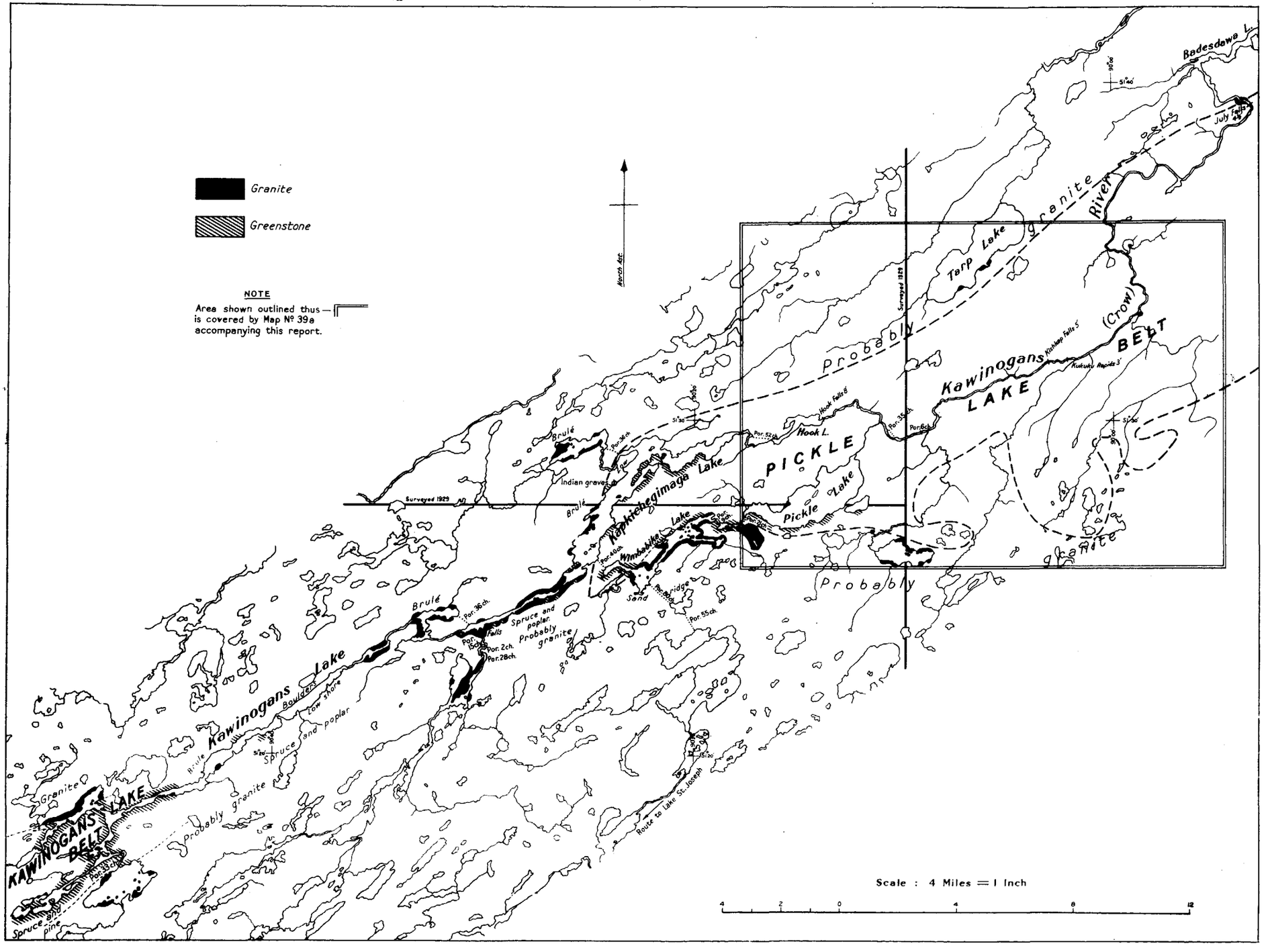
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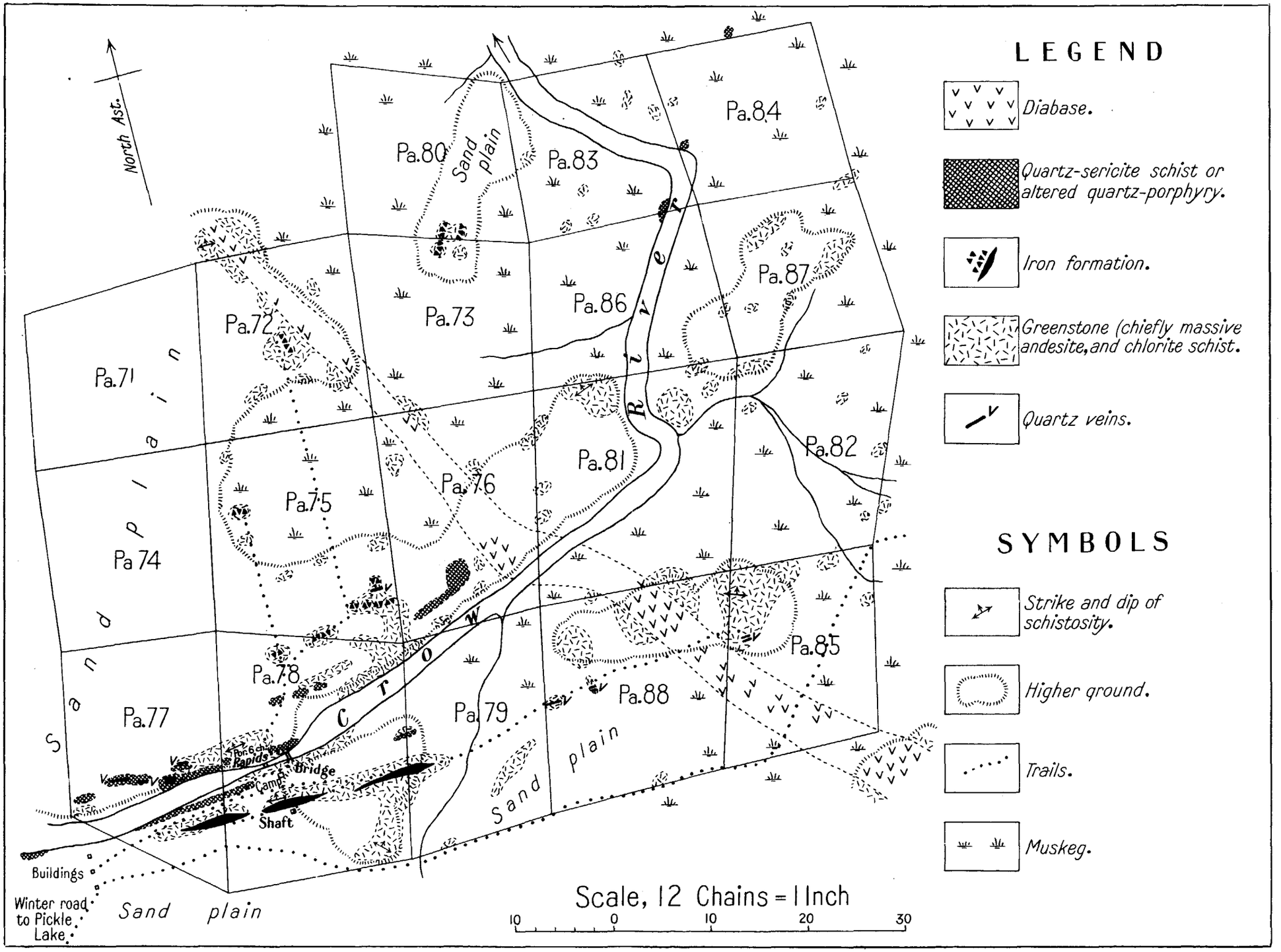
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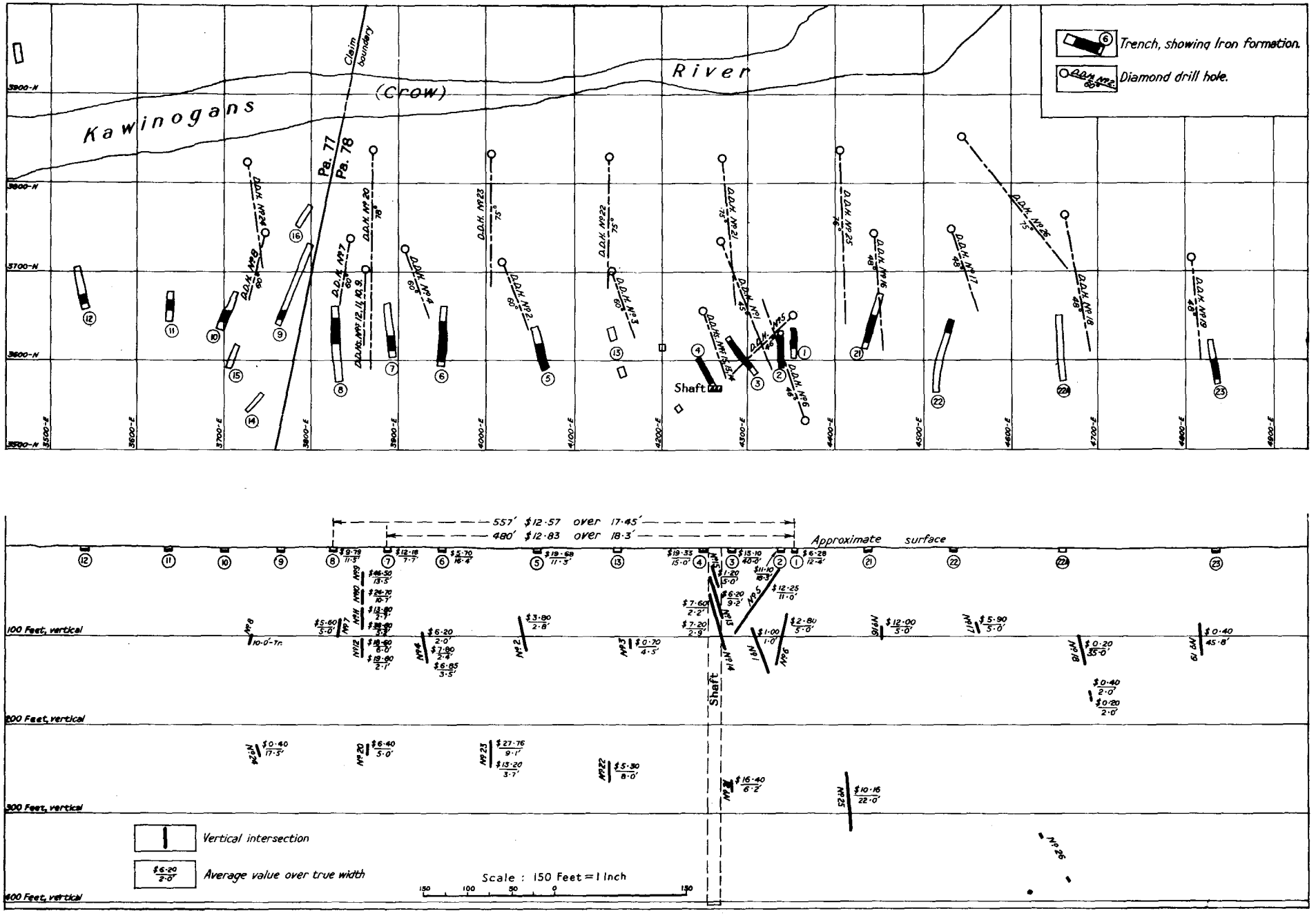
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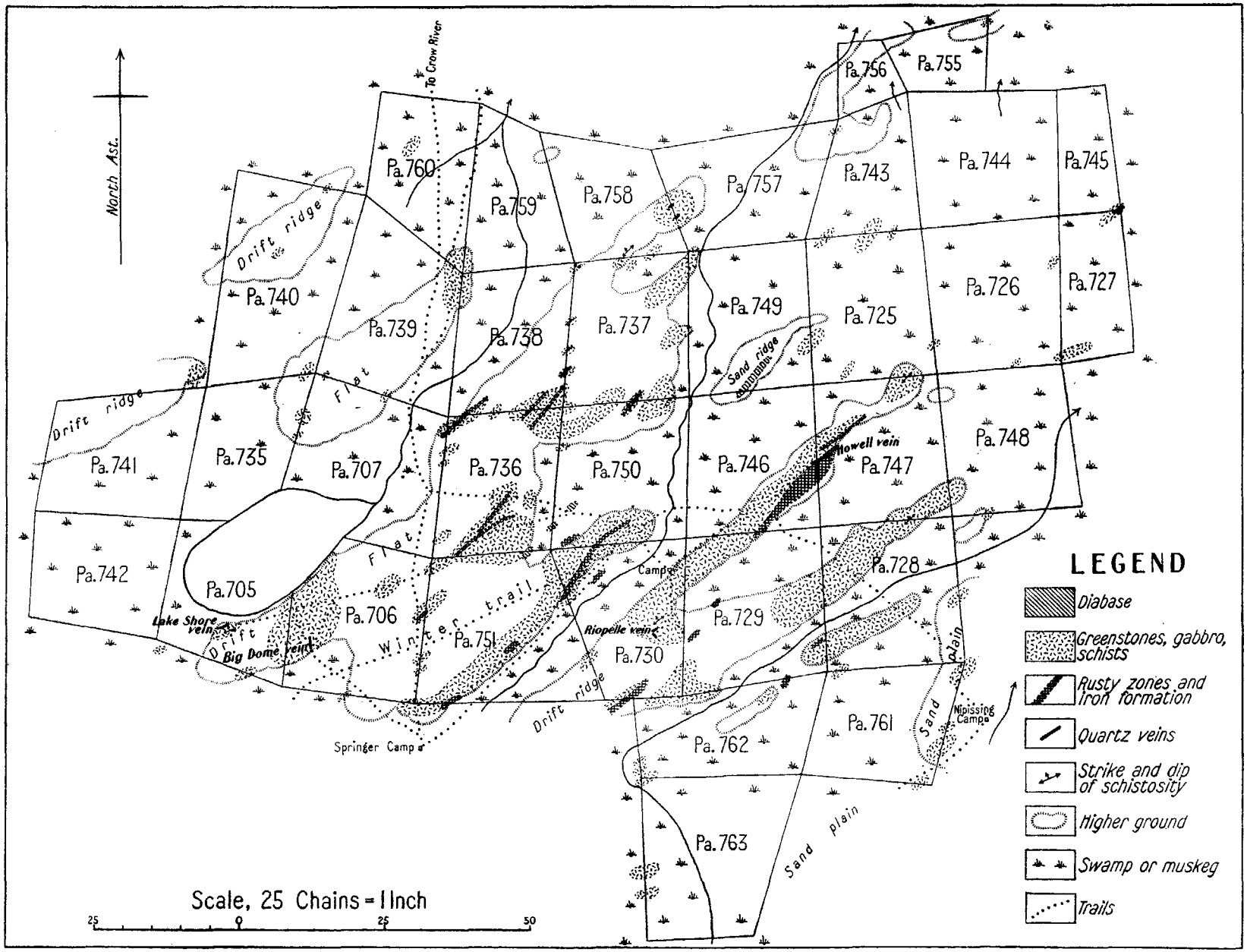
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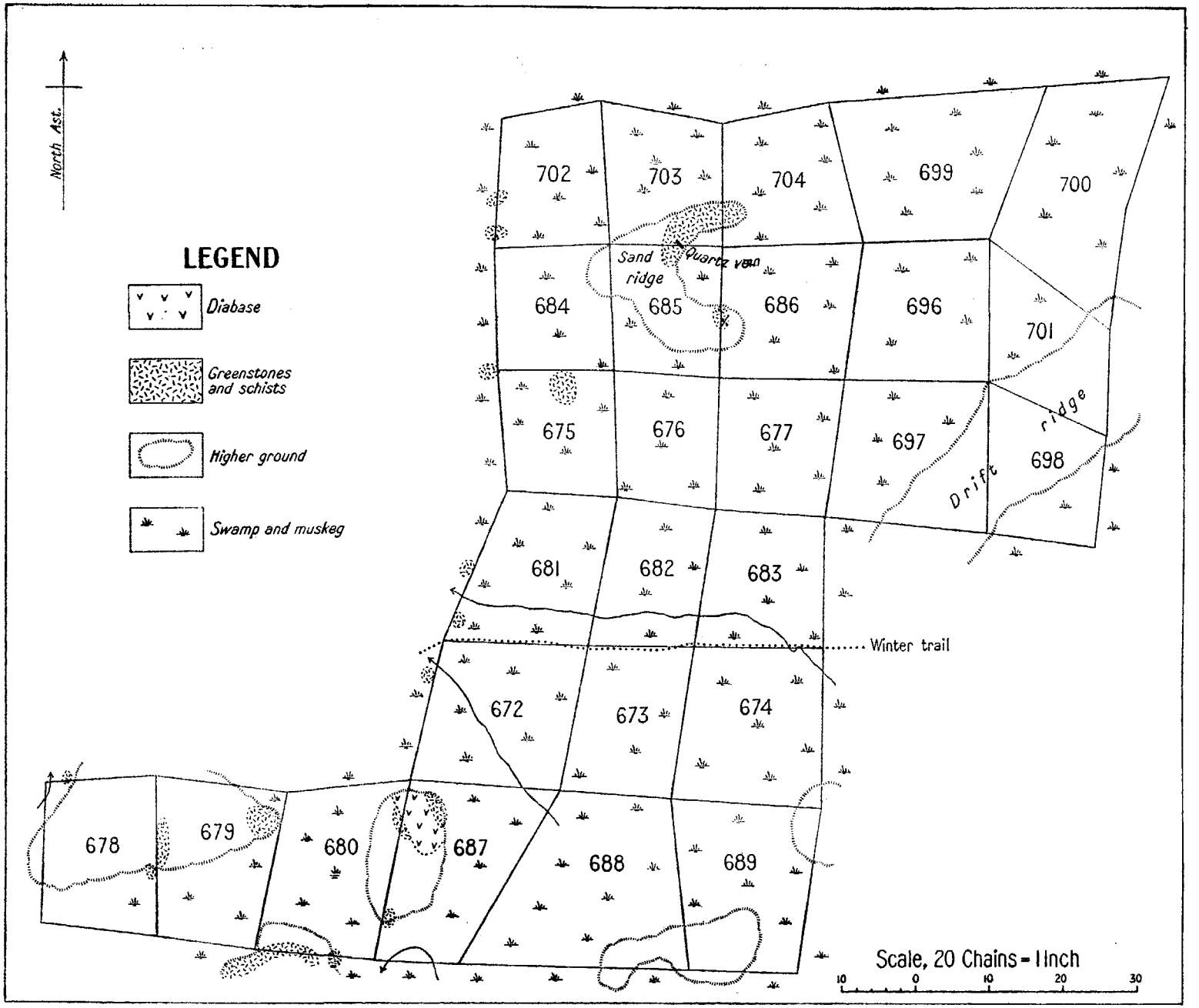
Preliminary geological map of the Central Patricia Mines group.



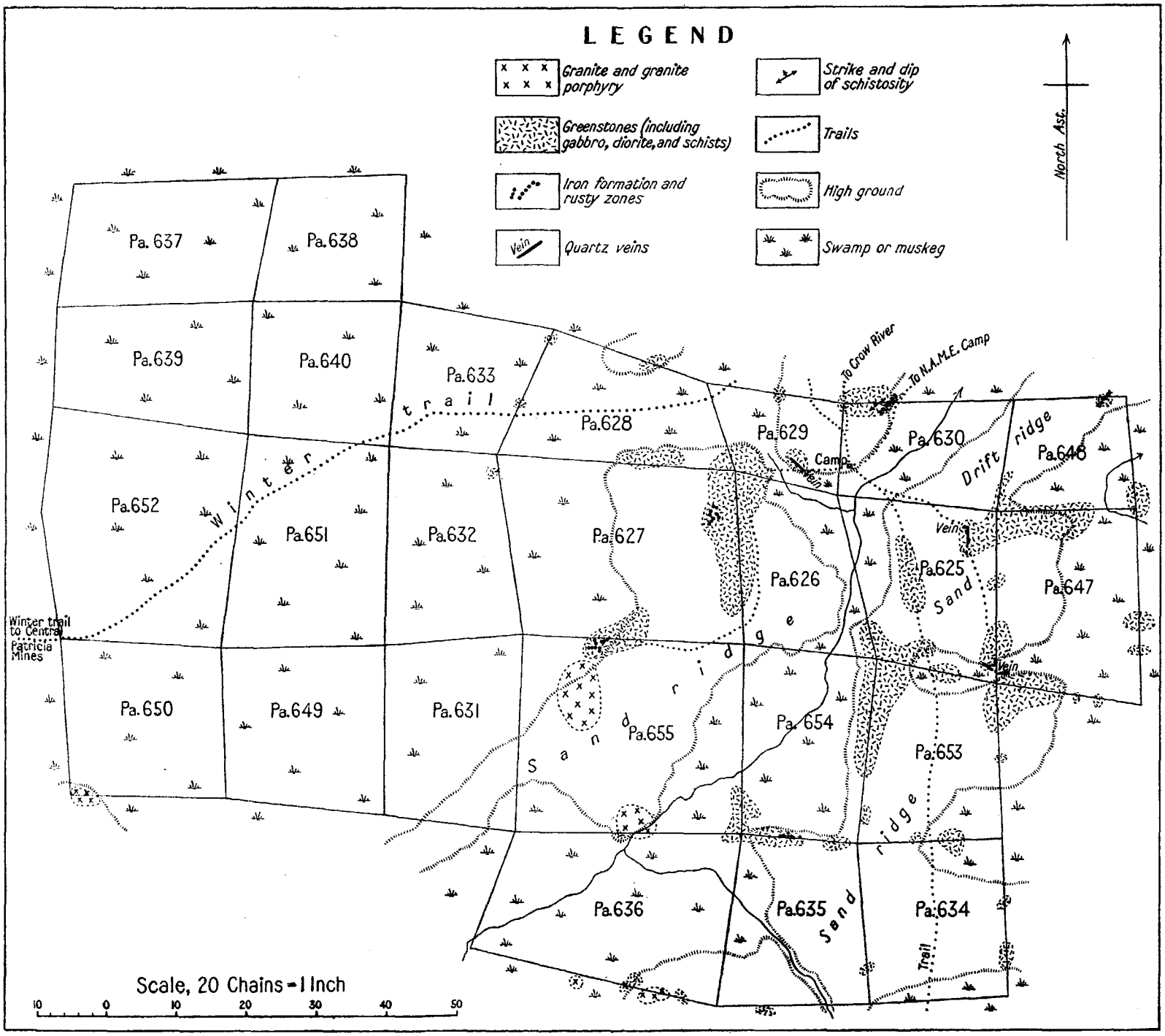
Plan and section showing diamond-drilling and assay returns on the principal ore zone, Central Patricia Mines.



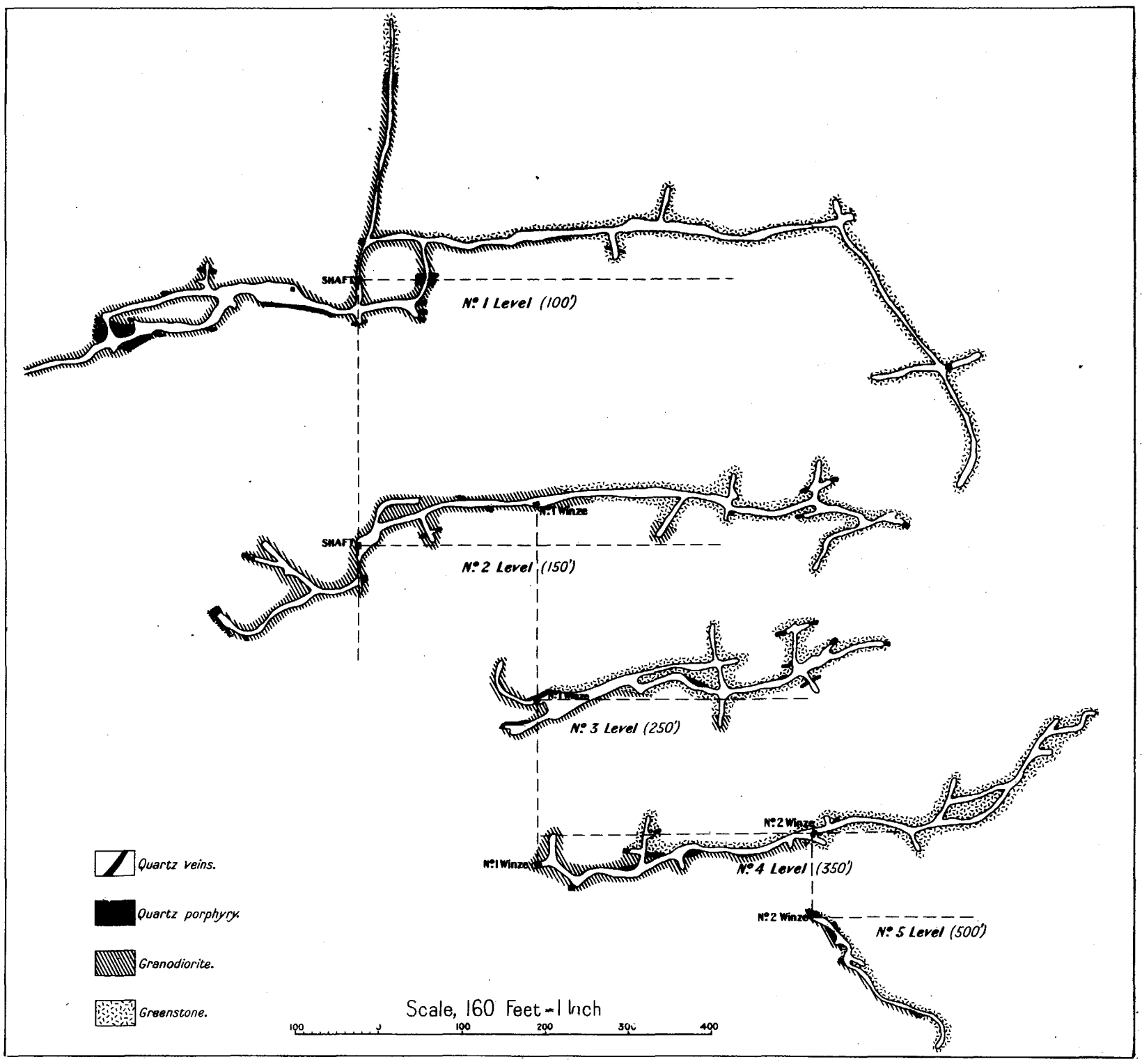
GEOLOGICAL SKETCH MAP OF EAST GROUP, N.A.M.E. CLAIMS.



GEOLOGICAL SKETCH MAP OF WEST GROUP, N.A.M.E. CLAIMS.

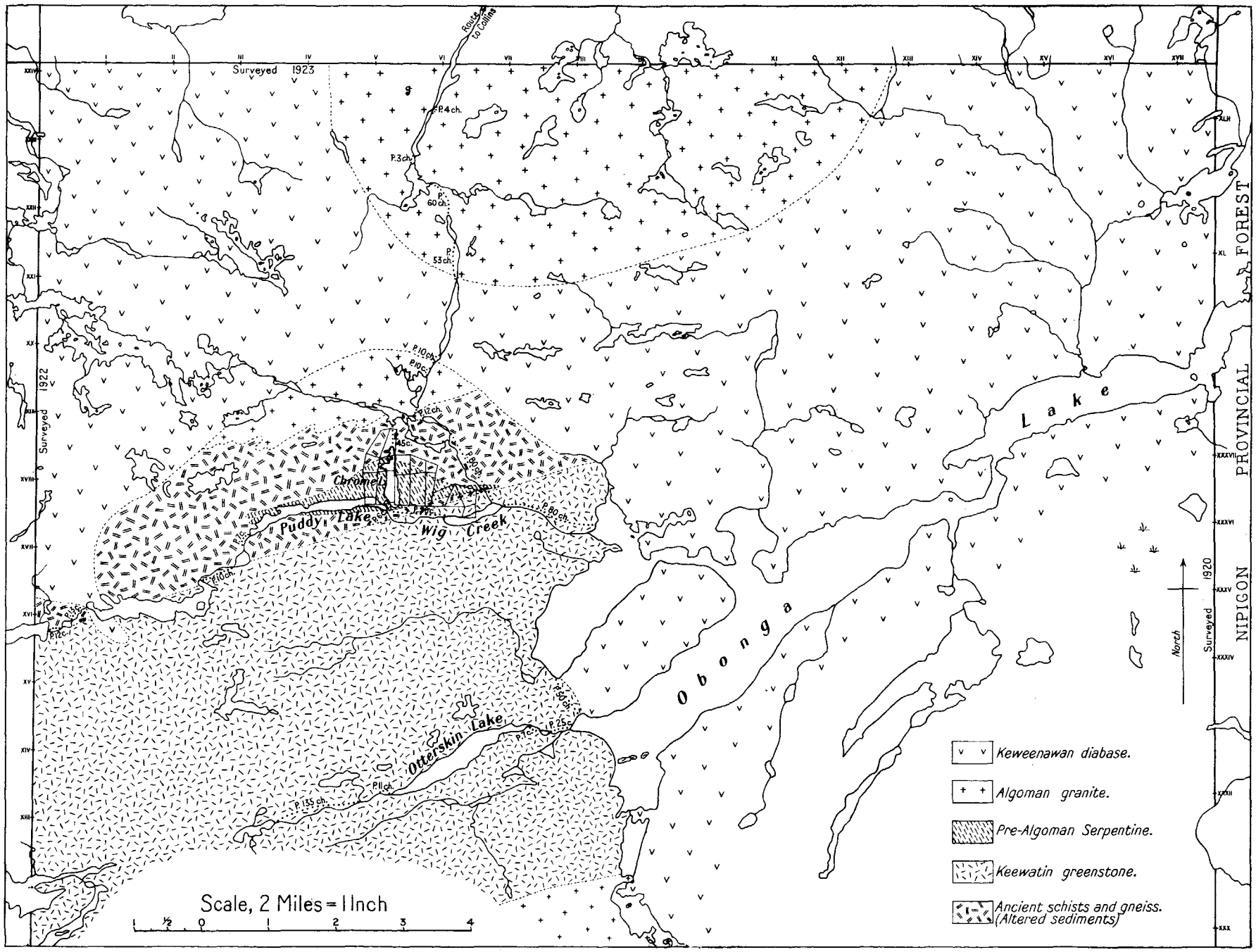


GEOLOGICAL SKETCH MAP OF THE SPRINGER GROUP.

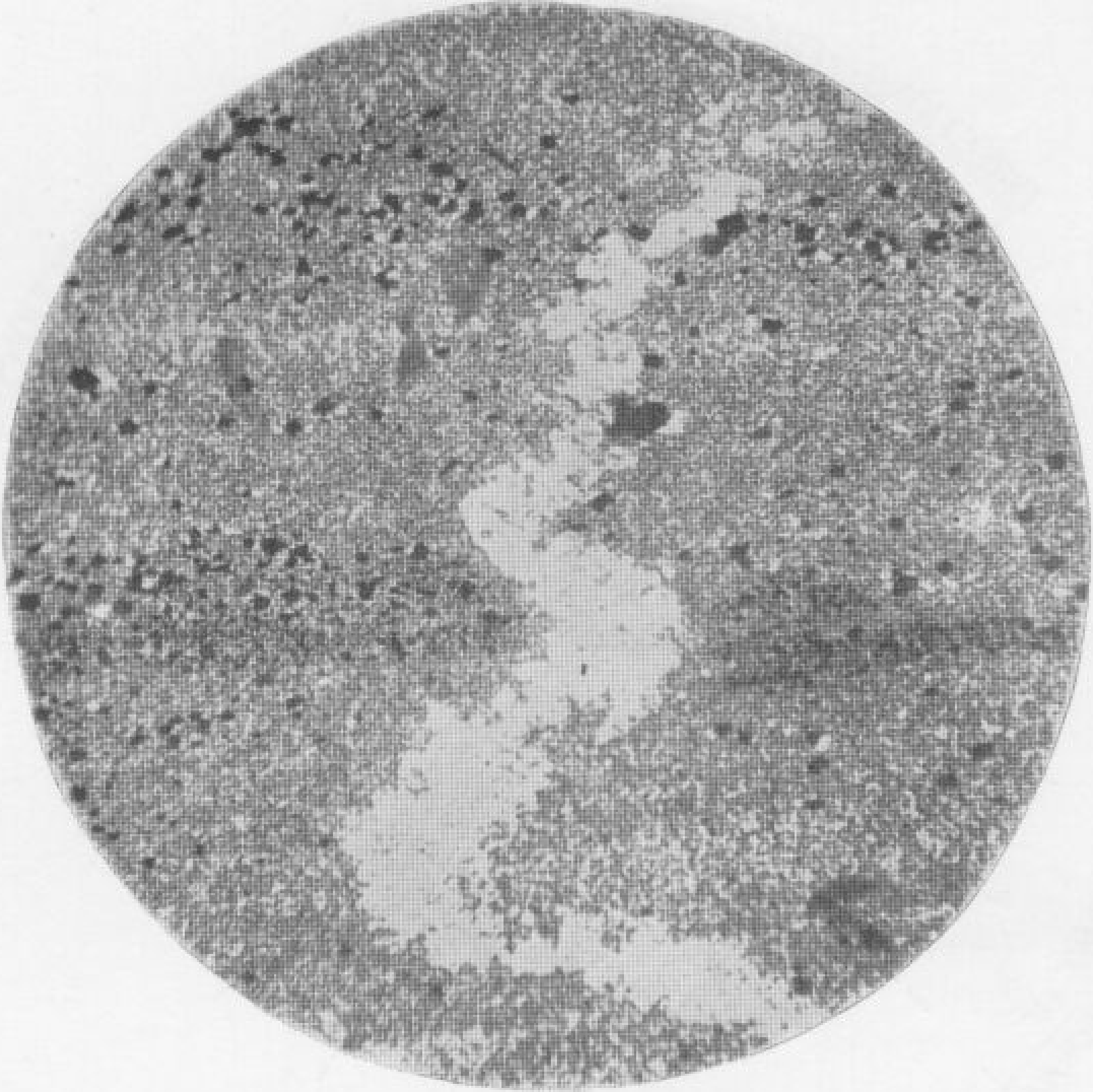


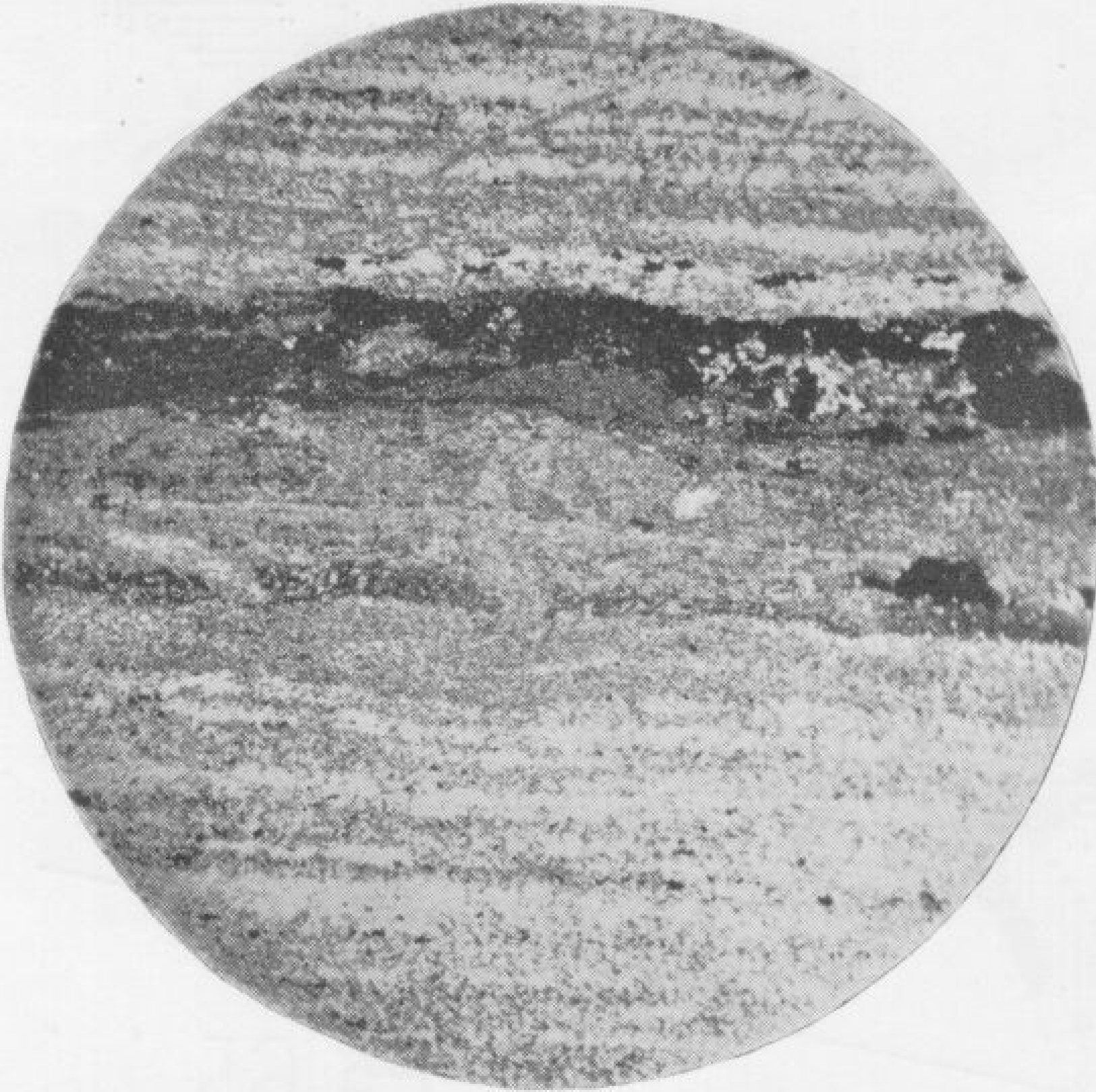
Geological plan of the levels, St. Anthony Mine.

To accompany Vol. XXXIX, Part 2, Ontario Department of Mines.



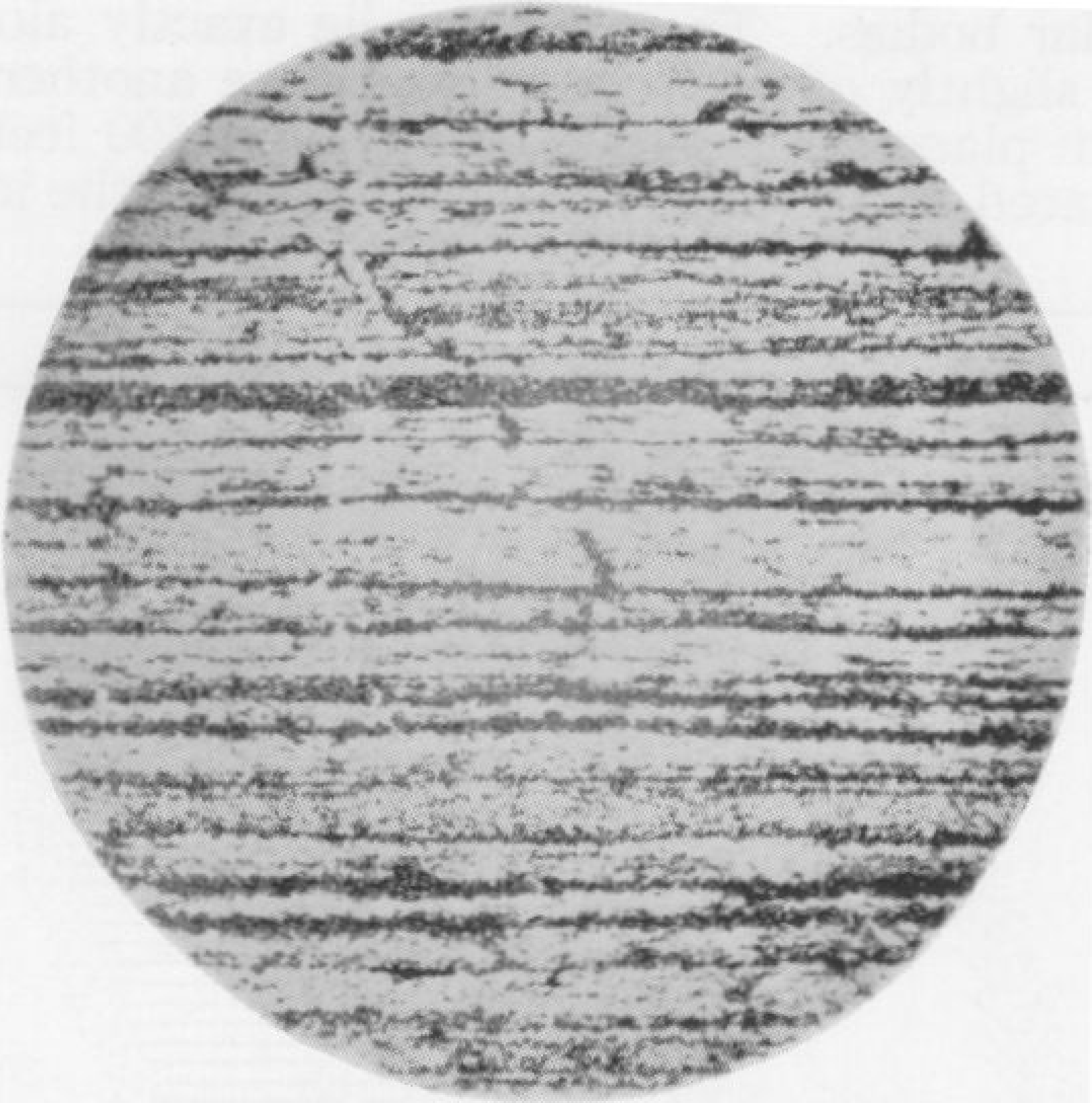
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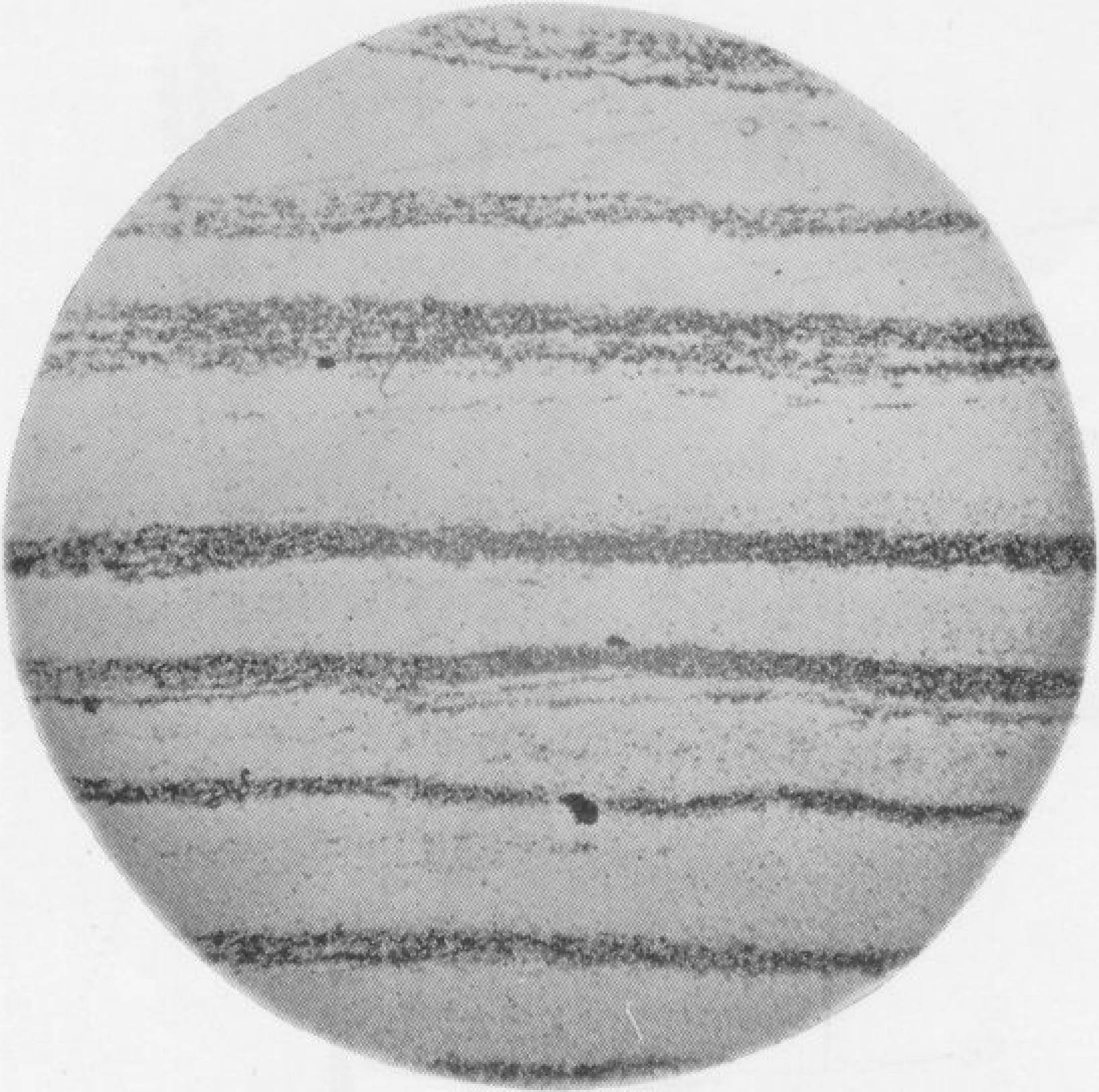












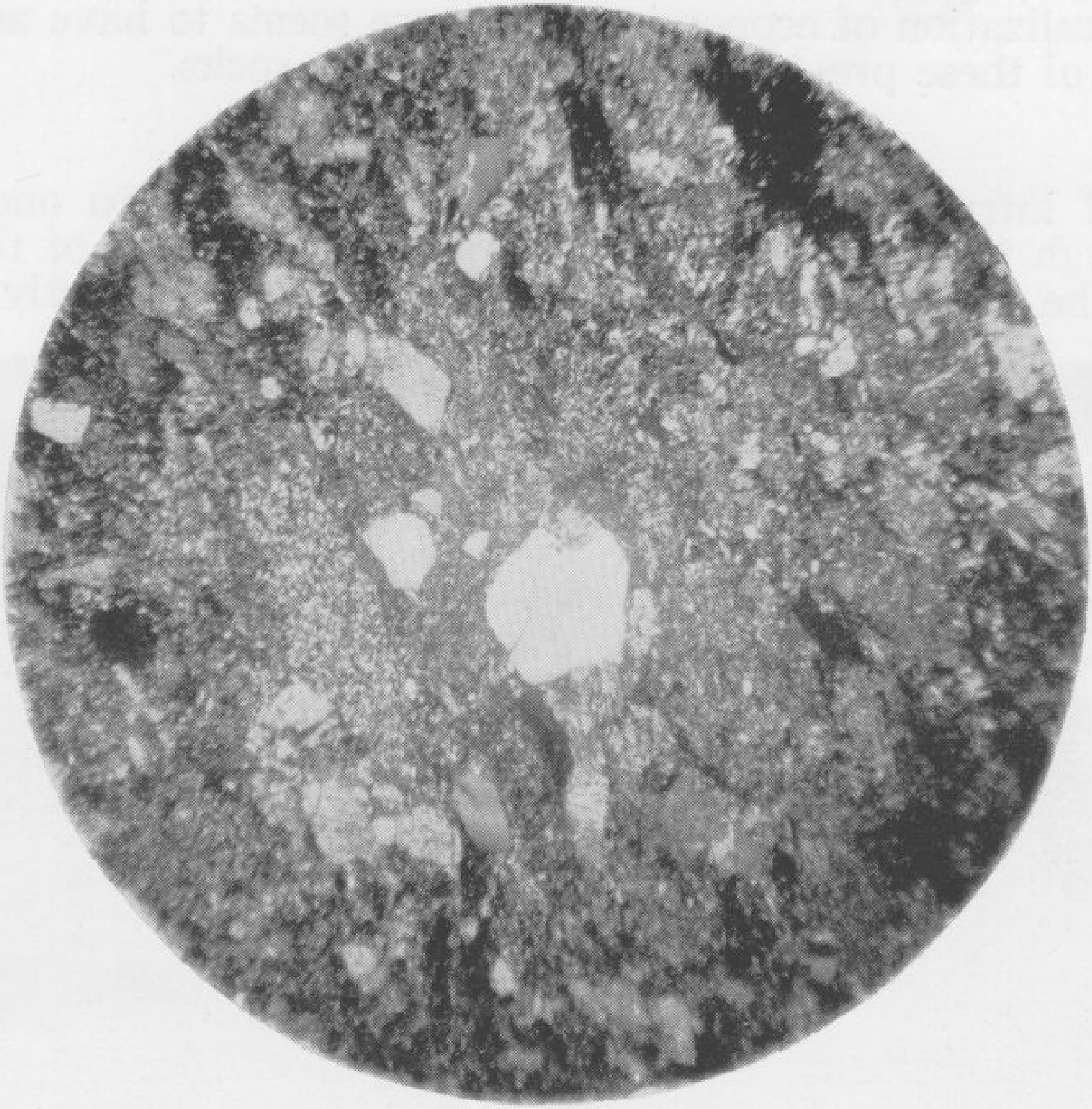




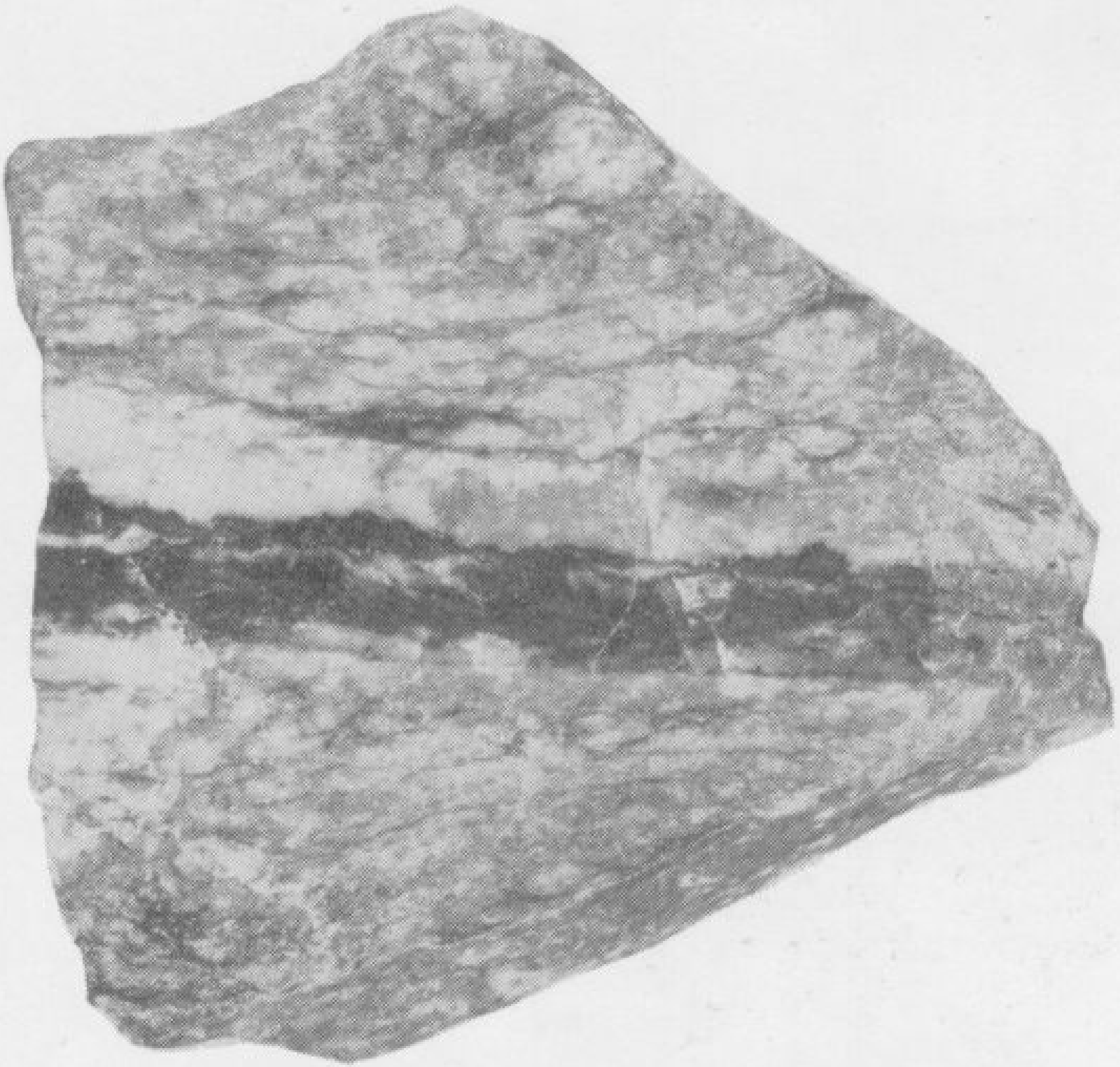


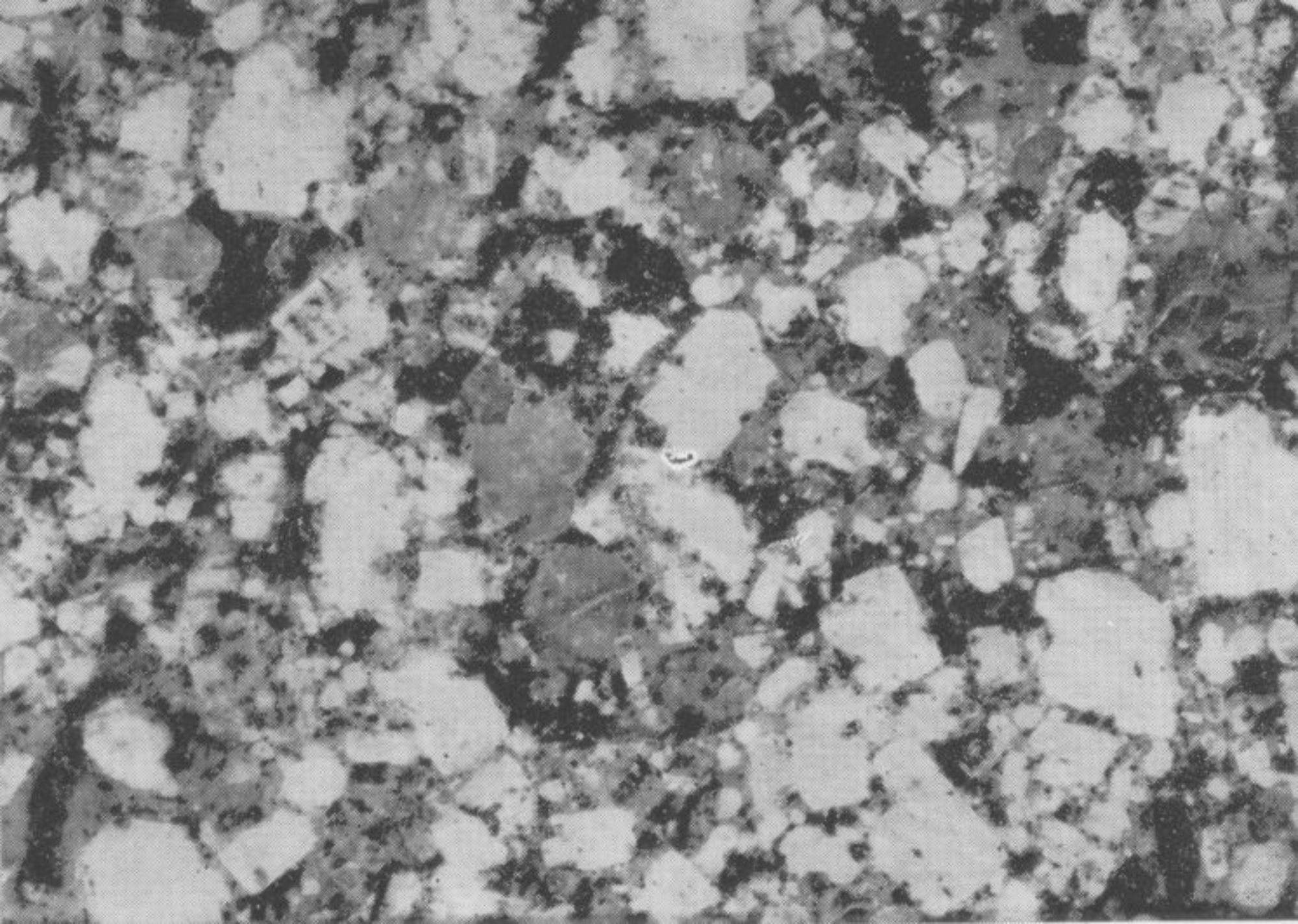










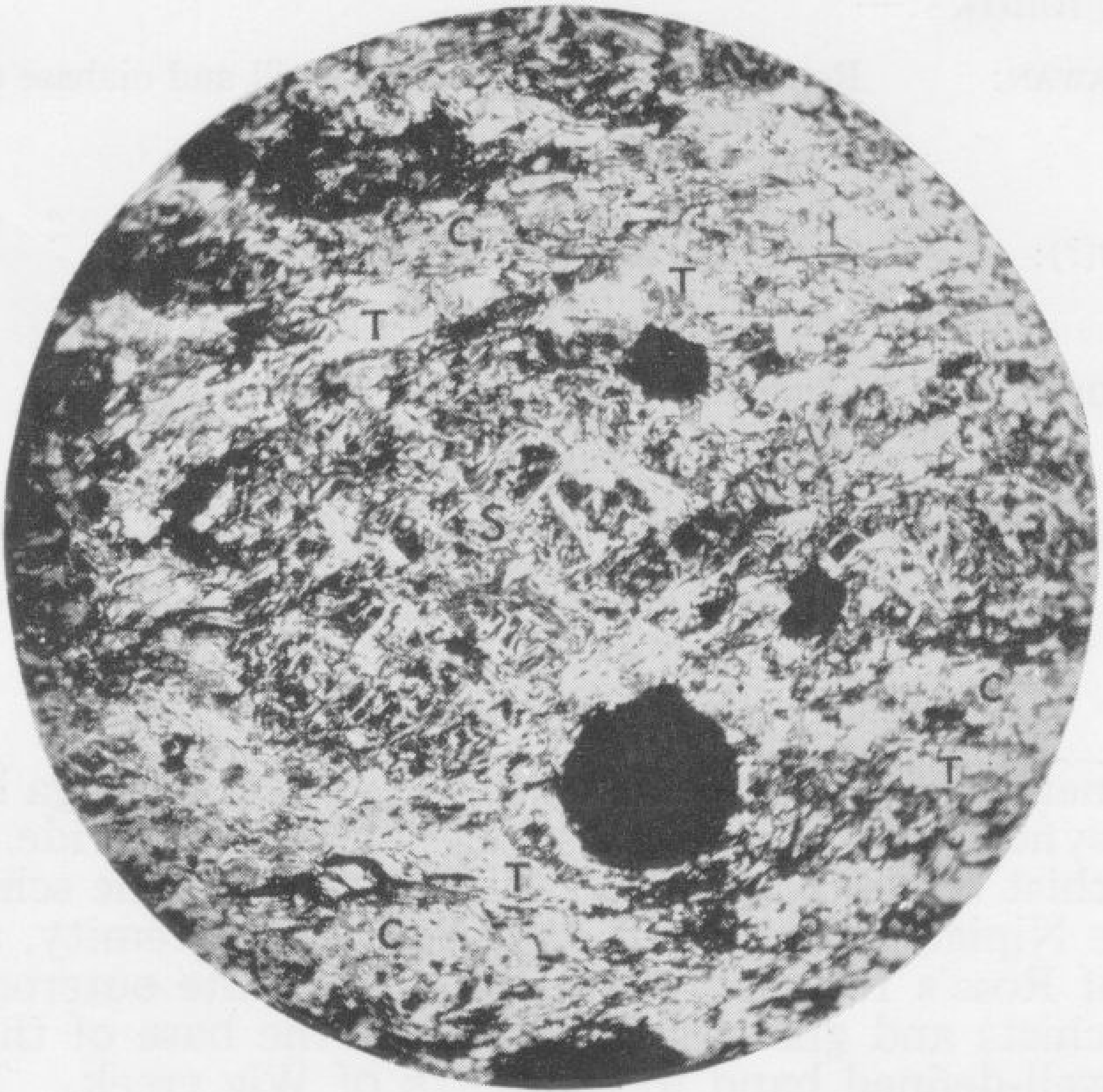



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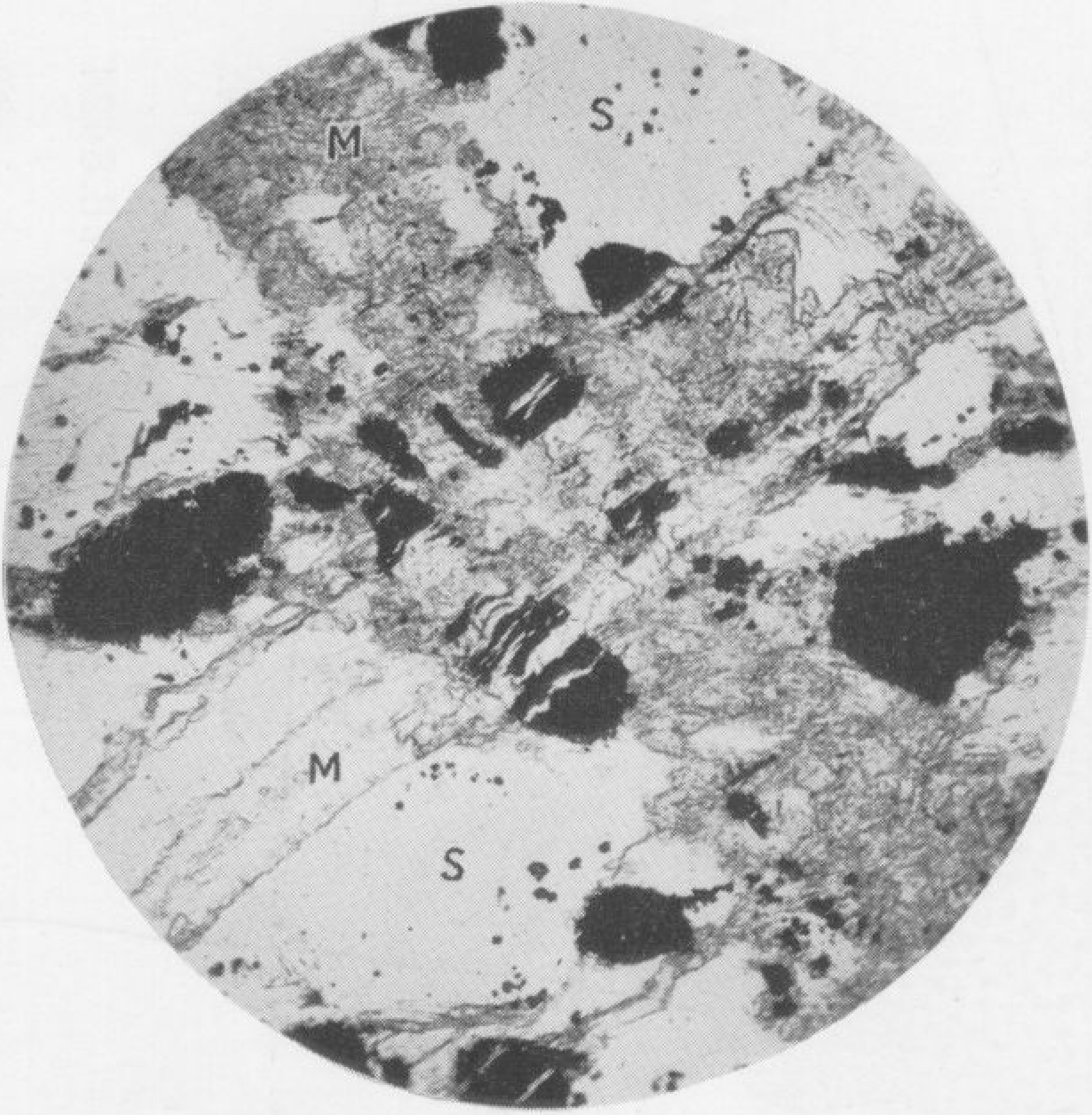


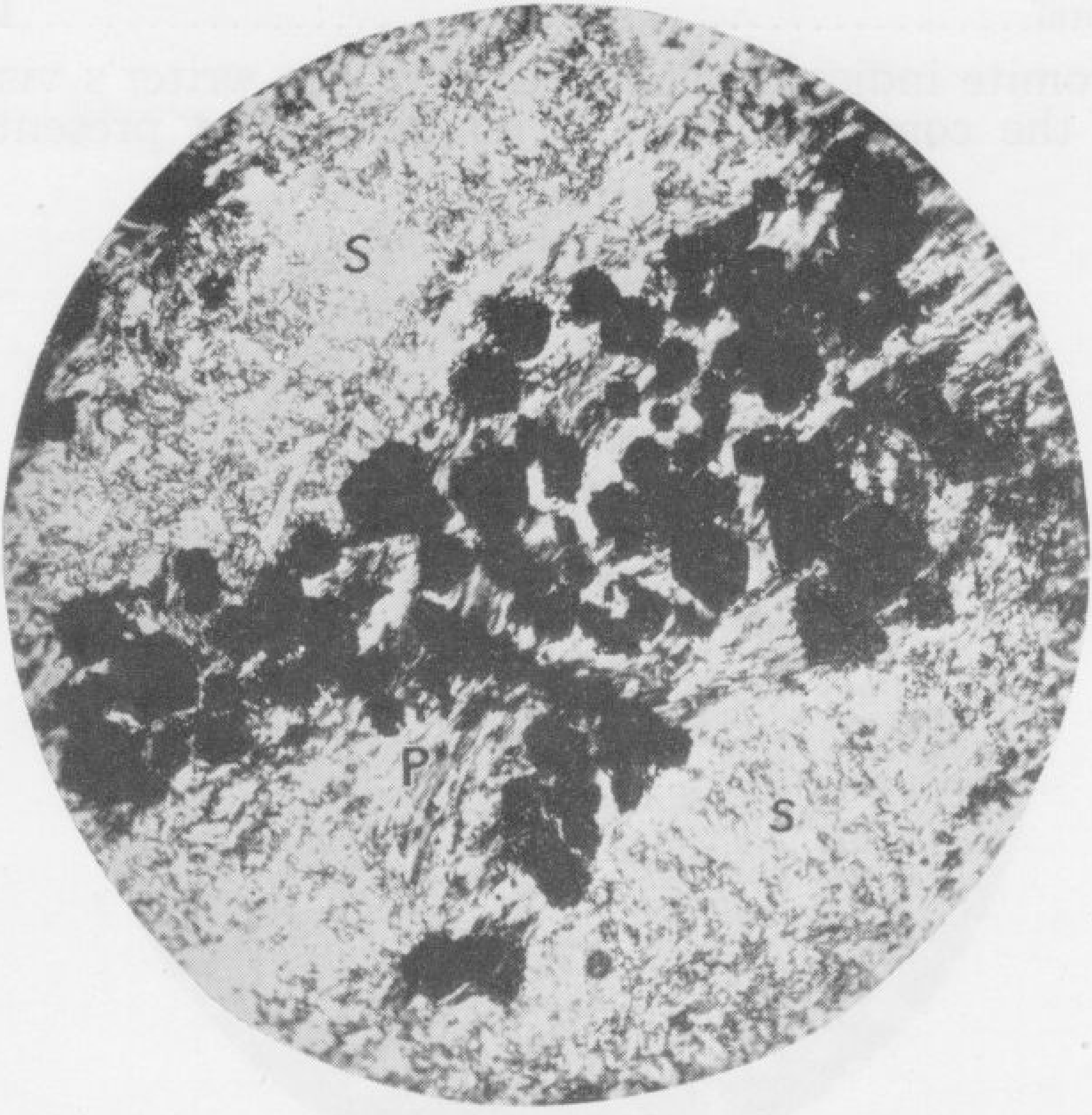
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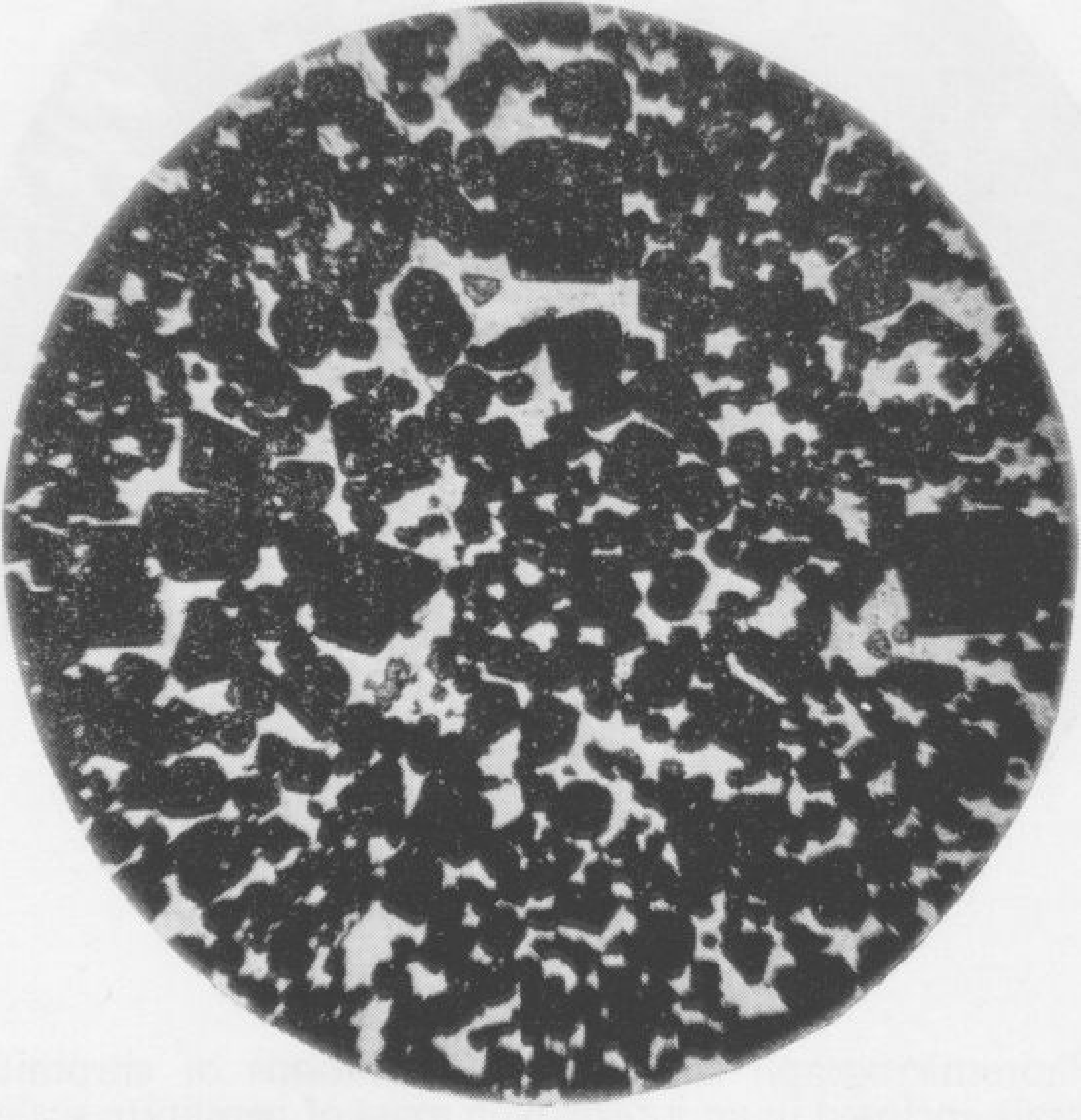



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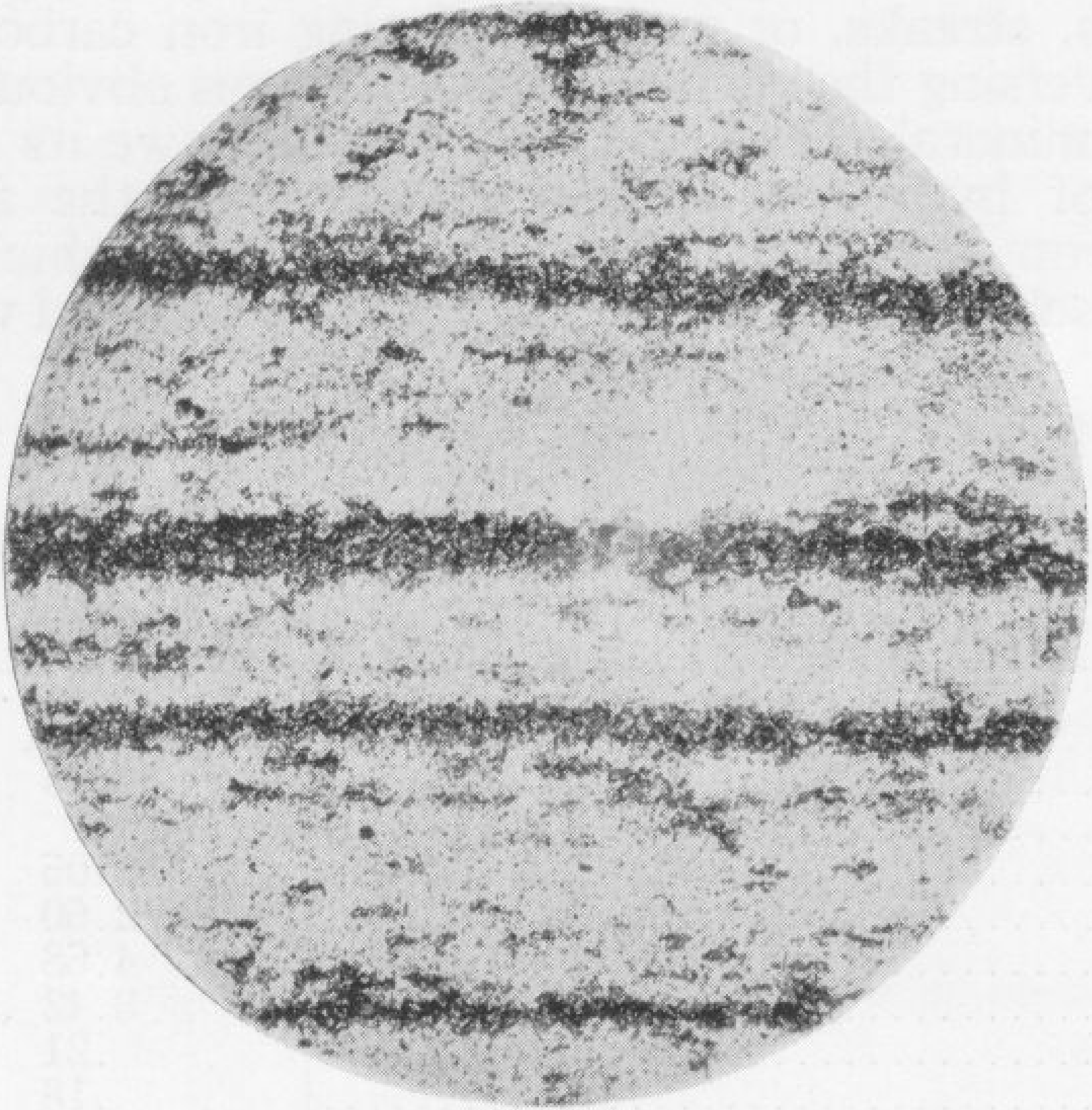

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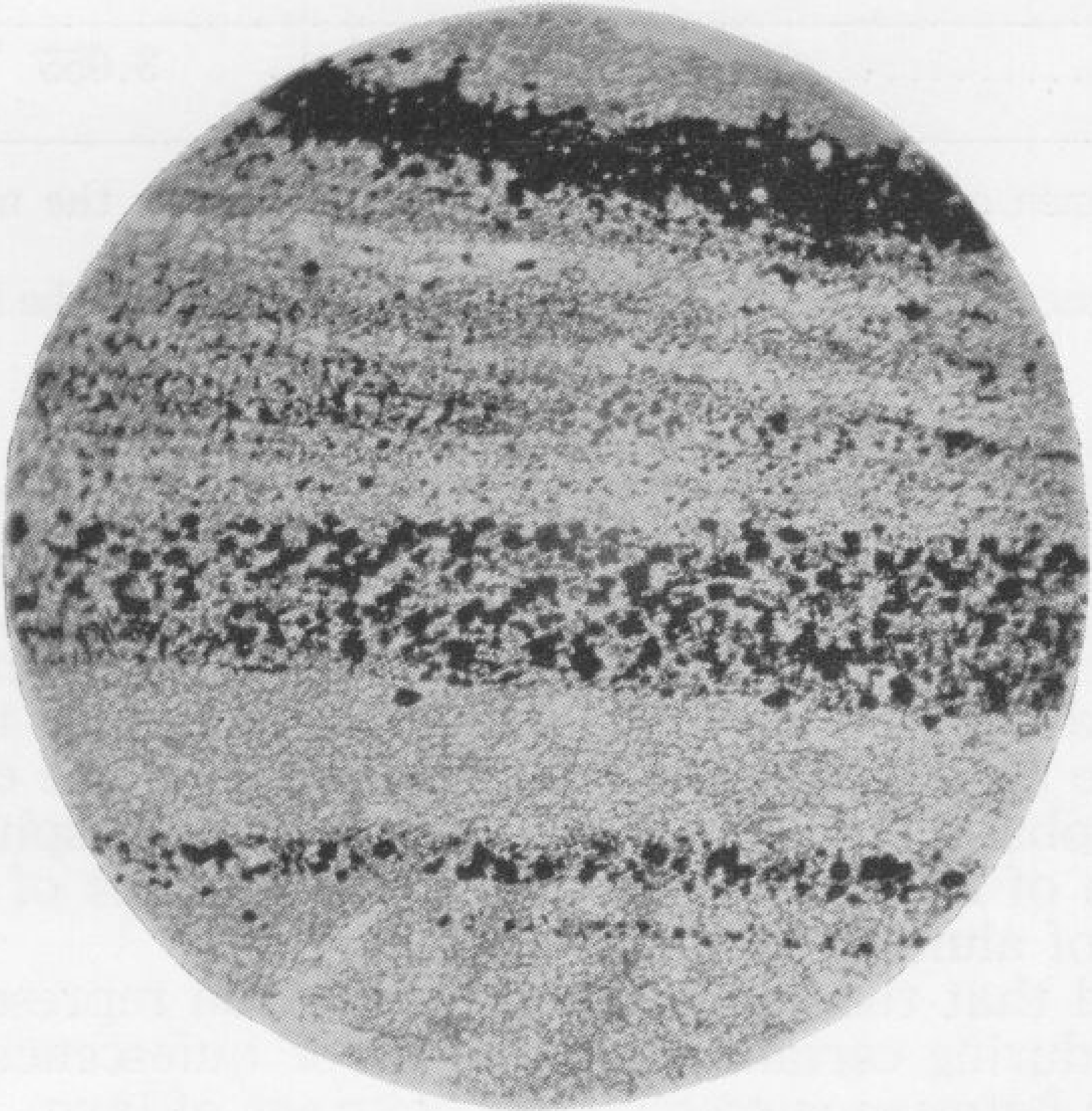

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PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

THIRTY-NINTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXIX, PART III, 1930

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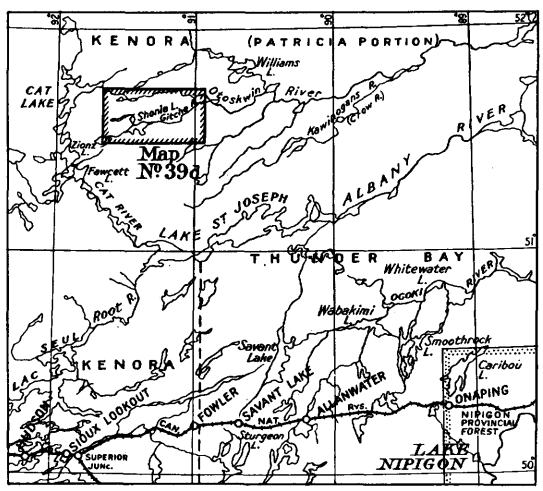
Geology of the Shonia Lake Area, District of Kenora (Patricia Portion)

By H. C. Laird

INTRODUCTION

Shonia lake is situated in the Patricia portion of the district of Kenora some 65 miles north and east of the Woman Lake area and 20 miles southeast of Cat lake. Although the lake is one of the smallest in the region, it lends its name to the whole area, owing to the fact that it was the scene of the original mineral discovery.

"Bill" Smith, a well-known prospector, was the first to appreciate the possibilities of a heretofore unknown belt of Keewatin rocks in this area.



Key map showing location of the Shonia Lake area. Scale, 60 miles to the inch.

In August, 1928, he and Stanley Watson staked a small group of claims between Shonia lake and the eastern part of McVicar lake. The news of the discovery of a new mineralized belt soon reached prospectors, and in a few weeks the whole Keewatin area surrounding Shonia lake was staked solidly. Before the snow fell prospectors already had a general idea of the nature of the rocks, and much useless staking in unfavourable areas was avoided.

The possibility of a new gold field gave much importance and publicity to the whole area. On the authority of T. W. Gibson, Deputy Minister of Mines, the writer was assigned the work of making a geological reconnaissance. This was carried on during the summer of 1929.

The writer takes this opportunity to thank all those who gave useful information and courteous assistance during the summer. In this connection special thanks are due to W. G. Woods and A. A. Beatty of the

Hudson's Bay Company; to A. E. Dumond, G. Younger, C. S. Johnson; to Major Nicol and staff of the Ontario Forestry Branch, Sioux Lookout; and to Angus McMillan and John Stoughton, prospectors. G. G. Duncan of the Northern Aerial Minerals Exploration, Limited, very kindly gave valuable information on the sampling of the Smith property. In the preparation of this report, many thanks are due to members of the staff in the Department of Geology and in the Department of Mineralogy, University of Toronto, for helpful suggestions.

Much of the success attained is due to the efficient and willing co-operation of three assistants, W. T. Boyes, University of Western Ontario; G. A. McVicar, Toronto University; B. I. T. Breakey, McMaster University.

Access and Canoe Routes

The Shonia Lake area occupies a central position with regard to prospecting activities in the Red Lake mining division. It lies 104 miles in a straight line north of Sioux Lookout on the Canadian National railway, 65 miles northeast of Woman lake, and 60 miles west of the Pickle Lake–Crow River area.

The Western Canada Airways, Limited, provides excellent service, making the trip from Sioux Lookout to Shonia lake in one hour. The more arduous task of paddling requires at least seven days. The advantage of the aeroplane in this country needs no further comment.

The most direct canoe route is from Hudson or Sioux Lookout, via Lac Seul, the Root river, and the Cat river. The Hudson's Bay Company has used this route for many years in the transport of winter supplies to the Cat Lake post. Large gas boats make the trip from Hudson to Perch ripple, at the east end of Lac Seul, in one day. Previously a portage was necessary here but the Ear falls development at the head of the lake has raised the water to such an extent that the ripple has disappeared, allowing the large boats to reach Nattaway falls without difficulty. Between Perch ripple and Lake St. Joseph there are 9 portages, all of which are short and well travelled. Root portage, the longest, is over the height of land between the English and the Albany River systems. The upper Root river is quite narrow but navigable with small canoes at all seasons. The stream leading to Lake St. Joseph is wide but shallow, and outboard motors are used with difficulty especially in the autumn. The Cat river flows into the northwest corner of Lake St. Joseph. For the most part this river is nothing more than a long chain of lakes connected by short steep rapids and waterfalls. The route to Shonia lake leaves the Cat river by a long narrow arm extending eastward from a point between Fawcett lake and Zionz lake. It is necessary to make three short portages before reaching the creek that leads into the Gitche river. In low water considerable distance is added to the last of these portages. There are three more short portages before reaching Shonia lake.

Good canoe routes connect Shonia lake with Savant lake, Pickle lake, Woman and Birch lakes, and with Gold Pines at the head of Lac Seul. A short route from Gold Pines, via the Wenasaga river, to Gull lake and Fawcett lake, is an old travelled one. From Woman lake there are two possible routes: one via Swain lake and Springpole lake to Gull lake; the other via Shabumeni and Birch lakes to Zionz lake. The route from the Pickle Lake–Crow River area traverses Kawinogans lake, Wright lake, and Dobie lake to the Gitche river.

The Topographical Survey of Canada has issued four aerial map sheets that cover the routes mentioned above, namely, Sioux Lookout, Lac Seul, Trout lake, and Lake St. Joseph.

History and Development

Mackenzie's map[1] shows the Cat river route from the trading post on Lake St. Joseph to the Cat Lake post. At this early date any interest in the country beyond that of pure exploration was in the fur trade.

In 1885, Thomas W. Fawcett, D.T.S., made a survey[2] from Lake St. Joseph to Cat lake by way of the Cat river. His description of the route is mainly topographical.

In 1902, A. W. G. Wilson and J. F. E. Johnson made a survey of Cat lake and the Cat river. Wilson's report[3] accompanied by map 9A (No. 1089) was published in 1910.

In 1904, Charles Camsell[4] reached Cat lake by way of the Wenasaga river. He was joined here by J. Williams of Osnaburgh House, who "had come straight across to Cat lake by a route hitherto only travelled by Indians." This route is shown on map 9A, accompanying Wilson's report. His traverse took him across the northern part of the present Shonia Lake map-sheet. Long lake on map 9A has been renamed Morris lake on the present map.

In 1912, W. G. Miller made a compilation[5] of all the exploration work up to that time in the district of Patricia, including the reports of Camsell and Wilson.

There is no record of the knowledge of a Keewatin belt of rocks in this area previous to Smith's discovery in 1928, but there is evidence that the Cat lake Indians knew of the mineralization because they had already given the name "Onamun" lake to Shonia lake (meaning "money" lake in their language). It is said that Smith learned of the "find" through one of the Cat lake Indians. The value of the native cannot be overestimated with respect to prospecting. Some of the larger prospecting companies are already making efforts to train our native Indians in the knowledge of rocks and in prospecting methods.

Nearly five hundred claims were staked along the strike of the greenstone belt between August and December of 1928. From then on the prospectors adopted a "watch and wait" plan. The Northern Aerial Minerals Exploration, Limited, took an option on the Smith-Watson group and immediately took in a winter camp by 'plane. During the winter they did considerable clearing, channel sampling, and shooting into the mineralized quartz. Results were very disappointing and in the spring work was discontinued.

Bracton Limited, a subsidiary of Dominion Explorers, actively prospected a group of claims under the direction of A. E. Dumond. They found three zones of interesting mineralization, but none were of economic importance. The representatives of several syndicates examined other groups and reported that they found nothing of interest. Kenora Prospectors, Ventures Limited, Cyril Knight Prospecting Company, Bunker Hill Extension, Beverly Syndicate, and the Lyman Exploration Syndicate, were among those who had prospecting parties in the area.

---

[1]A map of America between latitudes 40° and 70° North and longitudes 45° and 180° West exhibiting Mackenzie's track from Montreal to Fort Chipewyan and from thence to the North Sea in 1789 and to the West Pacific Ocean in 1793. Accompanying Voyages from Montreal through the continent of North America to the Frozen and the Pacific Oceans in 1789 and 1793, by Alexander Mackenzie, London, 1801.

[2]Thomas W. Fawcett, Dept. of Interior, Ann. Rept., 1885, pt. 11.

[3]A. W. G. Wilson, Report on a Traverse through the Southern Part of the North West Territories from Lac Seul to Cat Lake in 1902, Geol. Surv. Can., Publication No. 1006, 1909.

[4]Country around the Headwaters of the Severn River, Geol. Surv. Can., Vol. XVI, pt. A, 1904.

[5]Reports on the District of Patricia, Ont. Bur. Mines, Vol. XXI, pt. 2, 1912.

Physical Character and Drainage

The Shonia Lake area is typical height-of-land country. It presents a monotonous picture of many low rounded hills, interspersed with small lakes and wide areas of muskeg and alder swamps. It has an elevation of approximately 1,330 feet above mean sea-level. A comparison with other nearby areas can be made from the following compilation[1] of elevations above mean sea-level:—

	Feet
Cat lake	1,330
Woman lake	1,315
Red lake	1,146
Shabumeni lake	1,330
Windigo lake	1,200
Lake St. Joseph	1,185
Lac Seul	1,153
Savant lake	1,308

The sky line is remarkably even in all directions, indicating that this area is a part of an old peneplain of wide extent. Glaciation was the principal agent in bringing about the present topography and drainage system. The highest hills seldom rise more than 150 feet above lake-level, and the maximum relief is probably never more than 250 feet. Small sluggish streams drain the muskegs. Very few are navigable for more than a few chains but meander for long distances. There are many examples of small lakes in the last stages of development, a condition quite typical at the height of land. Some show the debris and vegetation creeping from the shore toward the centre, and others are nothing more than a mass of organic ooze. The final stage shows grasses taking root and a scattered growth of small tamarac and jackpine.

Scratches, grooves, fluting, and chatter marks on the rocks indicate that the glacier moved in a southwest direction. It gouged and scoured the deeply weathered rocks of the old peneplain, rounding off the more resistant knobs and completely removing many of the softer rocks. The eroded material was removed to the lower places, severely altering the original drainage system and giving rise to a great number of small shallow lakes. At the same time a thin mantle of glacial sand and boulders was deposited on the slopes.

Many of the long narrow lakes have their origin in the rock structure. The map shows that, in general, the trend of these follows the strike of the rocks. Whenever this is not the case, glacial material has interfered with the original structural channel.

Many of the low areas are due to the erosion of the soft rocks. An example of this is found in the area north of Cannon lake. The paragneiss here is crumbly and easily eroded, giving rise to wide areas of low spruce.

Although the area has been described as having little relief, nevertheless there are some hills that stand out prominently. Those south and west of Sor lake are probably the highest, forming a more or less continuous ridge extending from Gitche lake at the west to Dobie lake at the east. In the area between Sor, Gitche, and Bertrand lakes there are many high parallel ridges that trend a little south of east and conform to the gneissic structure of the granite. East of McVicar lake the ridge is less prominent until the area north of Dobie lake is reached, where it is again outstanding, breaking the monotony of the low country along the Gitche river.

The area between Lang lake and Cat lake lies directly on the divide, some streams flowing into the Cat river, others into the Otoskwin river. It has a very low relief and an imperfect drainage, presenting a monotonous

[1] James White, Altitudes in the Dominion of Canada, Commission of Conservation of Canada, Ottawa, 1915, p. 454.

tract of sand plain, muskeg, and low hummocky granite hills interspersed with many small kettle lakes. Immediately north and east of Cat lake the topography is very similar, being mostly sand plain with wide areas of open muskeg.

In the region of Morris lake brulé granite hills up to 150 feet in height skirt the north shore and form prominent ridges inland. Similar ridges occur in the south arm and to the east, where steep cliffs dip sheer into the water in many places. Covered hills of moderate elevation surround the basin of Upturned Root lake. The shore is largely sand and boulders with not a single rock outcrop. It is clearly of glacial origin. Between this lake and the Otoskwin river several high ridges and isolated hills rise above the general level.

The Gitche, Otoskwin, and Morris rivers provide the main features of the drainage system. The first two unite just beyond the eastern boundary of the map-sheet and thence find their way into the Attawapiskat system. The Morris river flows north.

The waters from the larger lakes to the west flow into the Gitche river. Bertrand lake lies within an irregular rock basin surrounded by high granite ridges. Its waters reach Lang lake after falling several feet over long shallow rapids. Boyes lake likewise flows into Lang lake by way of a wide creek that is navigable at all seasons of the year. Lang lake empties into Shonia lake by two small chutes, and the latter in turn empties into McVicar lake over a 6-foot rapids. Gitchè lake lies near the source of the Gitche river, which is an extremely meandering creek between Gitche and Stoughton lakes. Both arms of Gitche lake are very irregular in outline with low rocky shores and many small islands. The Gitche river for the most part flows through a low sandy area with a few low rock outcrops along the shore. It is narrow and has a gradient eastward of about 4 feet to the mile, giving it a fairly strong current. Most of this grade is taken up by several chutes and rapids.

The Otoskwin river forks at the west and drains the country between Lang lake and Cat lake. It consists of a series of small lakes connected by long swift rapids and low waterfalls; the gradient is much steeper than on the Gitche river. High ridges are prominent, especially on the way to Baggy lake and to the east. In this respect it differs markedly from the Gitche river.

The Morris river is similarly a chain of lakes, but on the whole they are larger than those on the Otoskwin river. Beyond Upturned Root lake it widens considerably and can be compared with the Cat river in size.

Timber, Agriculture, and Power

Much of the area near Shonia, Lang, and Gitche lakes is heavily covered with virgin forest consisting chiefly of spruce, jackpine, birch, and poplar. Where the trees are thinned out, the spruce grows to pulpwood size. Stands of large jackpine are common. Jackpine up to 2 feet in diameter were noticed on sandy ridges to the south of McVicar lake, and also west of Boyes lake. Red pine appears to have failed at this latitude; there is also an unusual scarcity of the Canada balsam. White cedar grows to a large size along the rivers. Tamarac is gaining a foothold in the open muskegs.

There is evidence that forest fires sweep the country intermittently every few decades. A few isolated spots of virgin forest remain south of McVicar lake and northwest of Lang lake. The northern part of the area between Baggy lake and Upturned Root lake has not yet recovered from a devastating fire that swept the country a few years ago. Forest fires have recently swept the Morris and Baggy Lake sections leaving scarcely

any green timber. The tree stubs still stand on the otherwise bare granite ridges, displaying a most desolate picture of the ravages of forest fire. The potential wealth in timber lies to the south of the area rather than to the north.

During the season, the Ontario Forestry Branch established a flying base and radio station on a point on the south shore of Kapikik lake in the Cat river. This will give more adequate protection to valuable tracts of timber in this area.

Good soil, suitable for agriculture, is almost entirely absent. Occasionally arenaceous clays. The mantle material is largely sand and gravel of glacial origin.

There are no waterfalls in the area of sufficient size to produce electric power.

Fish and Game

The lakes and rivers are well stocked with the usual types of fish, namely, pike, pickerel, perch, suckers, and whitefish. There are no clear-water lakes; hence the trout does not occur. The Indians have built many weirs along their routes of travel to insure them of a fresh supply of fish.

The small fur-bearing animals are becoming scarce, but big game is still fairly plentiful. During the summer, members of the party saw the following fur-bearing animals: black bear, rabbit, skunk, beaver, mink, ermine, wolf. No doubt others of the more timid types, such as fox, lynx, and otter, can be taken.

It is noteworthy that the larger game, moose and deer, are much scarcer here than 100 miles to the south. Especially is this true of deer, only four being seen during the entire summer, probably because of the character and scarcity of food. This latitude may be regarded as the northern boundary of a zoological province for moose and deer and the southern boundary of a zoological province for caribou, which are occasionally seen this far south.

Waterfowl nest here in great numbers, while the ruffed grouse and partridge appear to be less numerous than usual. This latter fact may be only a seasonal characteristic and contrary to the rule.

Mapping

The Lake St. Joseph aerial map-sheet, published by the Topographical Survey of Canada, was used as a base on which to plot the geology of the map that accompanies this report. The aerial sheet was correct in all except a few minor points, and the extraordinary detail is to be commended.

The map extends to Dobie's meridian and base line on the east and north, respectively, and to a line just east of Cat lake on the west. A large part of the work in the outlying areas was simply a reconnaissance, done largely from the canoe. An attempt was made to show some of the main topographic features along the routes, but this must be regarded as sketch work. In the schist belt, traverses were run at regular intervals across the strike of the rocks by pace and compass methods. The presence of many small lakes greatly increased the accuracy of mapping, since they served as fixed points to which traverses could be tied.

GENERAL GEOLOGY

The consolidated rocks of this area are all pre-Cambrian in age, and consist of intrusive, extrusive, and sedimentary types. The extrusive rocks form the basement schist series and are commonly known as greenstones

because of their highly metamorphosed nature. They occupy a synclinal basin, roughly rectangular in shape, extending from the west end of Lang lake to the portages leading from the Gitche river to Dobie lake, and some distance east. The total length is more than 25 miles, and the maximum width is about 5 miles. The series is completely surrounded by great masses of granite, and smaller bosses occur within it. Gabbro-diorites and amphibolites of pre-granite age probably form as much as 40 per cent. of the total schist area. Sediments of great thickness occur at Cannon lake and to a lesser extent on Lang lake. Diabase dikes, so common in most pre-Cambrian areas, are completely absent.

A great unconformity exists between the consolidated rocks and the more recent sands and gravels of the Pleistocene. No rocks of Paleozoic or post-Paleozoic age occur *in situ*, but limestone float, presumably transported by the glacier from the Paleozoic areas to the north, was seen.

The following table indicates the chief types of rock and their probable age relationships:—

QUATERNARY	
RECENT:	Sand beaches, peat, and other organic deposits.
PLEISTOCENE:	Glacial sands and gravels.
	Great unconformity
PRE-CAMBRIAN	
POST-ALGOMAN:	Trachyte dikes, lamprophyre dikes, and other basic dikes.
	Intrusive contact
ALGOMAN:	Older granite, younger granite, feldspar porphyry.
	Intrusive contact
PRE-ALGOMAN:	Gabbro-diorite and gabbro porphyrite.
	Contact not observed
TIMISKAMING (?):	Conglomerate, greywacké, quartzite, paragneiss.
	Slight unconformity
KEEWATIN:	Altered basic lavas, acid lavas, and their schistose derivatives, iron formation, conglomerate, slate.

Keewatin

The Keewatin rocks are the oldest in the area. They are essentially a much sheared and metamorphosed series of basic and acidic volcanic lavas, some of which can scarcely be recognized except by analogy with rocks of a similar nature. Their volcanic origin is strongly suggested by ill-formed pillow structure and the general scoriaceous nature of the surface.

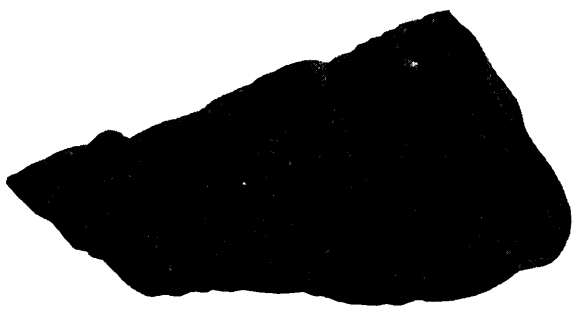
Basic Lavas

These rocks, commonly known in the field as greenstones, consist of fine-grained andesites and basalts, their schistose derivatives, and coarse-grained to porphyritic phases. They are dark-green in colour and have a characteristic weathered surface of soft chloritic substance up to a quarter of an inch in thickness. Under the microscope they show a fine aggregate of chlorite, hornblende, and epidote.

Pillow structures are fairly common as in many other parts of Ontario, but there was no place suitable for their study with a view to learning the tops and bottoms of the flows. As a rule they are so ill-formed that they scarcely suggest pillows at all. This fact indicates that these lavas flowed over the surface rather than beneath the water. In several of them good amygdules are seen, some completely filled with quartz, others only partly so. On the north shore of the largest island in the eastern part of McVicar lake an amygdaloidal andesite occurs. This rock has a pitted appearance due to the weathering out of the amygdaloidal substance, making it par-

ticularly conspicuous. Directly north from this island, on the mainland, and on the north shore of Lang lake near the creek flowing from Boyes lake, the lavas are characterized by a great abundance of quartz blobs, which are almost chalcedonic in aspect. These structures are irregular or almond-shaped, sometimes an inch or more in length, and arranged in a parallelism that is accentuated by the shearing of the rock. Owing to differential weathering the soft basic material wears away, leaving the surface quite rough. The upstanding blobs are in turn worn down to a common plane and usually show glacial scratches on their hard but otherwise smooth surfaces. These are not amygdaloidal rocks and differ from the rhyolite agglomerate mentioned below. They are known as basic volcanic fragmentals or agglomerates and have a pyroclastic origin.

A peculiar type of spotted lava[1] occurs at several places, notably to the north of the Smith-Watson group. It consists of a fine-grained basaltic rock, with many round light-coloured spots of various sizes up to an inch in diameter; two or more often unite to form a patch of considerable size. The rock weathers to an earthy green colour, the light spots standing out



Specimen (natural size) of "variolitic" lava from the northern part of the Smith-Watson group.

in high relief. The microscope shows that hornblende is the principal constituent of the rock, but the crystals are smaller and fewer in the light-coloured spots than in the darker spaces. The remainder is so fine-grained and altered as to preclude certain identification of any other mineral except calcite. It is thought that these spots are of secondary origin in the upper vesicular portion of a basaltic lava flow, and somewhat akin to amygdaloidal structure. This rock is similar in appearance to variolitic lava[2] seen by the writer at the Potterdoal mine, Munro township, and to specimens from the Amulet mine, Quebec, where it is known as dalmatianite[3] or spotted dog. Thin sections of the latter show that the spots may be composed of either fine-grained quartz, single crystals of cordierite with inclusions, or hornblende needles. It is therefore concluded that the spotted lavas here stand in close relation to the hornblende varieties of dalmatianite found elsewhere and that they have a common origin. In Quebec, some economic significance has been attached to this rock, but it would appear that no such importance is to be placed on a similar type found here.

The basic lavas throughout the area are characterized by coarse-textured and porphyritic phases, resembling gabbros or diorites. They are often found to grade from a fine-grained basalt to a coarse gabbro within short distances, sometimes not more than a few inches. This led to consider-

[1]For want of a better term, "variolitic" lava is retained on the map. Strictly speaking, the term suggests a spherulitic or radiating structure that is not present in this rock.
[2]T. L. Gledhill, Ont. Dept. Mines, Vol. XXXVII, pt. 3, 1928, pp. 39, 51, 52.
[3]H. C. Cooke, Geol. Surv. Can., Sum. Rept., pt. C, p. 41, 1925.

able difficulty in mapping, owing to the fact that one outcrop might be typical basalt with pillow structures, while the next would be partly gabbro. This variance in texture is somewhat difficult to explain. The lower parts of the flow would cool more slowly than the upper, and consequently have a coarser texture. This would account for the gradation from fine to coarse grained types on a large scale, but often there appear to be small centres of gabbro crystallization within the fine-grained basalt, quite independent of its position in the flow. An outcrop on the west shore of Shonia lake, just above the portage, shows this feature very well.

Hornblende is developed to an extraordinary degree in every type of basic rock, and many of them are composed almost entirely of this mineral. These rocks are known as amphibolites. On the freshly broken surface they show many dark-green to black glistening crystal faces of hornblende. Sufficient evidence was gathered to show that amphibolite is the alteration derivative from basic Keewatin lava and is due to recrystallization processes attending the granitic intrusions, with consequent development of heat and pressure. Whenever these rocks were found at some distance from a known granite intrusion, it was assumed that granite was not far beneath the surface. The widespread occurrence of this rock, north of Lang lake, on McVicar lake, and on the Gitche river, is evidence that the whole greenstone basin is shallow and underlain by granite masses; this has a considerable bearing on the economic possibilities mentioned below.

Many of the fine-grained greenstones have been silicified to a large degree. The silica, derived from granitic intrusions, is secondary after the consolidation of the lava. These siliceous rocks are not uncommon and occur widely on the shore of Lang lake, between the eastern part of McVicar lake and Andy lake, and south of the Gitche river.

Serpentine is a minor constituent in most of the basic rocks, but assumes massive proportions at the southeast corner of the second largest island in the eastern part of McVicar lake. It is thought to be a further alteration after amphibolite.

Acid Lavas

The rocks in this group are chiefly rhyolites and rhyolite fragmentals. The former is a hard fine-grained rock, usually yellowish-green in colour but sometimes black. It breaks with a good conchoidal fracture, and gives the characteristic resonance when struck with a hammer. The surface weathers dark-grey and shows the rough fractures common to this rock when it has been subjected to shearing stresses. The megascopic specimen often shows scattered phenocrysts of quartz. In the field, it so resembles a greenish quartzite at Cannon lake that it might easily be mistaken for it, except for the fact that flow structures are indicative of its volcanic origin.

Rhyolite fragmental occurs at the southeast corner of Lang lake. It can be traced from some distance along the strike and grades into pure rhyolite to the south of it. It is composed of rounded to elongated fragments of rhyolitic material or almost pure quartz, sometimes as much as an inch in length, placed in a darker matrix of rhyolite. The fragments are squeezed out in the direction of the shearing, being rounded at one end and tapering toward the other. They are white and stand out prominently on the weathered surface. The fragmental rhyolites are considered to be acidic extrusions at times of great volcanic activity. They are common to the pre-Cambrian rocks of Ontario.

The rhyolites are not nearly so extensive as the basic lavas. The principal belt extends from Andy lake westward across the Goodfellow group of claims to the chutes joining Lang lake with Shonia lake. Westward there are a few low scattered outcrops extending to the Dumond group, where they are cut off by the granite. On both the north and south shores

of the western part of McVicar lake narrow bands of rhyolite are interbedded with greenstones. At one point on the north shore, an irregular ankerite vein, a foot wide, cuts the rhyolite and gives rise to a prominent gossan zone. Other outcrops of rhyolite occur along the Gitche river between the eastern part of McVicar lake and Cannon lake. It is now largely sericite schist, sheared at N. 75° E. and dipping slightly to the north.

Schists

The Keewatin rocks have all been subjected to severe shearing stresses and gentle folding. They are sheared at N. 80° E., with minor variations, and stand almost vertical. The basic and acidic lavas are equally well sheared, giving rise to chlorite and sericite schists, respectively. The green colour of the rhyolite is largely due to the development of sericite along planes of movement.

Carbonate Rocks

Massive carbonate rocks are comparatively rare in this area. One outcrop, on the south shore of Cannon lake, shows where the calcite has been weathered out, giving the surface a pitted appearance. Minor carbonization is found in nearly all the sediments in the form of calcite. The ankerite veins on the western part of McVicar lake have been mentioned above. Ankerite is also the common carbonate in the quartz stringers of the altered granite, which will be referred to later.

Iron Formation, Conglomerate, Slate

Two narrow parallel strips of typical banded iron formation occur on the northeast shore of Lang lake, interbedded with conglomerate and amphibolite. They are somewhat lens-shaped or discontinuous, and sometimes attain a width of 12 feet. One could be traced for a few hundred feet, gradually becoming narrower and finally giving out. Associated with this termination were several small pebbles and one large boulder, clearly indicative of sedimentary conditions. Except for this scanty but nevertheless certain evidence, this rock would never be regarded as other than a fine-grained amphibolite. Coarse amphibolites stand close by. The strips follow the usual strike of the greenstones at N. 80° E. and dip at high angles to the south. Other bands occur near by in the lake as shown by the strong attraction in that direction. In the drift-covered areas to the north of Lang lake and Andy lake strong attraction was noted in several places, due no doubt to similar bands of iron formation. Another outcrop was noted on the south shore of a small lake southeast of the mouth of the Gitche river.

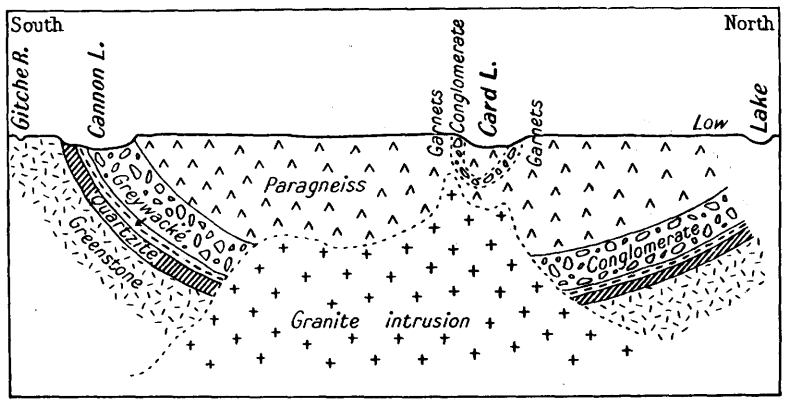
The banding consists of thin alternating layers of silica and magnetite, not more than a quarter of an inch in width but usually much less. The silica bands, formed of either jasper or chalcedony, stand out on the weathered surface in a manner characteristic of this rock. Minor subsequent movements fractured it slightly, allowing the introduction of sulphides along fracture planes. No quartz veins cut this formation as far as observed.

Directly opposite the iron formation, on the south shore of Lang lake, there are low outcrops of greenish to dark-coloured slate; this rock is also regarded as Keewatin in age, although there is no means of proving this point. It would, however, appear that the slate is intercalated with volcanics, which outcrop very close to the south. The slate is well banded in light and dark shades of green, the individual layers varying up to an inch in width. Certain layers are marked by the development of pyrite cubes, while others are absolutely devoid of them. The beds strike at N. 80° E. and dip at high angles to the north. From these facts it is assumed that the east arm of Lang lake is largely underlain by sedimentary rocks of Keewatin age.

Timiskaming(?)

A great series of sedimentary rocks at Cannon lake is considered to be Timiskamian in age, although there are scarcely any facts to support the conclusion other than analogy to similar rocks in other areas.[1] There is a remarkable scarcity of contacts with the Keewatin, and the Algoman granite was not observed in intrusive contact with the sediments, although a more careful search to the north might reveal this relationship. The great development of garnet indicates that igneous rocks are not far below the surface. At one point on the west side of Cannon lake the Keewatin-Timiskaming contact is exposed for a few hundred feet. The unconformity appears to be slight and much less marked than in other parts of the province. Although an attempt was made to pick up the contact farther west, low ground always intervened.

The sediments, all of which are exposed on the shores of Cannon lake, show a remarkable sequence from the south to the north. They are composed of quartzite, greywacké, conglomerate, and paragneiss, in order of



Theoretical section to show sequence of Timiskaming sediments between Cannon lake and Card lake.

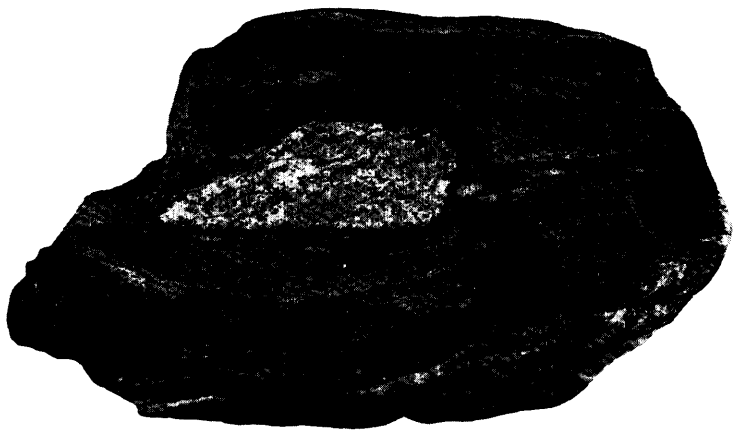
deposition. The beds strike slightly north of east and dip at very high angles to the north; local variations are due to close folding and other structural features that were not studied in any detail. The quartzite lies unconformably on the Keewatin. It is a fine-grained, yellowish-green rock resembling to a marked degree the rhyolite on Lang lake, but the microscope shows that it is a true quartzite, composed largely of a fine matrix of quartz grains with subordinate amounts of hornblende. Greywacké lies between the quartzite and the conglomerate. It was not possible to observe the contacts with these rocks owing to the heavy overburden. It is a dull-grey fairly coarse-grained rock with alternating bands of hard and soft material. The waves wash away the soft layers and leave the siliceous ones standing as much as 6 inches above the general level.

The main conglomerate band is about 12 chains wide and at least 3 miles long. It is in the nature of a basal conglomerate composed of water-worn boulders and pebbles of granitic, rhyolitic, and basic rocks in a dark matrix of impure quartzite, the whole of which has been subjected to considerable metamorphism. The larger boulders are as much $2\frac{1}{2}$ feet in diameter at the base, but toward the top (i.e., toward the north) they become smaller. The microscope shows that the matrix is composed of fine-

[1]E. S. Moore, Keewatin-Timiskaming Boundary, Bull. Geol. Soc. Amer., Vol. 40, Sept., 1929, pp. 547-556.

grained quartz with much hornblende, actinolite, biotite, magnetite, and calcite. Often the magnetite is so concentrated as to show spots with strong local attaction.

Outcrops of rock are very scarce north of Cannon lake, owing to drift and low ground. Nevertheless sufficient information was gathered to show that the conglomerate grades into a typical paragneiss. This rock is well exposed on Card lake. It is composed of thin layers of sugary quartz and biotite, giving it a distinctly gneissic appearance. On the south shore of the lake small red garnets are developed in great numbers, the surface being literally covered with them. Pebbles and small boulders occur in the paragneiss on both the north and south shores. Since some are angular, it would appear that they have not been transported far. They are probably intraformational in origin. Other outcrops are composed chiefly of



Specimen (natural size) of paragneiss from the north shore of Card lake, showing typical banding and garnets above and below the pebble.

quartzite, with flecks of mica here and there, but lacking the gneissic appearance.

The total thickness of this series is estimated at 13,000 feet, but this figure may even be exceeded if the series continues beneath the low ground to the north. Lack of time prevented the further exploration of this interesting part of the area.

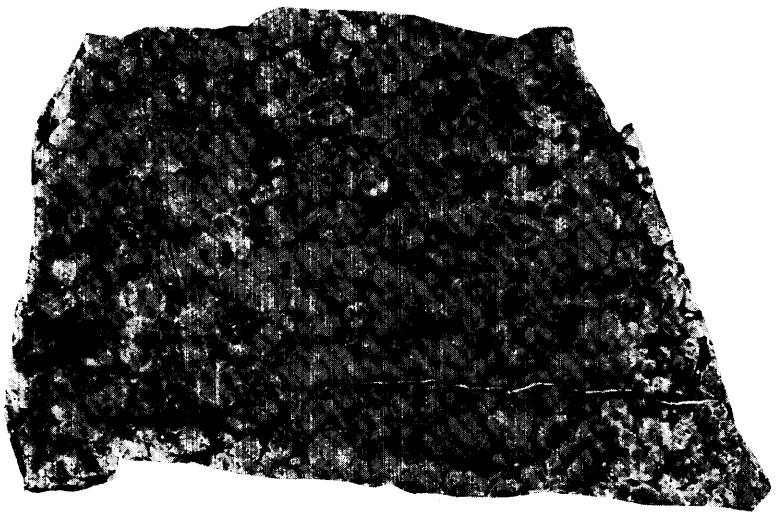
Pre-Algoman

Small bosses and dikes of igneous rock occur at many places in the area. The former are referred to as gabbro-diorite and the latter as altered gabbro-porphyrite.

Gabbro-diorite occurs along the north shore of the western part of McVicar lake, on the Dumond claims, and on the Smith-Watson claims. As mentioned above, some difficulty was encountered in distinguishing this rock from the coarse-grained varieties of the Keewatin. On this account there may actually be more of this type of rock than has been indicated on the accompanying map. The absence of pillow structures was used as one criterion with which to make the differentiation, but this cannot be relied upon since the presence of these structures in the coarse Keewatin rocks is often the exception. Evidence of the pre-Algoman age of the gabbro-diorite was seen on the Dumond group, where blocks of it were caught up in the later granite intrusion. The relationship to the Timiskaming can only be surmised, since these rocks are widely separated in the area.

The microscope shows that the rock is composed of severely altered plagioclase feldspars, hornblende, augite, epidote, and chloritic substances. Very often augen quartz can be seen, and the rock is known as quartz gabbro or quartz diorite.

At many places an extraordinary type of basic dike rock intrudes the greenstone or gabbro. It is coarsely porphyritic, with large phenocrysts of light-greenish porcelain-like feldspars in a dull-green matrix. It has a striking appearance and differs from any rock previously seen by the writer



Specimen (natural size) of altered gabbro-porphyrite near No. 6 showing of the Smith-Watson group.

in the field. The fact that it occurs widely in the area shows that it is of more than passing geological interest. The results of chemical and microscopic studies indicate that this rock is an altered gabbro-porphyrite.

An analysis of gabbro-porphyrite from No. 6 showing of the Smith-Watson group, made by W. K. McNeill, Provincial Assayer, is as follows:—

Chemical composition		Theoretical composition (norm)	
	per cent.		per cent.
Silica	45.75	Calcite	1.40
Alumina	26.02	Corundum	1.53
Ferrous oxide	3.64	Ilmenite	.15
Ferric oxide	1.33	Magnetite	1.85
Phosphorus pentoxide	.01	Orthoclase	3.89
Titanium oxide	.12	Albite	21.43
Manganese oxide	.05	Anorthite	53.93
Lime	11.67	Serpentine	14.46
Magnesia	4.11	Water	1.85
Soda	2.42		
Potash	.66	Total	99.49
Carbon dioxide	.59		
Water (+)	3.58	Plagioclase	75.36
Water (−)	.06	Serpentine	14.46
Sulphide of iron (FeS_2)	.13		
Total	100.14		
Specific gravity	2.977		

The above chemical and theoretical analyses indicate that this rock was originally a gabbro-porphyrite, containing as much as 75 per cent. of a variety of labradorite feldspar close to anorthite and 15 per cent. pyroxene. The remainder was composed of subordinate minerals. The microscope now shows that the phenocrysts of labradorite have been completely altered to a fine aggregate of chlorite, zoisite, grossularite, collectively known as



Photomicrograph of gabbro-porphyrite showing the alteration of a phenocryst to saussurite (dark) and the serpentine-chlorite matrix (light). (×30.)

saussurite. The serpentine that makes up a large part of the matrix was derived either directly from the pyroxene, according to the following equation,

$$\underset{\text{Diopside}}{3MgCaSi_2O_6} + 3CO_2 + 2H_2O = \underset{\text{Serpentine}}{Mg_3H_4Si_2O_9} + 3CaCO_3 + 4SiO_2$$

or it was preceded by the uralitization of the pyroxene to amphibole. The chloritic substance is so intimately associated with the serpentine that neither can be distinguished with ease under the microscope. Nevertheless, the great excess of serpentine is indicated on the surface where the white-weathering material from it usually pervades the rock.

Gabbro-porphyrite was exposed by stripping on No. 6 showing of the Smith-Watson group. It consisted of two parallel dikes, each about 10 feet wide, cutting the greenstone. Other outcrops occur on a small island at the extreme west end of Lang lake, locally on the Dumond claims, and at several places in the eastern part of McVicar lake. Some of the islands here show a variety that appears to be fresher and less porphyritic than is usually the case. It is almost completely composed of greyish-blue plagioclase feldspar of the labradorite variety.

This rock is thought to be of pre-Algoman age, and a late phase of the gabbro intrusion. As far as could be ascertained it did not cut rocks younger than the gabbro. Evidence of a fragmentary nature further supports this conclusion. A large slab picked up in some debris showed a stringer of granite with an inclusion of gabbro-porphyrite, indicating its earlier origin. As with the gabbro proper, the relation of this rock to the Timiskaming sediments is not known.

Algoman

Rocks of Algoman age are widespread in this area. The greenstone belt is surrounded for many miles by gneissic, porphyritic, and massive varieties of granite, and several small bosses of a fresher type approaching a granodiorite occur within it.

Older Granite

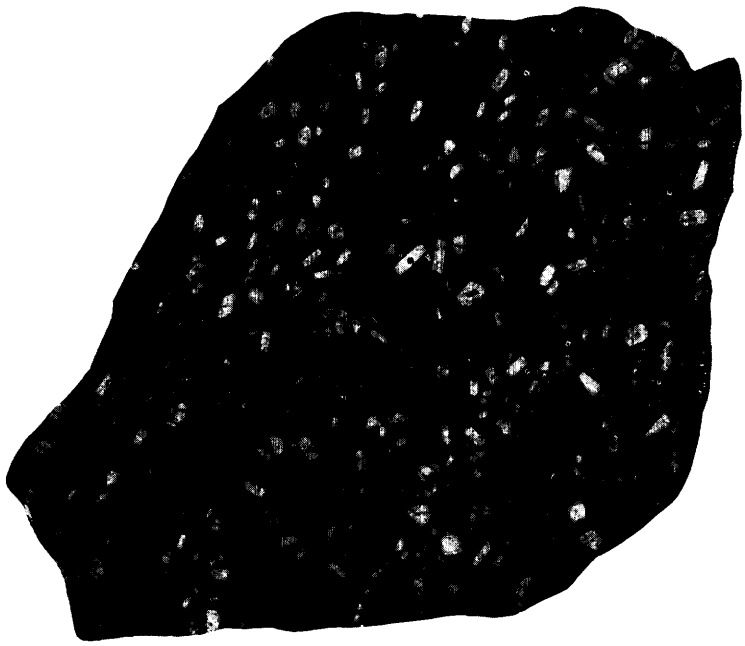
South of Sor lake, near the contact with the greenstone, the granite develops a gneissic and porphyritic arrangement that is more or less characteristic of this contact throughout the whole area. It is composed of small pinkish-white phenocrysts of feldspar, biotite, and abundant blobs of quartz, all oriented in one direction; this accounts for the banded or gneissic appearance. At the west end of Lang lake, dikes of granite interfingering with the greenstone are sheared and contain much assimilated basic material. The granite on Bertrand and Gitche lakes varies from the massive to gneissic type with the development of either hornblende or biotite. *Lit par lit* injection, narrow bands of mica schist, discontinuous aplite and pegmatite dikes up to 4 feet in width, characterize this granite. The same can be said of the granite on Baggy lake, Morris lake, and the Otoskwin river. In addition, sheeted granite and granite with large phenocrysts of pink or grey feldspars occur south of Upturned Root lake and on the south shore of Stoughton lake.

Younger Granite

Small bosses of granite occur on the Dumond claims between Sor lake and Lang lake, on the peninsula between Shonia lake and the eastern part of McVicar lake, and south of this. These are of some importance since the mineralized quartz veins on both the Dumond and Smith-Watson groups are associated with an altered phase of this intrusive. It differs so much from the granite surrounding the greenstone area that a difference in age is quite apparent. The former is considered to be younger but as still belonging to the Algoman period of intrusion. It is a fresh-looking rock with abundant pink and white feldspar, quartz, and hornblende, and tends to be porphyritic in places. The microscope, however, shows that it is not as fresh as it appears, the feldspars being much clouded with alteration minerals. There is some variation in colour from place to place, especially near the contact with the basic rocks, where there has been an assimilation of the basic material. In this case, the rock appears more like a granodiorite than a granite. The following analysis, by W. K. McNeill, Provincial Assayer, of a type specimen from a point just east of No. 1 showing on the Smith-Watson group, places it in the granodiorite class.

	Per cent.
Silica	61.80
Alumina	16.33
Ferrous oxide	2.67
Ferric oxide	2.26
Phosphorus pentoxide	.40
Titanium oxide	1.26
Manganese oxide	.10
Lime	7.85
Magnesia	1.63
Soda	4.05
Potash	.58
Carbon dioxide	.08
Water (+)	.94
Water (−)	.02
Sulphide of iron (FeS_2)	.10
Total	100.07
Specific gravity	2.977

Altered granite is a part of the main intrusive and grades into it. It is usually light-green in colour, but iron compounds often give it a reddish to brown appearance. It is especially characterized by the great development of augen quartz, which makes up nearly 75 per cent. of the rock in some instances. The microscope shows that quartz and sericite are the chief constituents, with minor amounts of secondary siderite or ankerite crystals along fracture planes. It would appear that this rock is the result of hydrothermal alteration in the granite near the contact with basic rocks, attended by the introduction of much secondary quartz, the development of sericite, and impregnation by pyrite and carbonate.



Specimen (one-half natural size) of feldspar porphyry from a dike on the west shore of the eastern part of McVicar lake.

South of the eastern part of Gitche lake there are a few outcrops of feldspar porphyry believed to be closely related to the younger granite. The phenocrysts are yellowish-green in colour, being largely altered to epidote. They attain a length of a quarter of an inch and stand out prominently on the weathered surface, giving it a somewhat speckled appearance. Some phenocrysts of quartz were also observed in this rock.

Post-Algoman

There are a few basic dikes of post-granite age, but they are narrow and on the whole less significant than those in other parts of the pre-Cambrian. At the Smith-Watson showing, a lamprophyre dike 15 feet wide cuts the altered granite at N. 55° E. This is later than the quartz veins since it cuts them off sharply. On the south shore of the Narrows, Lang lake, another basic dike occurs. It was not picked up on the north shore because there is a fault of considerable displacement at this point.

On the west shore of the eastern part of McVicar lake, a feldspar porphyry dike cuts the granite. The phenocrysts, somewhat scattered in a basic matrix, show good zonal arrangement and some Carlsbad twinning.

The microscope shows that the matrix is chiefly composed of hornblende, epidote, and small apatite crystals, and the original orthoclase feldspars are largely clouded with alteration minerals. The rock is close to trachyte in composition. Small cubes of pyrite are common.

Pleistocene and Recent

The glacier moved over this region in a general southwest direction, covering a large portion with a thin mantle of sand, gravel, and boulders. High sand ridges occur to the south and north of the west part of Lang lake, but on the whole sand plains predominate. The area between Lang lake and Cat lake is largely a sand plain, broken only by kettle lakes, muskeg, and low rock outcrops. There was little or no evidence of stratified sands or gravels in the area.

Recent deposits consist of long sand beaches on nearly all the lakes of any size, and organic deposits in those lying on the height of land.

Structural Features

The district of Patricia is characterized by a great terrain of granite, broken here and there by small patches of greenstones and sediments that have been preserved on its floor. The greenstone belt of the Shonia Lake area is of this general character. A study of the dip and strike of the rocks indicates that it occupies a synclinal basin, with the major axis slightly north of east. The top and bottom of the lava flows could not be ascertained with any degree of certainty. The sediments on Lang lake support the theory of a synclinal basin. On the north shore they dip toward the south at high angles, and on the south shore they dip toward the north at high angles. The whole lake basin is probably underlain by sediments standing almost vertically. Similarly, the attitude of the Timiskaming sediments at Cannon lake points to the same conclusion, although based on somewhat theoretical grounds. The fact that conglomerate occurs in the paragneisses on Card lake, dipping at high angles to the south, suggests that there is a northward repetition of the series, conglomerate, greywacké, and quartzite, similar to that on Cannon lake. These rocks form the rim of the basin, while paragneisses occupy the central portions.

There appears to be little evidence of major crustal movements, with the possible exception of a fault occupying the length of Lang lake. The rocks are for the most part sheared at N. 80° E., but this varies to E. 30° S. between McVicar lake and Cannon lake. The variation is caused by a gentle fold that is well illustrated on the map by the course of the Gitche river. A complementary set of fractures at E. 30° S. appears near Shonia lake and Lang lake. On the south shore of the latter, several small drag-folds occur, some of which are on the point of faulting. These fractures are much later than the original shearing and are attributed to disturbances attending the granitic intrusion.

ECONOMIC GEOLOGY

Gold

Gold occurs at Shonia lake, but up to the present time no deposit of economic importance has been found. The original discovery on the Smith-Watson group proved to be disappointing, with the result that prospecting in the area decline.

The writer saw no gold other than that on this group; but similar conditions exist elsewhere, and its presence may be inferred.

Native gold occurs in a stockwork of quartz veins in a hydrothermally altered granite. It is associated with pyrite and subordinate amounts of other sulphides. The gold solutions appear to have been introduced by the intrusion of the younger granite and to have followed the quartz in the altered portions. The mineralization occurs in both the wall rock and the quartz, but it is usually more extensive in the latter.

The country rock is all more or less mineralized with pyrite, but there appears to have been a general lack of conditions favourable to the deposition of gold. Quartz veins are abundant in almost every type of rock, but they are small, irregular, discontinuous, and for the most part quite barren. They are thought to be the last phase in the differentiation of the younger granite.

There are several factors that have a bearing on the possibilities of finding gold in this area: (1) Gold was found at one place only, and here the values were not promising. (2) The concentration of sulphides is nearly always associated with altered granite, a type of rock in which one would not expect to find gold in paying quantities. (3) There is a general lack of structural "breaks" and shear zones, suitable for the deposition of gold. (4) The great number of barren quartz veins points to the general scarcity of mineralizing solutions. (5) Much of the greenstone is recrystallized to amphibolite, testifying to the shallow nature of this belt of rocks and to the proximity of the underlying granite. It is possible that veins, which may have been of value, located higher up on the granite batholiths, have since disappeared during the processes of erosion. The veins of low value near the base of the batholith intrude the shallow amphibolite rocks.

Other Minerals

It would appear that there are no other minerals of economic importance in the area. The narrow bands of iron formation on the north shore of Lang lake cannot be regarded as a source of iron or gold. Gold-bearing solutions did not penetrate them as in some parts of Ontario. Small quantities of molybdenite were seen in a quartz vein on the north shore of Lang lake. Zones of heavy gossan are common, and in some cases might bear further investigation. One of these lies on the shore of the eastern part of McVicar lake, on the line between the Smith-Watson and the Goodfellow groups. The gossan, which is several feet thick and exposed over a considerable area, appears to be due to the breaking down of pyrite in a silicified greenstone. Other gossan zones can be traced to the weathering of ankerite veins. West of Lang lake several rusty zones in sheared granite at some distance from the greenstone contact were investigated; they were of little importance.

Description of Prospects

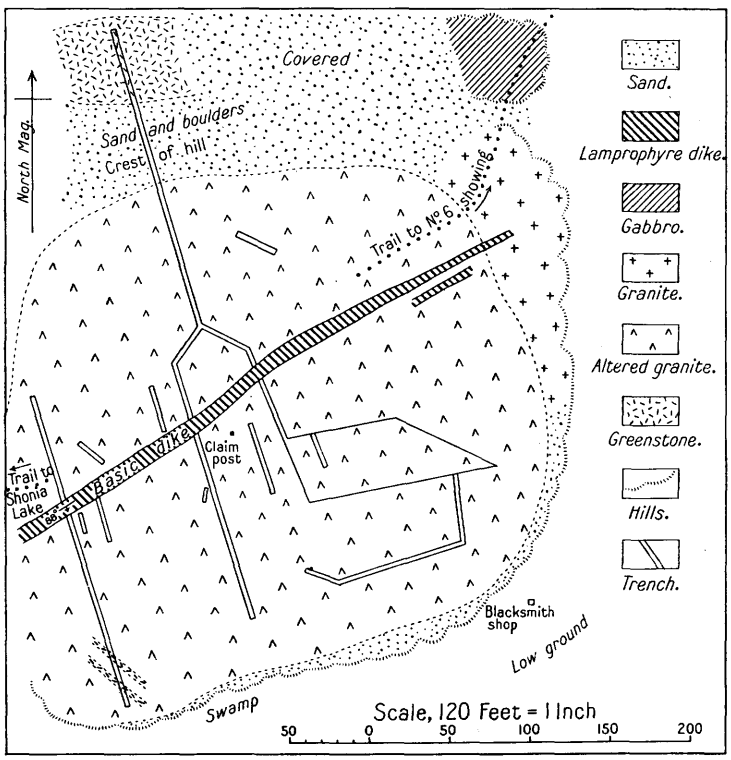
Smith-Watson Group

Gold was discovered on this group in August, 1928, by "Bill" Smith. Shortly after, the Northern Aerial Minerals Exploration, Limited, took an option on the group of 9 claims and during the winter stripped and sampled two promising showings. The results were disappointing, and in February the camp was abandoned. No further work had been done up to the time of writing.

The gold occurs in a stockwork of quartz veins in a hydrothermally altered granite. The veins range from half an inch to 2 feet in width, trend in a northeast direction, and dip steeply to the south. A lamprophyre dike 15 feet wide strikes across the hill at N. 55° E. cutting off the veins sharply. Smaller parallel basic dikes stand close by. The altered granite

grades into a fresh-looking pink granite that has been described above. Similar conditions are found about 15 chains to the northeast on what is known as showing No. 6. A well-mineralized quartz vein up to 2 feet wide was traced for several feet in the altered granite. An attempt to pick it up farther to the east was without success.

The minerals commonly associated with the gold are coarse pyrite, chalcopyrite, ankerite, limonite, arsenopyrite, and galena, in order of decreasing abundance. They usually follow small fracture planes in the quartz, but they also disseminated in the altered granite. The gold is



Geological plan showing trenches on the No. 1 showing of the Smith-Watson group. Assays gave low values in gold, ranging from a few cents to $5.40 per ton.

likewise found in the altered granite as well as in the quartz, although the values are more often higher in the quartz.

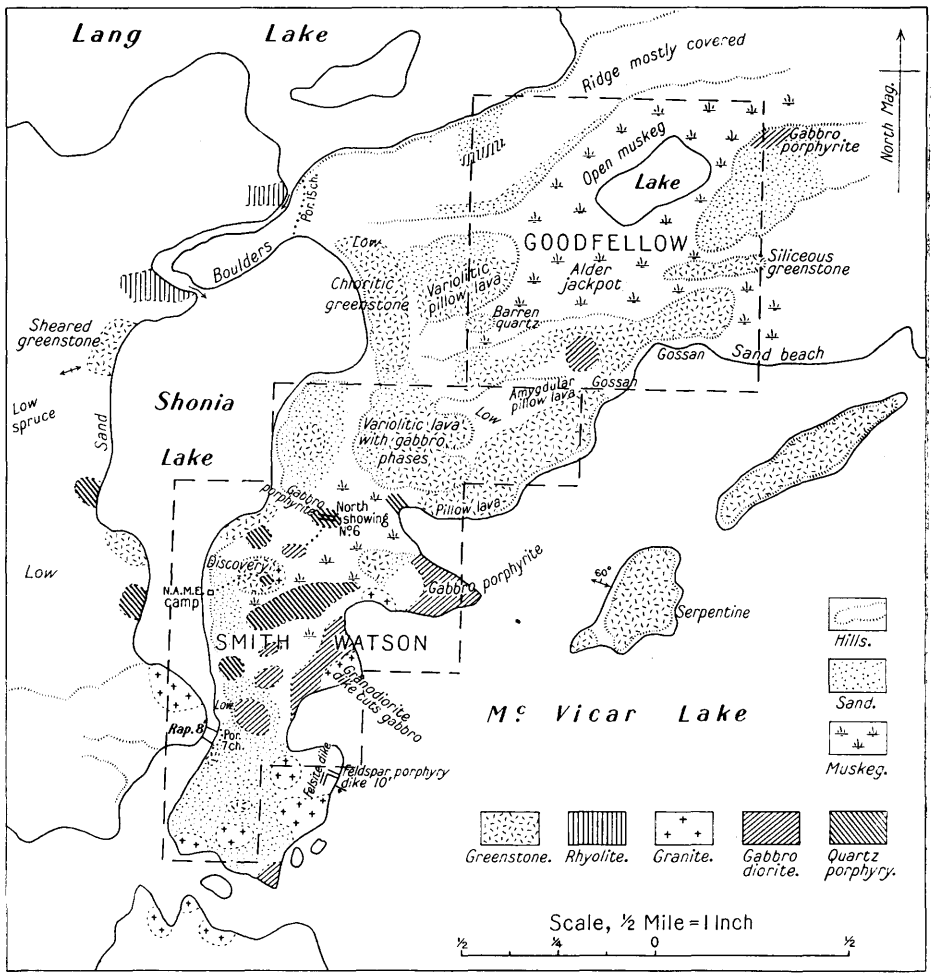
The following sketch map of the main showing indicates the consistently low values obtained from a thorough sampling by channel methods. The samples in nearly every case include altered granite with the quartz. The highest values were obtained from a pit on No. 6 showing, where one sample gave $8.60 in gold per ton over a channel length of 3 feet. Other samples from this showing gave almost negligible values. It is reported that gold can be panned from certain rusty pockets at the main showing, but this could not be verified by the writer.

Goodfellow Group

This group of 9 claims adjoins the Smith-Watson group on the north. The central part is occupied by a shallow kettle lake surrounded by muskeg.

High hills of greenstone and "variolitic" lava rise on the south and west, and a high ridge of rhyolite occupies the northern portion. Gabbro-porphyrite occurs at the north side of a high covered hill, east of the small lake.

There are many small gash veins of barren quartz; these are common to all rocks in the area and are of no importance. As mentioned above, a heavy gossan zone was seen on the south boundary of the group, on the



Geological sketch map of the Smith-Watson and Goodfellow claims.

shore of the eastern part of McVicar lake. There was no investigation of this, although it appeared to have interesting possibilities.

Dumond Group

In the autumn of 1928, A. E. Dumond staked a number of claims between Sor lake and Lang lake. Bracton Limited, of Sioux Lookout became interested in this group, which comprises 27 claims. They thoroughly prospected it and found three mineralized quartz veins. The results of sampling were disappointing, with the result that nothing further was done. This work was done under the direction of A. E. Dumond.

The veins are well defined, occupying definite "breaks" or shear zones in a reddish to greenish altered granite, a metamorphic phase of the more extensive pinkish granite in the northwestern portion of the group. The geological conditions are very similar to those on the Smith-Watson showings, with regard to the type of rock and mineralization.

The mineralization consisted of pyrite, chalcopyrite, ankerite, limonite, and pockets of galena. The writer saw no visible gold, and a grab sample from a very promising part of one vein, rich in sulphides, gave no values in gold or silver.

Beverly Syndicate

Three groups of claims, 27 in all, comprise the holdings of this syndicate. One group is located on Lang lake near the creek connecting it with Boyes lake. The rocks consist chiefly of coarse greenstones and amphibolite, with a few narrow bands of iron formation, and small rusty zones. A rusty quartz vein 3 feet wide was followed inland from the shore by stripping, but



The Dumond camp at the west end of McVicar lake.

it soon narrowed down to nothing. The other groups lie northeast of Andy lake and near the mouth of the Gitche river. The former is largely occupied by muskeg, while the latter has a few scattered outcrops of greenstone, showing nothing of interest.

Kenora Prospectors and Miners, Limited

The 72 claims prospected by this syndicate consist of several groups staked by Mosher, Radford, and others. One group lies south of the Narrows of Lang lake, and the others are somewhat scattered north of Lang lake and east of Angus lake. High hills of basalt occur on the claims at the Narrows. The other groups show few rock outcrops, being largely covered by either muskeg or sand.

Lyman Exploration Syndicate

This syndicate prospected 14 claims north of the Narrows of Lang lake. There are high hills of basalt and coarse greenstones with disseminated pyrite. A few gossan bands were seen, but they were quite small. There was little to warrant further work on this group. They also prospected 4 claims in the sediments at Cannon lake, but discovered nothing of interest.

APPENDIX

Cat River

In 1885, Thos. W. Fawcett, D.T.S., made a survey[1] of the Cat river from Lake St. Joseph to Cat lake. His impressions are as follows:—

> I had been informed several times previous to this that the route to Cat lake was a difficult one to find, and that the Indians themselves often missed the way after they had been over the route several times. This I found to be the case, as the guide had to stop and study sometimes before he would advance and would occasionally change his course. The route is made up of a succession of lakes joined by narrow channels, assuming the form of a river only at these places and for but a short distance at a time. The lakes are full of islands, and their extent could not be determined without making a survey of their shores. . . . the largest of these lakes are Black Iron [Blackstone] lake, Cross [Bamaji] lake, Quill [Kezik] lake, Smoothrock [Fawcett] lake, Gull lake, Pine [Zionz] lake, Channel [Kapikik] lake, and Cat lake. . . . The land so far as I could judge, with the exception of a little around Gull lake, was exceedingly rocky, and the water full of boulders—some round and smooth, in consequence of transportation, others angular and deposited at a more recent date or detached from some neighbouring rock. The rocks were all granitic and gneissoid; iron and mica were scattered throughout the rocks but not in such quantities as to deserve special note.

The rocks on the Cat river are largely pink and grey granite gneisses, with frequent pegmatite and aplite dikes, *lit par lit* injections, and inclusions of mica schist, which assumes massive proportions on Blackstone lake and is often more extensive than the grey granite in which it is included. The lake derives its name from the occurrence of this rock, which is a massive, jet-black, crumbly type and has been mistaken for coal by the natives.

Slate Falls

A short time was spent in the examination and delimitation of a belt of Keewatin greenstones and associated sediments, occurring at Slate falls, at the head of Bamaji lake. Wilson's report[2] on his traverse of the Cat river in 1902 mentions a belt of basic schists at this point and attaches little importance to it other than the occurrence of molybdenum in doubtful economic quantities.

The belt is $1\frac{1}{2}$ miles wide and at least 4 miles long, narrow at the east but widening toward the west. The rocks consist of greenstone, amphibolite, sericite schist, and sedimentary iron formation or quartzite. The magnetite layers in the latter gives strong local attraction. It is evident that this belt occupies a very shallow synclinal basin, since the beds on the north dip south at 45 degrees, those on the south dip north at 60 to 80 degrees, and those in the centre are horizontal. Near the Tivy camp site the beds are heaved up from their horizontal position by underlying granitic masses, and in some places these have broken through, exposing small patches of granite porphyry and feldspar porphyry, presumably of Algoman age. The rocks are highly sheared at N. 80° E. at the rapids and are now largely sericite schists. Small rusty quartz veins are common, but of little significance.

In 1927, Philip Tivy staked several claims on a west bay of the Cat river above Slate falls. When visited, the camp was abandoned, but there was evidence that a great deal of work had been done in stripping, cross-trenching, and shooting into a promising-looking quartz vein that was traced for more than half a mile to the point where it dipped into the low ground to the west. A good trail leads from the camp site to the main showing. The vein is 3 feet wide in places but often narrows to a few inches. It strikes directly east and dips at high angles to the north. It occupies a sheared zone in the Keewatin rocks, 6 to 10 feet wide. This zone is now

[1]Thos. W. Fawcett, op. cit.
[2]A. W. G. Wilson, op. cit., p. 19.

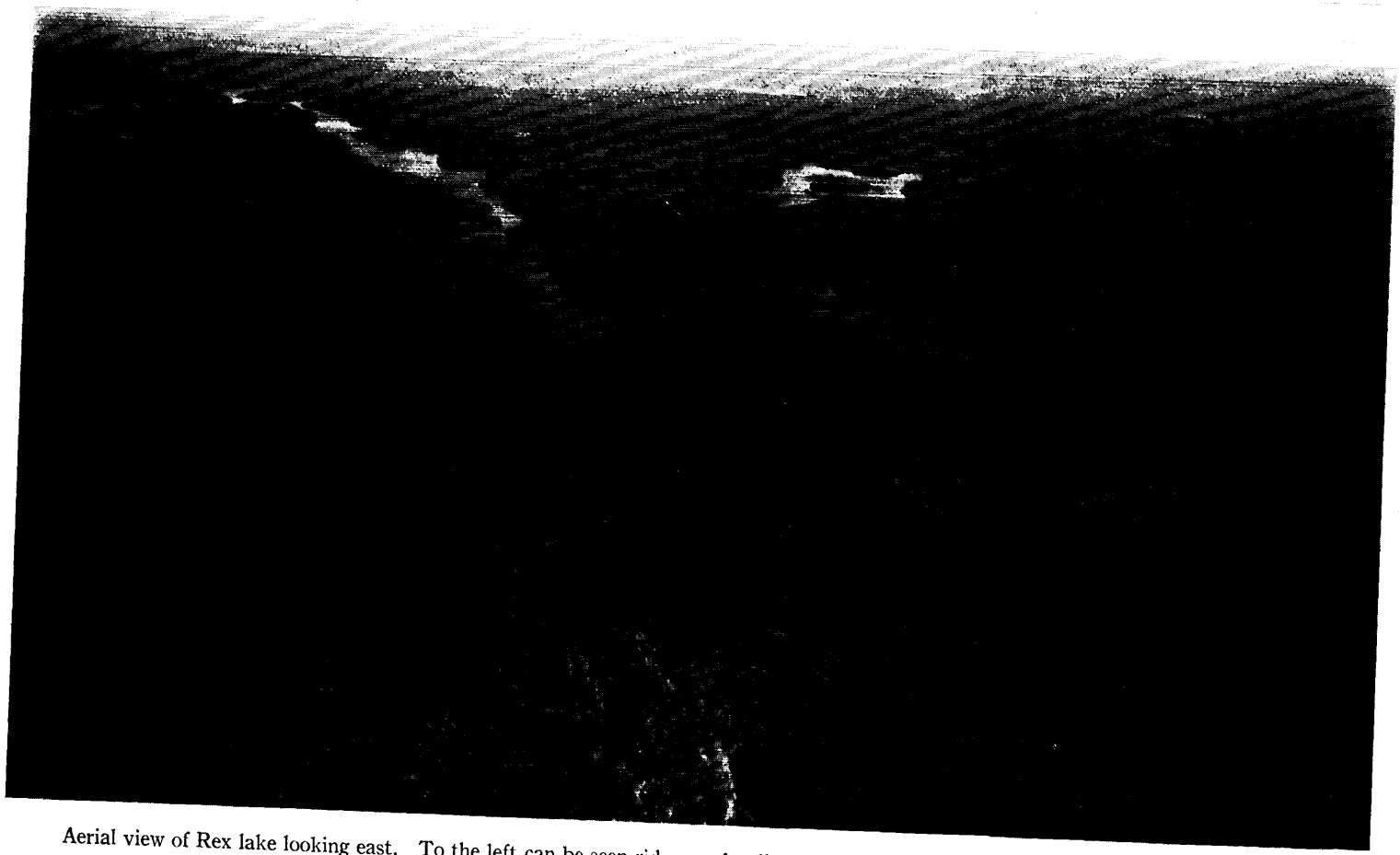
largely a soft iron-rich gossan; in places it has been removed with a shovel, leaving the vein standing 2 feet above the general level. A 20-foot pit has shown the downward extension of the vein. The country rock is largely basalt or amphibolite. An intrusion of greyish feldspar porphyry stands close to the vein at one point.

The vein is well mineralized with pyrite, chalcopyrite, and pockets of sphalerite, and these extend into the wall rock for some distance. A grab specimen from a promising section gave no values in gold or silver. The copper and zinc are not present in economic quantities.

At the camp site some work has been done on a heavily pyritized gossan zone in flat-lying rocks, probably an old quartzite. A grab specimen likewise gave no values in gold or silver.

The fact that the camp is now abandoned indicates that the results of the work were not satisfactory. Picked specimens assayed for the writer by the Provincial Assay Office gave no gold values. These features, supported by the fact that the whole belt is narrow and thought to be very shallow, points to the improbability of finding gold in economic quantities.

Photo by Topographical Survey, Dept. of Interior, Ottawa.



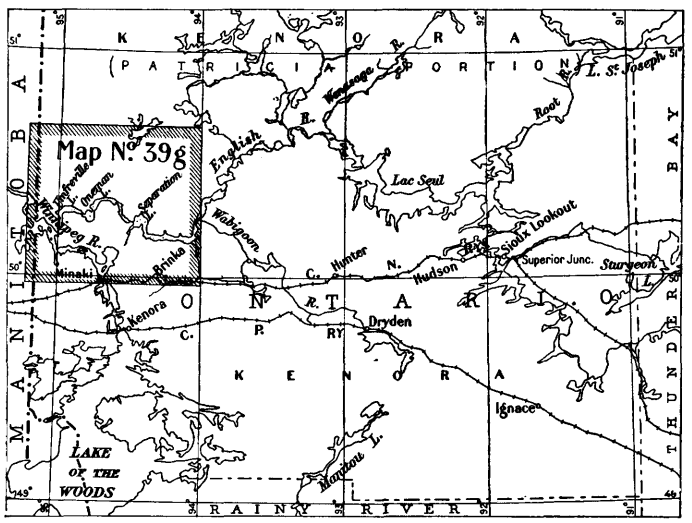
Aerial view of Rex lake looking east. To the left can be seen ridges and valleys following the strike of sedimentary gneisses and schists.

Geology of the Area from Minaki to Sydney Lake, District of Kenora

By D. R. Derry

INTRODUCTION

During the summer of 1929, a reconnaissance survey was made of the geology of the area from Minaki, on the Canadian National railway, north to Sydney lake at the head of the Sturgeon river. The area examined lies in western Ontario, the part north of the English river being in the Patricia portion of Kenora district, and that to the south in the district of Kenora proper. The western limit is the Ontario-Manitoba boundary; and the work was extended to the east as far as Ball lake (meridian 94 W.) on the



Key map showing location of the Minaki–Sydney Lake area. Scale, 60 miles to the inch.

English river. The geology was also mapped along several routes south from the English river to Minaki.

The adjoining area to the north has been described in a report by G. Gilbert,[1] and that to the east up the English river to Lac Seul, by E. L. Bruce.[2] On the west, E. S. Moore[3] first made a reconnaissance survey in 1912 from Lake Winnipeg to the Interprovincial boundary. E. M. Burwash[4] has described the geology along the Interprovincial boundary, and J. F. Wright[5] has covered the adjoining area in Manitoba in his report on "The Oiseau River Area."

[1]G. Gilbert, Ont. Dept. Mines, Vol. XXXVI, pt. 3, 1927, pp. 73-84.

[2]E. L. Bruce, Ann. Rept., Vol. XXXIII, pt. 4, 1924, pp. 1-11.

[3]E. S. Moore, Geol. Surv. Can., Sum. Rept., 1912.

[4]E. M. Burwash, Ont. Dept. Mines, Vol. XXXII, pt. 2, 1923, pp. 1-48.

[5]J. F. Wright, Geol. Surv. Can., Sum. Rept., 1924, pp. 51-104 B.

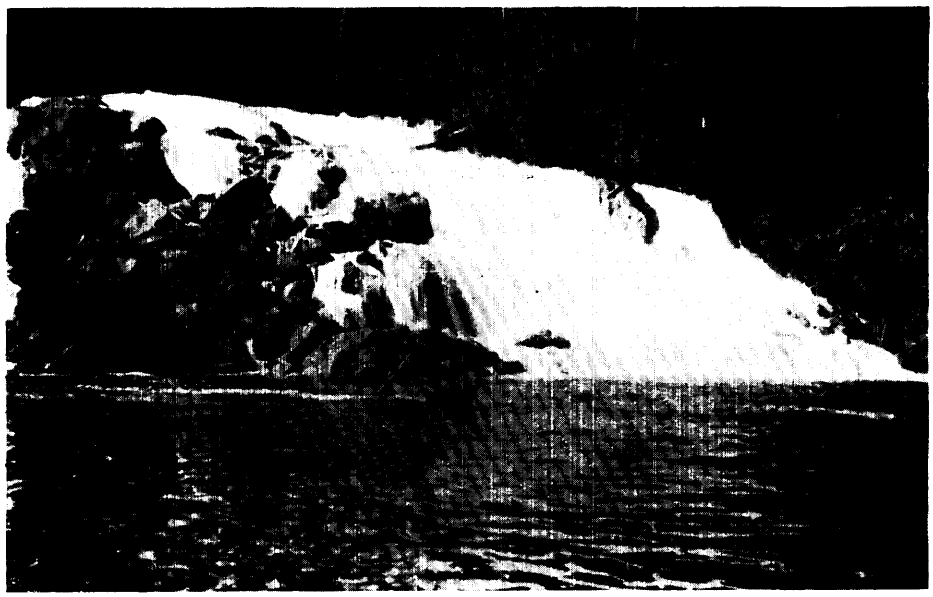
Acknowledgments

Credit is due to G. R. Gibson for excellent services as assistant in all the field work.

The writer is also indebted to the officials of the Manitoba Tin Company, Jack Nutt Mines, Limited, and Kenora Prospectors and Miners, Limited, for their hospitality and help when their properties were visited.

Means of Access

From Manitoba the district may be reached by travelling from Lac du Bonnet by the Winnipeg City Power Tramway to Pointe du Bois. From here travel is by canoe up the Winnipeg River for about 30 miles, at which



Falls on Sturgeon river, below Right lake.

point it crosses the Interprovincial boundary. The English river joins the Winnipeg river 8 miles east of this point.

The English river may also be reached from Minaki, Ont., by three routes: (1) Down the Winnipeg river to the mouth of the English river, a distance of 26 miles; there are three portages on this route, totalling 63 chains. (2) Down the Winnipeg river to a point two miles below lower Whitedog falls, and thence north through Whitedog and Goshawk lakes to Oneman lake on the English river. (3) North from Minaki across Sand lake and thence by a series of lakes and portages (totalling 125 chains) into Separation lake.

Topography

In general the country is level, but it rises gently towards the north and northeast. Sydney lake, in the northern part of the area, is 175 feet above the level of the Winnipeg river at the Interprovincial boundary. In detail the topography is rough, particularly in the region of sedimentary or volcanic rocks where sharp ridges, in places rising vertically 100 feet from the lakes,

run parallel to the general east-west strike of the formations. Outcrops are numerous in most parts, though some of the lower ground near the English river is covered with a good clay soil.

The English river, with its tributary the Sturgeon river, drains most of the area and joins the Winnipeg river just east of the Interprovincial boundary.

Lakes are exceedingly numerous, particularly in the northern and western part of the area, so that most of the reconnaissance travel can be done by canoe.

Falls are frequently caused by dikes or lenses of hard red granite cutting the faster-weathering intermediate intrusives (see photograph on page 26). They often occur also where sedimentary belts cross rivers. This is due not so much to the sedimentary material itself as to the very hard white granite that occurs abundantly, cutting the sediments parallel to the strke.

Timber

Very little timber of commercial size for lumber was seen. The granite areas are covered with a small growth of jackpine, black spruce, and birch; on sedimentary-volcanic areas, in the valleys between ridges, white poplar is abundant, though not of any great size. A few Norway and white pine were seen, apparently remnants of stands on areas that have been burnt over and since grown over with spruce and jackpine.

Game

Red deer were extraordinarily abundant in many parts of the area. It was noticed that they were most numerous on land underlain by sedimentary-volcanic rocks, probably owing to the long deep valleys in these parts, where grass grows well.

Moose were also common all over the area, and one bull caribou was seen. Black bear were seen several times. Wolves seemed very scarce, which may account, in part, for the abundance of deer.

Both spruce and birch partridge are common. The smaller varieties of duck were seen nesting along the large rivers and lakes, and the wild rice in the eastern part of the area attracts large flocks of mallards on their way south in September.

Sturgeon are very abundant both in the English and Winnipeg rivers, particularly near the falls. They were not noticed in the Sturgeon river except near the mouth. Of smaller fish, pike and suckers seem most numerous, but black bass, pickerel, and golden-eye may also be caught.

GENERAL GEOLOGY

The consolidated rocks of the area are all pre-Cambrian. These are covered in part by glacial drift, though nowhere to any great thickness or wide areal extent.

Briefly, the exposed pre-Cambrian rocks fall into two series: (1) a sedimentary-volcanic series, much folded and metamorphosed; (2) an intrusive series ranging from diorite to acid granite and pegmatite. These instrusions are of great extent and now occupy about 80 per cent. of the area. No sedimentary rocks of later age were seen. Keweenawan diabase dikes, so common in the pre-Cambrian areas of central and eastern Ontario, were not observed here.

The following geological table is suggested:—

QUATERNARY	
RECENT:	Peat. Lake deposits of clay and sand.
PLEISTOCENE:	Glacial boulder clay. Sand.
PRE-CAMBRIAN	
ALGOMAN (?): (Intrusive series)	Pegmatite and aplite. White binary granite. Red microcline granite. Porphyritic biotite granite. Grey granodiorite and oligoclase granite. Grey quartz monzonite. Brown granodiorite.
KEEWATIN: (Sedimentary-volcanic series)	Sedimentary gneiss, conglomerate beds, quartz-biotite schists, basic schists possibly of igneous origin. Basic volcanic flows. Quartzite and greywacké.

Keewatin

The sedimentary-volcanic series has been included under this name for the following reasons: Firstly, it is made up of the oldest rocks found in place in this or the adjoining areas; secondly, the lavas and some of the sediments are similar lithologically to those of the series first named Keewatin in the Kenora region. Although there is no continuous outcrop of these rocks across the 40 miles between this area and Kenora, inclusions in the granites of the same rock types occur frequently throughout the intervening area.

The similar rocks of this series across the boundary in Manitoba were first described by E. S. Moore,[1] who divided them into the Rice Lake volcanics at the base and the Wanipigow sediments above. Burwash adopted this classification in describing the geology along the Interprovincial boundary. J. F. Wright, however, mapping on a more detailed scale, could find no sharp division into an underlying volcanic and a younger sedimentary series, but held that lavas, tuffs, and sediments were interbedded in one series, with the possible exception of some of the younger sediments, which might have been deposited in a later period.

In Ontario, the present writer could identify with certainty only one band of lava, but as this lies conformably between two sedimentary beds, it seems reasonable to follow Wright in including the whole under one sedimentary-volcanic series, which has been classed as Keewatin for the reasons given above.

The sedimentary-volcanic series occurs in the area in three narrow belts. The northernmost, in which no volcanic rocks were found, runs east from Davidson lake on the Interprovincial boundary across the northwest corner of Werner lake, whence it seems to turn east-northeast, since a similar band was picked up on the Sturgeon river, just south of Sydney lake. A narrow branch runs off farther south along Rex lake and crosses the Sturgeon river six miles south of the main belt. The boundaries of these belts are poorly defined owing to the high percentage of igneous material in the form of granite dikes and lenses and pegmatitic bands forming *lit par lit* gneisses.

Another belt, consisting of volcanics and sediments, extends from Ryerson lake on the boundary eastwards through Twelnor lake, striking the English river at the north end of Oneman lake. From this point it widens, covering most of the area between the lower part of the Sturgeon river and Separation rapids on the English river, sediments lying to the north and

[1]E. S. Moore, op. cit.

lavas to the south. The belt then runs N. 60° E.; the volcanic rocks pinch out northeast of Lennan lake, but the sedimentary gneisses widen as far as they were followed. These sedimentary gneisses were picked up by E. L. Bruce along the upper waters of the English river, where they occur quite extensively.

A third, very narrow band, not more than a mile in width, was observed just north of Deer falls, near the mouth of the English river, and again on the south shore of Oneman lake. It consists of sedimentary gneiss with some *lit par lit* structure and, on the northern edge, what is probably a narrow strip of altered volcanic material. This belt may be connected toward the east with the central band, somewhere southwest of the Kettle falls.

It should be stressed that many parts of all these sedimentary belts are abundantly invaded by igneous, granitic material, which may form more



Pillow structure in andesite lava.

than 50 per cent. of the rock. Nevertheless these belts are mapped as sedimentary, as they are continuous along the strike and show no evidence of being oriented inclusions in the granite.

Volcanic Rocks

The volcanic rocks of the sedimentary-volcanic series are generally of andesitic composition, green to black in appearance. They cover a limited area, occurring as narrow, rather schisted bands interbedded with, or adjoining, the sediments. In the vicinity of Separation rapids on the English river, there is a wider area of volcanic rocks, much less altered. Here, as well as south of Ryerson lake near the boundary line, pillow lavas are well shown. Two main types of andesitic lava were noticed; a fine-grained variety, often showing pillow structure; and a coarser, more massive type, which may be a slower-cooled phase of the same material. There are also a few occurrences of a rock very rich in garnets and biotite, forming irregular bands within the lava. These rocks may represent metamorphosed tuffaceous material, as suggested by Wright in his report on the adjoining area in Manitoba.[1]

A specimen of the fine-grained variety from a point midway between Ryerson and Twelnor lakes shows, in thin section, that hornblende forms 80 per cent. of the rock, the remainder being made up of interstitial quartz,

[1]J. F. Wright, op. cit.

possibly secondary, and fine plagioclase feldspar. Magnetite grains are scattered throughout, and small apatite prisms form inclusions in the quartz and feldspar. Specimens from more schisted areas show marked parallel orientation of hornblende crystals.

The coarse variety shows, under the microscope, large, irregular phenocrysts of hornblende, embedded in a mosaic of coarse plagioclase (between andesine and labradorite), and a little interstitial quartz, in part, at least, secondary. The plagioclase contains numerous inclusions of finer hornblende. Granular titanite is quite common.

Quartzite and Greywacké

The fine-grained sediments, consisting of quartzite and greywacké, cover a very small area. They are seen in two narrow strips, between the volcanics and the intrusive granodiorite and granite, at the southern edge of the Ryerson lake–Twelnor lake belt. On a continuation of the same belt, they may be seen again near the Indian Reserve on the north shore of Oneman lake. The rocks vary from a dark-grey, cherty, fine-banded greywacké to a pure white, finely granular quartzite, which weathers rusty red, owing to the presence of fine, disseminated sulphides. Under the microscope the pure quartzite is seen to consist of a mosaic of quartz, with a small proportion of fine muscovite in roughly parallel stringers and a little fine pyrite. The darker quartzites have a small proportion of biotite in fine flakes. Finer secondary quartz occurs in stringers and pockets in most specimens.

The banded greywacké shows in thin section quartz and hornblende in proportions varying with the different bands. Biotite, calcite, and sericite are also present in small quantities.

Sedimentary Gneisses and Schists

This part of the series is far more extensive in area than the quartzite and greywacké and forms the major part of all Keewatin belts. These beds appear to be more highly metamorphosed than the quartzites and greywacké, but this appearance is probably due to a coarser original texture and the presence of clayey material having given rise to a rather large proportion of biotite.

A common type is a fine well-banded gneiss of grey or brown colour, the bands being light or dark according to the content of biotite. A thin section shows, besides quartz and biotite, albite forming about 15 per cent. of the rock. Some beds contain garnets in addition to the other minerals, and along such beds there is often replacement by sulphides, mainly pyrite and chalcopyrite, in small lenses scattered along the strike. It is in these banded gneisses that the *lit par lit* structure is most typically developed by the injection of pegmatitic stringers from half an inch to several inches in width. The proportion of the injected material may increase until the rock becomes a gneissic granite with narrow sedimentary inclusions.

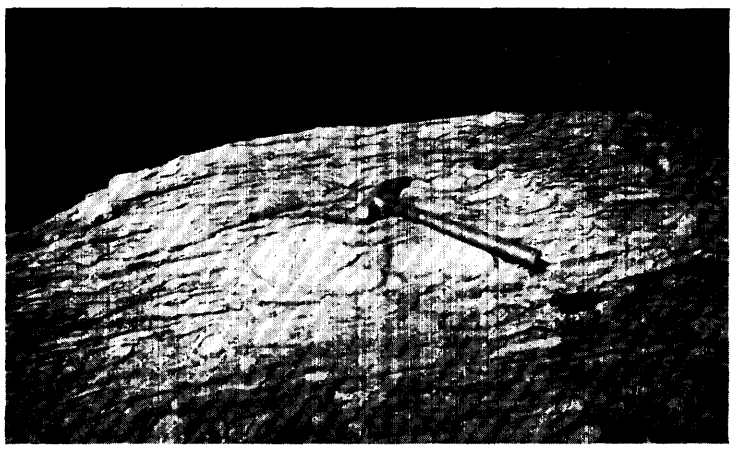
The quartz-mica schists are coarser in texture and owe their schistosity to the greater proportion and larger size of parallel flakes of biotite. Under the microscope they are seen to be of simple composition, consisting of quartz, biotite, and a little feldspar, usually microcline and albite.

A more basic schist occurs less commonly than the above-mentioned types. A representative specimen from a point on the northeast corner of We ner lake shows clear, well-formed crystals of andesine-labradorite forming about 60 per cent. of the rock, a very small quantity of quartz, colourless pyroxene partly replaced by hornblende, and biotite in parallel plates. Apatite occurs as rather large inclusions in all the other minerals. This mineral association suggests that the basic schists may have been produced by the metamorphism of a basic igneous rock.

Another rock, found only on the south side of Sydney lake at the granite sediment contact, is a yellowish to grey hornstone. Under the microscope it is seen to consist of a very fine groundmass of quartz and sericite, in which are embedded larger crystals of quartz and some albite. These larger crystals have irregular, "eaten" boundaries, suggesting that they are the only remains of the original minerals of the rock. The fine silica has probably been added from the neighbouring granite intrusion.

Conglomerate

Several bands of conglomerate have been traced for many miles in the adjoining part of Manitoba; Bruce notes a similar rock north of the eastern end of the English river. In the area under review only one occurrence was seen and that runs across the Interprovincial boundary, on the southern



Conglomerate bed, Ryerson lake.

promontory on the east side of Ryerson lake. The bed is 200 feet across the strike and was followed for about 500 feet east of the boundary. The matrix, being now a fine micaceous gneiss, is the same material that makes up the beds on either side into which the conglomerate grades by a decrease, in size and number, of the pebbles. The included material varies from small pebbles to boulders a foot in diameter. Compression of the bed has resulted in the boulders becoming much elongated in a vertical direction and slightly in a horizontal direction parallel to the strike.

Most of the boulders appear to be of igneous origin. Some 50 representative boulders were selected and listed. There are no sharply defined types, but they may be roughly classified as follows:—

	Per cent.
1. Light-grey biotite granite	38
2. Light-brown granite	12
3. Grey granodiorite	20
4. Fine quartzose rock in tabular boulders	22
5. Quartz in small pebbles	8

The origin of the rocks of group No. 4 is doubtful. They are fine-grained, consisting of quartz with a little decomposed feldspar and a few specks of biotite. There is no banding or stratification but the boulders are plate-shaped, suggesting a cleavage in the rocks from which they were derived. Owing to this feature and their fine texture, it is possible that they are highly altered sedimentary fragments. The granitic boulders are not identical with any of the intrusive rocks of the area found in place, though

in the hand specimen a similarity exists in a few cases. No boulders of volcanics were seen, but Burwash reports finding boulders of lava identical with that of the "Rice Lake volcanics" in the corresponding conglomerate beds in Manitoba.

Origin of the Gneisses and Schists

The possibility that some of these gneisses and schists are of igneous origin should be considered, as this has been suggested for similar rocks in other regions. Some of the gneisses show in thin section a crystalline structure similar to a gnessic granite. Certain features, however, have led to the conclusion that most of these rocks are in all probability of sedimentary origin. The conglomerate, which must be of aqueous, or possibly glacial origin, grades both above and below into gneisses identical with its groundmass. Gradational stages, lithologically, exist between these beds and all the more acid schists and gneisses in the area. The constancy in composition and width of the different bands when followed along the strike is also strong evidence of a sedimentary origin. In the case of the darker schists and gneisses, if a volcanic origin is postulated, it would seem unlikely that they would be so susceptible to the production of *lit par lit* structure on being intruded, a feature that was never observed in this area in the definitely volcanic rocks that have undergone exactly the same degree of compression and intrusion.

The only type that does seem to be of igneous origin is the basic schist mentioned above, which was found only over a short lateral extent in a few places. The presence of a rather basic feldspar (andesine-labradorite) and pyroxene and the low quartz content both point to an igneous origin, probably a basic sill or dike. This type, however, forms such a small proportion of the schists and gneisses that it is impossible to map it separately on a small scale; consequently the whole series has been mapped as sedimentary.

Age Relationships of the Sedimentary-Volcanic Series

The Ryerson-Twelnor-Oneman lakes belt was the only occurrence seen where the volcanics were bounded on both sides by sedimentary rocks. Here beds of fine-grained quartzite and greywacké lie in a broken narrow strip on the south border of the volcanics, with the wider band of sedimentary gneisses and schists, including the conglomerate bed, on the north side. It seems, therefore, that the lava is interbedded between two series of sediments. The difference in composition and texture precludes the possibility of the two sedimentary bands being the same beds repeated by folding. It only remains to be decided which band of sediments originally underlay the volcanics. The dip along this belt is, in general, steeply to the south, which would rather suggest that the quartzite series was on top. But in a region so highly folded this is not strong evidence. Both the northern and southern contacts of the lava with the sediments seem to be conformable. The northern contact was examined with some care on the Interprovincial boundary line, where a forest fire had exposed the rock. The volcanics appear to grade easily into the gneiss through a fine-grained pyroclastic rock showing fine banding but also much dark material similar to that in the volcanic rock. This would suggest that the lavas were earlier fine volcanic material, held in suspension at the end of a submarine eruption and deposited simultaneously with clastic material. Further evidence for the conclusion that the northern sedimentary band is the younger is afforded by the discovery by Burwash of boulders of volcanics in the conglomerate in this series on the Manitoba side of the boundary. As Wright, however, has shown in Manitoba that there were a number of interbedded flows of very similar material, even this evidence is not conclusive. Largely on structural grounds, Wright places the sedimentary gneiss and schist, including the conglomerate beds,

at the bottom, and the fine-grained sediments (which are more abundant in Manitoba) and interbedded lavas and tuffs at the top.

The floor on which the sedimentary-volcanic series was laid appears to have been entirely destroyed by the later intrusions and subsequent erosion. The only evidence we have of it is in the boulders of granite and granodiorite that occur in the conglomerate. Since the granitic rocks of the area are, wherever seen, intrusive into the sedimentary-volcanic series, these boulders cannot have originated from them. They must represent the old granitic floor, none of which remains.

Intrusive Rocks (Algoman?)

The sedimentary-volcanic series has been invaded and metamorphosed by a series of intrusive rocks ranging from diorite to acid granite and pegmatite. These intrusive rocks are widespread, now covering about 80 per cent. of the total area. The order of intrusion seems to have been regularly from basic to acid, which feature is best seen in the western part of the area where differentiation is most complete. The oldest rocks in Manitoba are ultra-basic: peridotites and amphibolites. On the Ontario side of the boundary these rocks were never found in place, but high metamorphosed remnants were seen as included blocks and lenses in the later acid intrusives.

Of the intrusive rocks in place, the following types are representative of the differentiation that has occurred.

Brown Granodiorite

A rock of this type covers a large area north of the English river on both sides of the Sturgeon river. In the hand specimen it is of medium to coarse texture, rather iron-stained, and in some places very friable. Some occurrences are basic enough to be called diorite, while others more nearly approach granite. A specimen from a point at the east end of Salvesen lake was examined in thin section, and the mineral composition calculated by the Rosiwal method. The constituents are:—

	Per cent.
Quartz	22
Oligoclase-andesine	60
Allanite (?)	15
Biotite and magnetite	3

The mineral thought to be allanite is not always so abundant, and biotite often forms a much higher percentage.

Where this rock lies near the brown sedimentary gneisses, it appears to have incorporated part of the sedimentary material while in a molten condition. In such a place, for example four miles east of Roger lake, it is very hard to draw the line between the intrusives and the sediments.

Grey Quartz Monzonite

This rock, of rather coarse texture, occurs quite frequently, chiefly in the western part of the area. One long narrow mass runs through the southern parts of Umfreville and Oneman lakes, and another through Gib lake and the middle of Oneman lake. The northern band changes to red and green granodiorite as the Interprovincial boundary is approached and to porphyritic granite at its northern edge.

Under the microscope, a specimen from the west shore of Umfreville lake was seen to be made up as follows:—

	Per cent.
Quartz	25
Albite	48
Microcline	12
Hornblende	9
Biotite	4
Apatite, magnetite, titanite	2

The biotite replaces amphibole, but otherwise there is little alteration and the minerals look quite fresh.

In the field, a curious characteristic is the "slabby" structure. This is due to parting planes, either horizontal or dipping as much as 30 degrees, dividing the rock up into slabs from a few inches to a foot in thickness. At a distance this feature gives the appearance of a well-bedded sandstone. Bruce, who found the same structure farther east, attributed it to planes of weakness being developed near the roof of the batholith, due to the com-



Contact of red acid granite with dark greenstone, north shore of Gib lake.

pression of overlying rocks during cooling. The removal of these overlying rocks by erosion, allowed the actual parting planes to develop.[1]

Grey Granodiorite

This type is found in a mass around Lennan and Ball lakes, again west of Separation rapids on the English river, and, in a rather more acid phase, around the Islington Indian Reserve on the Winnipeg river. It is usually grey in colour and often slightly porphyritic. A thin section shows fresh albite to oligoclase forming half the rock and quartz about a quarter, the remainder being hornblende, biotite, and apatite. Where quartz is more abundant the rock has been called oligoclase granite.

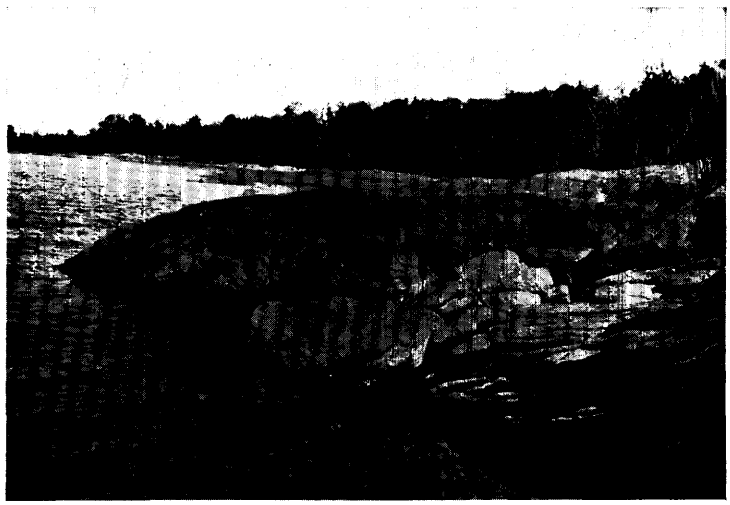
Porphyritic Granite

This type occurs most abundantly in the eastern part of the area, along the English river. In the hand specimen it is coarse-grained with large rectangular phenocrysts of pink feldspar, up to an inch in length, embedded in a grey granitic matrix. The feldspar phenocrysts under the microscope are seen to be microline, partly replaced by quartz and albite. The groundmass consists of quartz, orthoclase, albite, and biotite. Biotite and rather fine-grained quartz tend to form flow lines curving round the phenocrysts. The porphyritic granite also shows the "slab" structure, though not so well developed as in the quartz monzonite.

[1]E. L. Bruce, op. cit., p. 8.

Red Biotite Granite

This type is the latest intrusive on a large scale, occurring both in large masses and in dikes and lenses cutting earlier intrusive phases and the sedimentary-volcanic series. In the hand specimens it is red, compact, and usually of fresh appearance. It may vary locally to cream or white in colour and is sometimes gneissic, particularly near its contact with sedi-



Grey quartz monzonite showing slab structure, intruded by red massive granite, Umfreville lake.

ments. Under the microscope it is seen to contain quartz, microcline, orthoclase, albite in varying proportions, biotite, and muscovite. In the region of Sydney lake the granite is light-grey to white and rather fine grained but shows in this section much the same constituents as the red granite. Biotite is less abundant, and there is a good deal of fine recrystallized quartz.

White Binary Granite

This type was seen only as small lenses up to 500 feet in width, nearly always cutting sedimentary gneiss. It is pure white and very hard and typically consists of quartz and albite. In places it carries biotite in minute flakes and sometimes garnet. On account of its superior hardness, it tends to stand out from the surrounding rocks in sharp ridges, usually striking about east-west.

Pegmatite

Red pegmatite occurs over the whole area in dikes, sills, and lenses, usually not over 100 feet in width. The typical composition is red microcline, quartz, muscovite, and biotite. Graphic intergrowth of microcline and quartz is common. In places the pegmatite is pure white, and in such cases albite predominates over microcline. This variation may be due to assimilation of material from soda-rich country rock. Locally the pegmatite contains tourmaline, sometimes very abundant, garnet, magnetite, and in one occurrence east of Ryerson lake, antimonite. In the corresponding pegmatites a short distance over on the Manitoba side of the Interprovincial boundary, cassiterite, beryl, spodumene, amblygonite, and lepidolite have been found. These minerals were not seen in pegmatites on the Ontario side, but it is probable that a careful search would reveal some or all of them.

Red aplite dikes were seen in a few places, consisting mainly of quartz and red potash feldspar. In an outcrop between Cabin and Fletcher lakes, aplite was seen to be cut by pegmatite, both intruding brown granodiorite.

A period of mineralization, closely following the latest intrusives, is described under the section devoted to Economic Geology.

Relationships of Intrusive Rocks

All the above-mentioned types are intrusive into the sedimentary-volcanic series wherever the contacts were seen.

The brown granodiorite, the grey quartz monzonite, and the grey granodiorite were not seen in contact with each other. Relationships with other rocks, however, suggest that these three phases are of about the same age. They often contain inclusions of an earlier basic intrusive and of a basic lava. The red granite intrudes these three phases both as large masses and as numerous dikes and sills. The approach from a mass of one of the grey or brown intermediate types, to a mass of the red acid granite is usually marked by an increase in the number of dikes of the latter, which finally merge to form the whole rock. The brown granodiorite, however, may sometimes merge into the red granite by gradational stages. In such a case the red granite is usually nearest the sedimentary bands. This feature is seen on Winding river, north of Oneman lake, where the brown granodiorite occupies a belt midway between two sedimentary bands, with a border of red granite to the north and south.

The porphyritic granite seems to be the connecting link in the process of differentiation, between the grey granodiorite and monzonite on the one hand and the red granite on the other. For example, in the western part of the area, the difference between the grey quartz monzonite and the later red granite is sharply marked. But as these rocks are followed eastwards the difference becomes less definite, and at Oneman lake both merge into the porphyritic granite. The predominance of the latter in the eastern part of the area is presumed to indicate that this point was nearer the centre of the batholith where less differentiation has taken place. Rock analyses show less difference in composition than the appearance of the rocks would lead one to expect. The analyses quoted below were made by W. K. McNeill, Provincial Assayer.

	No. 1	No. 2
	per cent.	per cent.
Silica	69.68	68.52
Alumina	14.82	16.86
Ferrous oxide	1.60	1.11
Ferric oxide	1.61	1.13
Sulphide of iron (FeS_2)	.13	.22
Lime	3.25	2.86
Magnesia	1.22	.96
Soda	3.30	3.84
Potash	3.20	2.99
Water (—100)	.16	.16
Water (+100)	.45	.68
Carbon dioxide	.19	.12
Oxide of titanium	.39	.36
Oxide of manganese	.04	.03
Phosphorus pentoxide	.09	.20
Total	100.13	100.04

No. 1.—Brown granodiorite, west end of Rex lake.
No. 2.—Porphyritic granite, south shore, Lount lake, English river.

From these analyses it would seem more proper to call No. 2 a granodiorite also. The name granite, however, has been kept on account of the

pink, acid appearance in the field and to distinguish it from the grey granodiorite, which may also be porphyritic but is of quite different appearance and mineral composition.

Differentiation on a small scale is well shown in two lenses intrusive into sedimentary gneiss, one west of Lower Kettle falls on the English river and the other on the south shore of Salvesen lake on the Sturgeon river. In both of these lenses the centre is brown to grey monzonite or granodiorite, showing slab structure. This rock changes towards the sides to a porphyritic stage similar to the porphyritic granite described above, which in turn gives way to compact cream or pink granite around the border and at the tapering ends of the lenses.

The hard, white binary granite seems to be closely related to the red granite and was seen to grade into it in a few places.

The red pegmatite, as dikes and sills with sharply defined borders, cuts all other rocks with the exception of the most acid red granite and the white binary granite. It occurs in the red granite, but only as irregular segregations and border phases. It is, therefore, thought to be the last and minor intrusive stage of the red granite magma. The relation of the pegmatite to the white binary granite was not seen, but the latter is so compact that it would not readily be intruded by later dikes.

The igneous injections forming *lit par lit* structure, vary in composition between the red granite, the binary granite, and the pegmatite, hence the structure was probably formed during the later stages of the intrusive period.

Thus we have an intrusive series, from intermediate to acid, in which the different phases are linked up by gradational stages, though the later phases may cut the earlier with sharp boundaries where a high degree of differentiation has been reached.

In the accompanying map an attempt has been made to separate the earlier phases from those later and more acid. Thus the brown granodiorite, grey quartz monzonite, and grey granodiorite have been grouped together and signified by one colour, and the porphyritic granite, red granite, white granite, and pegmatite have been included under another colour. It should be remembered that in some parts the change from one group to another is gradational and in such cases the placing of geological boundaries is largely arbitrary.

Glacial Geology

The area in glacial times was covered by an ice-sheet which came from the northeast. This has rounded off and polished the rocks, leaving striae running S. 35° W. to S. 60° W. In valleys and lakes transverse to the direction of movement, the sides nearest the northeast are often precipitous. Glacial drift is nowhere very thick and in some of the higher ground quite absent. Most of the boulders found were apparently of local origin, definite erratics being rare. Banks of sand up to 40 feet in height were found east of Lennan lake, north of Sand lake, and elsewhere.

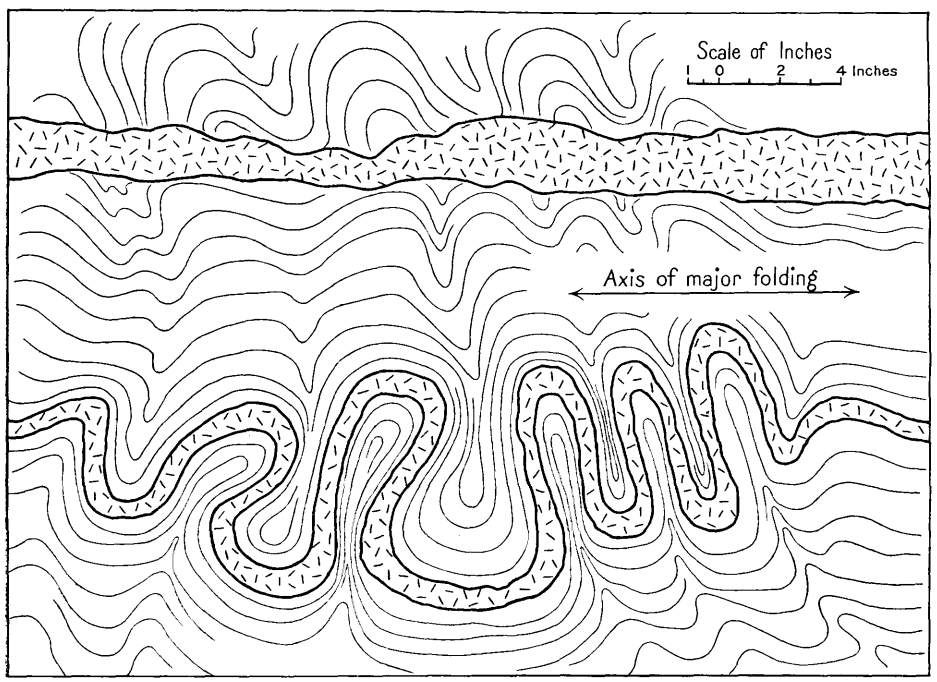
Post-glacial lakes have deposited fine, bluish stratified clay on low ground on the sides of the English river. This deposit is often covered by a thin layer of Recent sand at the edge of the river or lakes.

Structure

Folding.—The folds produced during, or just previous to, the intrusion of the batholith have axes striking in a general east-west direction, trending towards northeast-southwest in the northern and eastern parts of the area. Not only do the sediments and volcanics follow these strikes, but the lenses and larger masses of the different intrusive phases have their long axes lying in the same directions. The dips of the schistosity and the banding in the

sedimentary gneisses is steep, often vertical, rarely less than 60 degrees. The dip usually continues in the same direction when following along any particular band of sediments or volcanics, though both strike and dip may be locally altered around small intrusive lenses. Thus on the English river west of Kettle falls, the plane of schistosity dips away from an intrusive lens to the north, south, and east. The region around Separation rapids on the English river seems to have been a low spot in the roof of the batholith. The volcanics are here much less altered, pillow structure being well preserved. The outcrop is wider than elsewhere, and bands run off in three directions.

Faulting.—Few faults were seen, and these were apparently of small displacement. One fault, however, parallel to the strike, was picked up at two points 8 miles apart, near Deer falls and on the south shore of Oneman lake, both being in the same position with respect to the belt of sediments. The fault is indicated, not by visible displacement but by a well-marked fault breccia. Angular fragments of what appears to be altered andesite lava are cemented by rather drusy quartz. The fault dips at 55° N.



Sketch showing two pegmatite veinlets in contorted sedimentary gneiss.

Rock Flowage.—The study of small stringers and veins of pegmatite in the sedimentary gneiss brings out two interesting features. The first is that rock flowage, compensating the displacement due to lateral compression, was largely upwards, as has been suggested by Spurr.[1] The second feature is that this compression, resulting in contortion and rock flowage, was still going on during the final stages of intrusion, that of the pegmatites. The evidence for these conclusions is as follows: Near Ryerson lake a pegmatite veinlet an inch wide, cutting sedimentary gneiss, is contorted and shortened to occupy a length one-third the length measured along its sinuations.

[1]J. E. Spurr, The Ore Magmas, McGaw-Hill Book Co., New York, 1st ed., 1923, Vol. 1, pp. 165-170.

The strike of the gneissic banding is similarly contorted. This shortening is along the east-west strike or at right angles to the north and south pressure that has produced the original major folds. There has, therefore, been shortening in both horizontal directions, so there must have been flowage in a vertical direction. Increase in density could not account for so much decrease in space. Additional evidence is in the nearby conglomerate where even the compact boulders have been elongated in a vertical direction. Another slightly wider veinlet of pegmatite lies a few inches away from the first with its strike in the same direction. This one is straight and has not been shortened but cuts through the contortions of the gneiss. There has been shortening, therefore, in an east-west direction after the intrusion of the first pegmatite veinlet, but before the second. Both veinlets are of the same composition and there is nothing to suggest that they are not from the same magma. Other pegmatite veinlets in the vicinity show varying degrees of contortion. Movement during the period of minor intrusion seems the only explanation of these phenomena.

ECONOMIC GEOLOGY

A period of mineralization, on a limited scale, seems closely associated with the later phases of intrusion. Quartz veins are rare, and the mineralization generally takes the form of replacement of the country rock.

Several veins of the replacement type occur in the sedimentary gneiss around the contact of a granite lens, northwest of Lower Kettle falls on the English river. Pyrrhotite with a small amount of pyrite and molybdenite were the chief minerals deposited. One such vein, on the south side of the English river, was staked by P. Dusang some years ago; but as only low gold and silver values were obtained, the claims were allowed to lapse. The vein is about 10 feet wide with ill-defined walls and lies close to the northern contact of the granite lens. The ore is pyrrhotite, almost solid in some bands, with a little pyrite and molybdenite. A sample taken of the pyrrhotite ore gave no values in gold. Other veins in the vicinity consist of the same barren sulphides.

Mineralization was found 300 feet west of Lower Kettle falls, consisting of a band of sedimentary gneiss 8 feet wide between two pegmatite dikes, partially replaced by molybdenite. Samples were assayed for gold, silver, and tin, the last because of the close association with the pegmatite, but no values were obtained in any of the metals.

Several zones of sulphide replacement, a mile southeast of Ryerson lake, were discovered and staked by H. C. McNairnay during the summer of 1929. These replacements are in volcanics and quartzitic sediments, and the breaks follow the general strike. The ore is pyrite in a siliceous groundmass, with a varying proportion of chalcopyrite. Disseminated pyrite may be found over zones 100 feet wide and traceable for a quarter of a mile or more. Within these zones are bands of nearly solid pyrite with a small amount of chalcopyrite in stringers and pockets. Samples from the earlier discoveries yielded no gold values, but more recent work has shown low gold values up to $3.25 per ton across a width of 8 feet.

This type of mineralization in the volcanics and fine quartzitic sediments is markedly different from the pyrrhotite replacements in the coarser gneiss and is thought to be more favourable.

Cobalt

At the west end of Werner lake, about 20 miles north of the junction of the English and Winnipeg rivers, a vein of cobaltite was discovered in 1921 and staked. The occurrence was described by J. F. Wright in 1922. The claims were later allowed to lapse, but during the winter of 1928-29,

owing to a sudden rise in the price of cobalt, interest was renewed and 48 claims were staked around the original discovery. It is now the property of Kenora Prospectors and Miners, Limited, and surface work was carried on during the summer.

The vein, of the replacement type, lies at the southern contact of a narrow belt of sedimentary gneisses and schists intruded on both sides by red granite. Wright[1] has claimed that some at least of the schists and gneisses are of igneous origin. There has, however, been so much metamorphism with the injection of igneous material that even the presence of typically igneous minerals can hardly be taken as definite evidence of an igneous origin for the schists and gneisses themselves. They closely resemble undoubted sedimentary schists and gneisses in other parts. The granite is of the acid pink type and is rather gneissic in places. The vein follows a garnet-rich band which may be traced for a mile or more along the strike. The walls are ill defined but at the best showing, where a test-shaft has been sunk, the vein may be taken as a zone about 12 feet wide consisting of fractures along which replacement has taken place. The ore from the fractures where the original rock has been totally altered consists of crystalline cobaltite (CoAsS) in a matrix of green chloritic material. Pyrite, later than the cobaltite, is found in a few stringers and pockets; chalcopyrite, pyrrhotite, covellite have also been found. Oxidation, producing erythrite or "cobalt bloom" and a little annabergite has taken place in the upper part of the fractures, and from the amount of bloom on the ore dump, the alteration seems to take place very rapidly. The shaft was flooded at the time of examination, so the vein could not be followed down far from the surface. A channel sample was taken 10 feet below the surface, across a width of 9 feet. This was assayed by W. K. McNeill, Provincial Assayer, and showed 4.20 per cent. cobalt, which is good payable ore if it occurs in any quantity. Earlier assays indicated that there was no trace of silver, which is often associated with cobalt. A sample across 8 feet, taken by J. F. Wright, showed in partial analysis 2.10 per cent. cobalt, a trace of nickel, 0.10 per cent. copper, and no values in gold or silver. The vein dips under a swampy creek just west of the shaft, and to the east it is largely covered by drift. Along the same garnet-rich band a number of small lenses have been found, consisting of replacements by chalcopyrite with a very little cobaltite. The sulphides tend to replace the other minerals, leaving garnets embedded in the ore.

Similar pockets and lenses of pyrite and chalcopyrite replacement were noticed in garnet-rich bands in other parts of the area, for example on the north shore of Rex lake. It would appear that the garnet-rich bands were favourable channels for uprising ore solutions and are therefore worthy of careful search in any prospecting in the area.

Possibilities of Tin

Owing to the recent discovery of tin in the form of cassiterite (SnO_2) in pegmatites in the part of Manitoba adjoining this area, a search was made for this mineral in favourable formations. The properties of the Manitoba Tin Company and Jack Nutt Mines, Limited, in Manitoba were visited on the way in to the area and the rock associations noted. The Ryerson-Twelnor-Oneman lakes belt of sediments and volcanics was found to be a continuation of the series in which the Manitoba tin properties are situated, though it is narrower and more altered in Ontario. The pegmatite dikes in Ontario were also found to be of the same age and general composition as those in the Manitoba tin area, but no cassiterite was seen in the pegmatites or in any other rocks in Ontario.

Although the later acid intrusive rocks in this region are similar to those often associated with tin deposition, it is thought that erosion has cut too

[1]J. E. Wright, Geol. Surv. Can., Sum. Rept., 1922, p. 74C.

deeply into the batholith to be favourable for mineralization on a large scale. Typically, veins of cassiterite and its associated minerals occur in the uppermost part of acid intrusives or in the rocks which they intrude. The extent of granite exposed in the district, particularly on the Ontario side of the boundary, indicates that such "high spots" in the batholith have long since been removed. The cassiterite-bearing pegmatites in Manitoba are thought by the writer to be the deep-zone equivalent of true veins, but having a lower ratio of tin to rock-forming silicates. Local differentiation within the small intrusive masses is thought to account for the pockets and segregations of cassiterite, which generally occur in the hanging-wall side of the pegmatite dikes or sills, particularly where they take the form of an arch. If the companies working in Manitoba can make a commercial success of mining these segregations in pegmatite, the corresponding dikes and sills in Ontario are certainly worthy of prospecting. The pegmatites most like those in Manitoba are those cutting the sedimentary-volcanic band between Ryerson and Twelnor lakes.

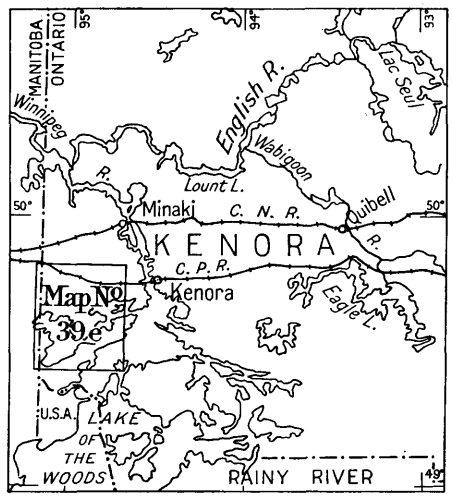
Geology of the Shoal Lake (West) Area, District of Kenora

By Leonard Greer

INTRODUCTION

Shoal lake is an arm of the Lake of the Woods, being connected with it by a narrow strait at Ash rapids. A small part of the lake lies in Manitoba, and the Northwest Angle of Minnesota is but a few miles to the south. This report is based on four months of field work during the summer of 1929. The base map is part of the Kenora sheet and was compiled from aerial photographs by the Topographical Survey of Canada.

The mineral possibilities of the region appear to have attracted attention as early as 1895. Shortly after this date a large number of gold-bearing



Key map showing location of the Shoal Lake area. Scale, 50 miles to the inch.

veins had been discovered and the district was soon booming. Unfortunately most of the development was in the hands of inexperienced men, and there was much waste of money and effort. Not less than 4 mills were erected, but only the Mikado had any considerable production. During the past 20 years there has been little activity. In 1924 operations were resumed for a short time at the Mikado, and some diamond-drilling was carried out on Cameron island during the winter of 1928-29 and the succeeding summer.

Acknowledgments

It is a pleasure to acknowledge the courtesy and hospitality extended by Colonel H. A. C. Machin, M. Malmo, Jas. Smith, the staff of Ventures Limited, and many others. Efficient service in the field was rendered by C. G. Langille, W. E. Newham, and Danvers Bateman.

Location and Means of Access

The lake is about 22 miles from Kenora, a divisional point and holiday resort on the Canadian Pacific railway. The fall at Ash rapids is usually small and depends upon the amount of rainfall and the prevailing wind. Many of the rocks in the channel have been blasted out, and in seasons of normal rainfall tugs and large gas boats can pass from one lake to the other. If the water is low the passage is difficult and sometimes impossible, except for small boats. M. Malmo's *Helen M* makes the trip between Kenora and Shoal lake several times a week, carrying freight and passengers. The Greater Winnipeg Water District railway provides direct access from Winnipeg, the terminus being at Waugh on Indian bay, Shoal lake. Trains are operated three times weekly.

Previous Work

The earliest geological map is that of Lawson,[1] who studied the geology of the area in 1883, 1884, and 1885 and introduced the term Keewatin for the ancient volcanics and sediments here so extensive. His subdivision of the Keewatin series into four groups was based largely on lithological differences. The greater batholithic areas of granite surrounding the Keewatin rocks he interpreted as Laurentian. A number of smaller granitic masses, of which one is the Canoe lake batholith, are indicated on his map as being still younger.

In 1895 and 1896, Coleman[2] visited the area and described the early workings.

Parsons[3] made further investigations and reported on the gold properties in 1910 and 1911. His 1912 report includes a geological map of the northwestern portion of the Shoal Lake area.

In 1924, Bruce[4] examined the old properties and made detailed maps of some of them. The Mikado mine was in operation at the time of his visit, so he was able to inspect the underground workings.

Natural Resources, Game

There have been few fires in the last twenty years, so the natural beauty of the country has not been destroyed. The timber resources are largely exhausted, however, though some pulpwood is cut as well as a little poplar for barrel staves. Fishing is a well-established industry and is a source of revenue for many Indians and three outfits of white men. Whitefish, jackfish, pickerel, and trout constitute most of the catch. The fish are shipped to Kenora by gas boat in the summer and motor truck in the winter.

Moose and deer are fairly plentiful.

Topography

The topography differs in no important respect from most parts of the Canadian shield. The drainage is probably better and the relief slightly greater than in some areas. Though the drift and soil is not heavy, the rock knolls and ridges are usually nearly covered with moss and lichens. For this reason good outcrops are rather scarce except along the lake shore.

GENERAL GEOLOGY

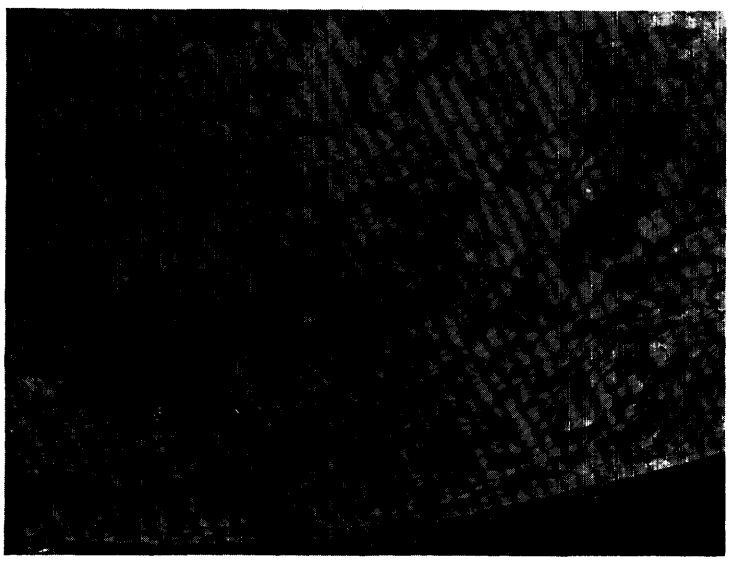
Lawson placed more emphasis on lithology than is the custom at the present time. In modern geological practice rocks are classified according

[1] A. C. Lawson, Geol. Surv. Can., Vol. I, pt. CC, 1885.
[2] A. P. Coleman, Ont. Bur. Mines, Vol. V, 1895; Vol. VI, 1896.
[3] A. L. Parsons, Ont. Bur. Mines, Vol. XX, pt. 1, 1911; Vol. XXI, pt. 1, 1912.
[4] E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925.

to their origin, regardless of their present appearance, and the writer has

associated with the pillows. The most common agglomerate is composed of angular blocks of green lava embedded in a tuffaceous matrix, the composition of fragments and matrix being essentially similar. Presumably this type of agglomerate accumulated as a result of occasional explosions, which shattered lava flows previously extruded through long fissures.

Here and there are small amounts of interbedded sedimentary material. On the mainland immediately north of Martineau island there is at least 12 feet of stratified black slaty rock. The contacts are covered, but greenstone is exposed a short distance to the north and south. Undoubtedly such a layer represents a temporary halt in volcanic activity, during which there was erosion and local deposition of a little sedimentary material.



Agglomerate or volcanic breccia, west shore of Martineau island, Shoal lake.

LAVAS WITH INTERBEDDED FRAGMENTAL AND CLASTIC SEDIMENTS

These lavas differ in no way from the lavas of the group already described, but there is a much larger proportion of agglomerates; tuffs, which are in part water-lain; and clastic sediments. At three localities the sediments were of sufficient areal extent to justify separate mapping.

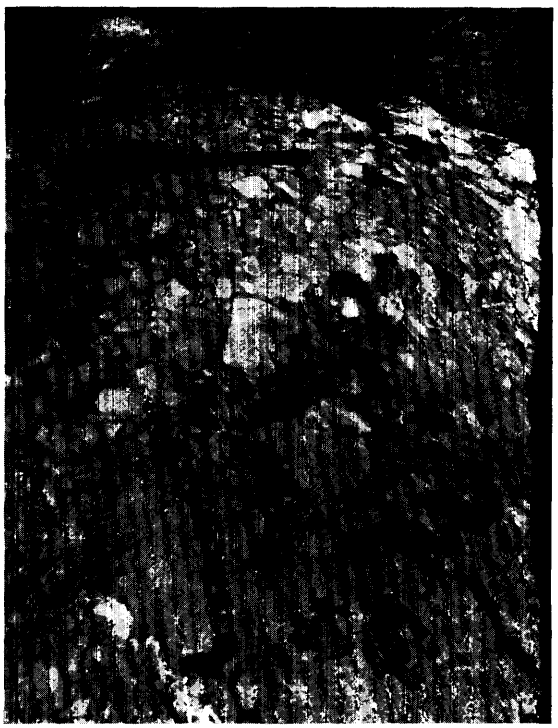
Agglomerates

Agglomerates occur very commonly. The fragments in any one outcrop are usually rather uniform in size, but over the area as a whole they range in diameter from a fraction of an inch to several feet. There is considerable variation in degree of roundness. Usually the well-rounded fragments are composed of grey felsitic material. The matrix is always dark-green and often schistose.

Whether or not the agglomerate was deposited by and in water is frequently hard to decide. In some instances one type of deposit can be traced into the other. To illustrate, at Picture Rock point, Lake of the Woods, the agglomerate is made up of pale-green angular fragments up to 3 feet across, embedded in a dark-green schistose matrix and is obviously a terrestrial deposit. This kind of rock outcrops along the shore to the northeast for nearly a mile and a half, but gradually the fragments become more

pebble-like and stratification begins to appear. Such strata must have been laid down in water, and possibly the term volcanic conglomerate should be applied instead of agglomerate. The pebbles are not distributed uniformly. Layers in which the pebbles are abundant pass gradually across the strike into zones containing only fine material. Interbedded with the agglomerate are dense cherty sediments in beds up to 6 inches thick.

One cannot go far without seeing these agglomerates and their associated thin-bedded cherty sediments. Very good exposures occur along the west shore of Shoal lake and south of Shoal Lake narrows. Thick sections with-



Agglomerate or volcanic conglomerate, Silver Fox island, Shoal lake.

out interbedded lavas are not common, but the east shore of the large island southwest of Royal island, Lake of the Woods, is entirely made up of stratified agglomerate and so far as could be determined from a rapid examination no lavas are interbedded. Along the shores of the small islands to the south, however, lava flows, 200 to 300 feet thick, begin to make their appearance and soon predominate.

At an exposure on the south shore of Shoal Lake narrows a few pebbles of granite and vein quartz were discovered among those of felsite. In this instance the term agglomerate is scarcely fitting. Such a rock is certainly a conglomerate. How much of the agglomerate is really of this nature is an open question. Quite frequently all the pebbles are coated with a black film of vegetable matter and their character cannot be determined. The pebbles are usually flush with the surface of the outcrop and are difficult to extract. Most of the agglomerate is quite definitely of pyroclastic origin hence the term is retained. A true Keewatin conglomerate is described in a later section.

Tuffs

Associated with the agglomerates and clastic sediments is a pale-green fine-grained, sometimes well-stratified rock, to which the term tuff is properly applied. It is composed chiefly of volcanic ash.

Clastic Sediments

Three belts of sediments have been differentiated from the volcanic rocks. The field relations indicate that they were formed locally during pauses in volcanic activity.

Southern Belt.—All of Royal island and many of the smaller islands toward the northeast are composed of a fine-grained, brownish mica schist. The section has a maximum thickness of one mile, striking approximately N. 80° E. and dipping toward the south at an angle of about 70 degrees. Bedding can be recognized at a few places and is parallel to the cleavage. The schist is composed largely of small quartz grains firmly cemented by secondary quartz. Occasional feldspars occur. The good cleavage is due to abundant small flakes of brown mica. Occasionally the schist contains a few small pebbles.

Exposures south and west of Royal island show clearly that the mica schists pass into agglomerates. The agglomerates are more or less stratified and toward the north are certainly water-lain.

Spike Point Sediments.—Spike point and the country to the east is chiefly underlain by slate and greywacké. The section is approximately half a mile thick, the dip being about 75° S. Arkosic beds are common. Near the south margin thin flows are interbedded. The eastward extent of the sediments is difficult to determine, since there is a good deal of muskeg. At both the east and west ends of James lake there are many exposures of agglomerates and associated sediments. The same rocks are found at the west end of Seager lake and for some distance north and south. Apparently the fine-grained clastics of Spike point pass into coarser fragmental formations, which are interbedded with lavas to some extent.

Crowduck Lake Conglomerate.—The most important section of sediments lies north of Crowduck lake and is composed of conglomerates interbedded with a little finer clastic material. The pebbles are rather well rounded and are made up of several kinds of rock. At an outcrop on the north shore of Crowduck lake where, owing to spalling, there is a fresh surface, a count of the various types was made. The pebbles in an area 4 feet wide and 8 feet long included 103 of granite, 44 of dark-red felsitic material, 23 of chlorite schist, 6 of quartz, and 2 of cherty material. Those of granite that are undistorted attain a maximum width of one foot, but many have been squeezed and are as much as two feet long. The schist pebbles are always smaller and are usually squeezed. A fine-grained quartzose rock containing much chlorite makes up the matrix.

There is considerable variation in the composition of the granite pebbles. Some contain a great deal of quartz, others scarcely any. A microscopic study of one specimen showed it to be composed largely of quartz, feldspar, and calcite. Feldspar, including both orthoclase and albite-oligoclase, is most abundant. The quartz and feldspar phenocrysts are much shattered, the cracks being filled with calcite. Ferromagnesian minerals are not plentiful, but there are small masses of badly altered material in which only quartz and sericite can be identified.

The north shore of Crowduck lake conforms closely to the strike of the conglomerate. Usually the dips are nearly vertical, but at several places an inclination toward the north was observed. The maximum thickness of the section is about half a mile. At the narrows of Crowduck lake it is

only 900 feet. On the south shore, near the portage between the lake and Rush bay, Lake of the Woods, is the most easterly exposure of conglomerate. It is safe to say that the conglomerate pinches out not far east of Crowduck lake, since only greenstones and schistose felsites can be found north of Rush bay. To the west of the lake, swamp and heavy drift occupy most of territory in which conglomerate could be expected. The few exposures that can be found consist of greenstone or felsite. Accordingly, the mapping of the conglomerate west of the lake is largely conjectural. Probably, however, the formation does not continue more than a mile or two beyond the lake.

A long sill-like mass of schistose felsite with a maximum width of about 1,000 feet lies between the conglomerate and the greenstone to the south. To the north of the conglomerate, volcanics intricately cut by schistose felsite and quartz porphyry occur extensively. At one place along the north



Crowduck Lake conglomerate. The large boulders are granite.

shore of Crowduck lake the conglomerate is cut by a 20-foot dike of quartz porphyry.

Granite pebbles predominate in the Crowduck lake conglomerate, whereas in the occurrence on Shoal Lake narrows previously described volcanic material is more abundant. There is no other difference. Evidently there was a period of erosion during Keewatin time, probably in the early part of the epoch. In most places only lavas would be exposed and the products of erosion would be entirely of volcanic origin, but apparently a pre-Keewatin granite was uncovered locally and was the source of the granite pebbles. This granite was not recognized in the field. Near the present site of Crowduck lake it may have formed a mountainous mass, for the outline of the conglomerate and its general make-up rather suggests piedmont deposition.

The Crowduck lake conglomerate appears to be comparable with the Doré conglomerate of the Michipicoten area. Early workers assigned the latter to the Huronian series, but recent studies show that it belongs to the Keewatin. Collins suggests that the Doré conglomerate represents "land accumulations of sedimentary debris in regions of mountainous relief."[1]

[1]W. H. Collins and T. T. Quirke, Michipicoten Iron Ranges, Geol. Surv. Can., Mem. 146 1926, p. 22.

Algoman(?) Intrusives

The volcanics and sediments are cut by several kinds of acid intrusives, the chief types being felsite, quartz porphyry, and granite. Probably all three are genetically related.

Felsite and Quartz Porphyry

In some cases felsite and quartz porphyry are so intimately associated with granite that they cannot be mapped separately. Around Squaw and Cul de Sac lakes there is a good example of this. Along the west shore of the south bay of Squaw lake the rock is a dark brecciated felsite, which is difficult to distinguish from lava. Along the shore of the west bay the rock becomes coarser, resembling quartz porphyry at first, then becoming more and more granitic in appearance. The felsite and quartz porphyry here appear to be the quickly chilled margin of the Canoe lake batholith.

Dikes and small bosses of felsite and quartz porphyry are common features of the area. The felsite is a dense, brittle, greyish or flesh-coloured rock in which small quartz eyes can sometimes be seen. Occasionally there is a greater development of quartz phenocrysts, the rock then being properly called quartz porphyry. Under the microscope the felsite is seen to be composed of a mosaic of quartz and feldspar with a little micaceous material.

In the northern part of the area the felsite is most common and is usually schistose. The schistosity is due to abundant sericite. Felsite dikes, a few inches to many feet in thickness, frequently cut across the strike of the greenstones at such a small angle that it is easy to mistake them for interbedded lavas or sediments.

Intrusion of the felsite may have immediately preceded injection of granite. The granite is massive everywhere, so far as could be observed, but much of the felsite is schistose. Obviously the felsite has been folded, but there is no indication that the granite was subject to the same process. In all probability felsites are slightly earlier phases of granite batholiths.

Lawson's map indicates that a large felsite dike outcrops along the shore north of Martineau island. There are a few exposures of felsite along this shore, but the dikes of which they are parts is too narrow to be shown on a map of this scale.

Granite

The Shoal lake sediments and greenstones are surrounded by granite and are also intruded by small masses of granite. As might be expected the granite varies considerably in appearance and mineral composition, but most commonly it is a massive pink hornblende or biotite granite. Its mode of occurrence dates it as post-Keewatin, but there are no means of determining its age more closely. Since many of the pre-Cambrian granites are pre–Middle Huronian, it is tentatively assigned to the same period of intrusion, i.e. Algoman.

Lawson's map indicates two granites, one cutting the other. The Canoe lake, Carl bay, Portage bay, and several smaller granite bodies are shown as belonging to the younger group, the Laurentian granites north and west of the greenstones being older. Lawson was able to distinguish several small masses of the younger granite within the Laurentian along the west shore of Shoal lake. The present writer examined this shore very carefully, but could recognize only one variety of granite, viz. a massive hornblende granite, pink in colour and of rather fresh appearance. Moreover, the lithology of this rock is identical with that of the Canoe lake batholith. Unless further evidence becomes available, there seems no reason for not assigning all granites within the area to one period of intrusion.

The narrow dike-like body of granite on the south shore of Canoe lake differs in appearance from most of the other intrusives. It is a dark-grey massive granite containing much hornblende and biotite. Dikes of pink pegmatitic granite a few inches in width traverse it in all directions. The dark-green variety is also found on the north shore at the east end of Snowshoe bay and is cut by pink granite dikes in a similar fashion. Toward the west it gradually becomes lighter in colour, the feldspar more pinkish, and quartz more plentiful. Possibly the grey and pink granites represent different stages in the crystallization of one magma, the grey type having solidified first and later being cut by dikes of the residual magma.

Pleistocene

During Pleistocene time the country was completely glaciated. Judging from the scratches on the rocks the course of the ice sheet must have been about S. 49° W. Drift was deposited rather generally though not thickly. At one time, probably as the ice was retreating, the lake must

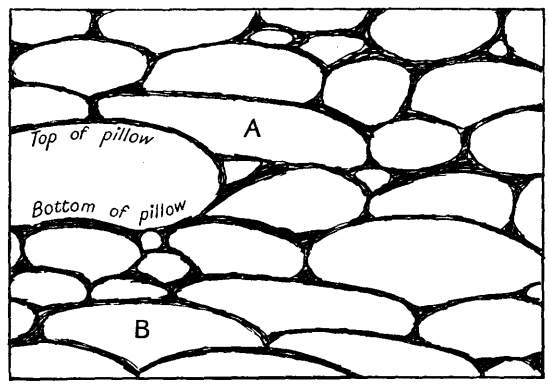


Fig. 1—Diagram illustrating ideal case of pillow lava.

have been considerably higher and more extensive than at present, for along its shore many exposures of varved lake clays up to 10 feet in thickness can be found.

The southwest shore of the lake is low and lined with small boulders. Some of the islands off this shore are probably drumlins, being nothing but great heaps of boulders.

For a good description of glacial phenomena in the region the reader is referred to Lawson.[1]

Structure

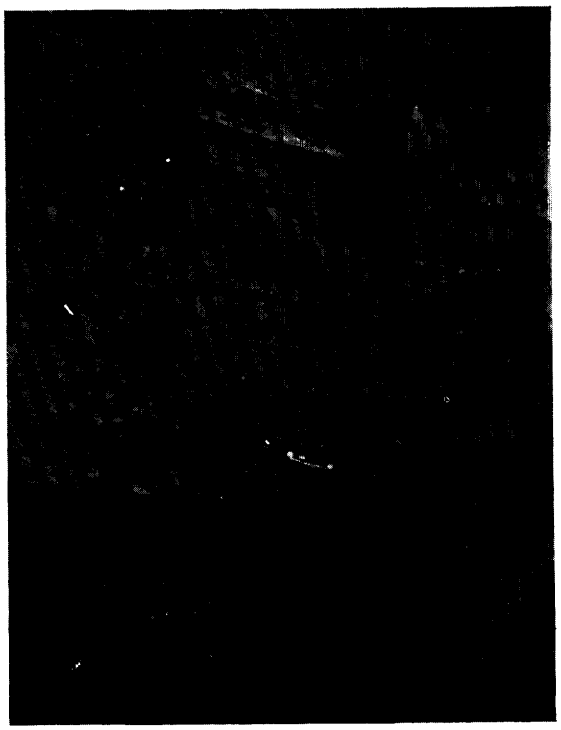
The steep dips and the development of flow cleavage in the Keewatin rocks of the area prove that the series is closely folded, and ordinary structural methods of study are of little value. Strikes vary considerably over short distances. The dips are consistent in neither direction nor amount and the possibility of overturning can never be discounted. There are no distinctive beds to be used as horizon markers. In general the flows and sediments have limited extent along and across the strike.

Fortunately there is much undistorted pillow lava. A method suggested by Alcock[2] can often be used to determine the attitude of the flows.

[1]A. C. Lawson, op. cit., pp. 130-140.

[2]F. J. Alcock, Geol. Surv. Can., Sum. Rept., 1922, pt. C., p. 11.

Quoting Alcock, "during cooling, the viscous materials making up the ellipsoids shaped themselves against the underlying layer of pillows, filling the irregularities of the surface." Fig. 1 illustrates an ideal case. In general, the process results in two special and characteristic pillow forms, A and B, Fig. 1, being examples. It is obvious toward which direction is the top of the flow. As a check on the method the textures of two flows were closely studied, one being south of Monument bay, Lake of the Woods, the other on Martineau island, Shoal lake. Near the east end of Monument bay, along the south shore, the grain is very coarse. As it is traced to the south

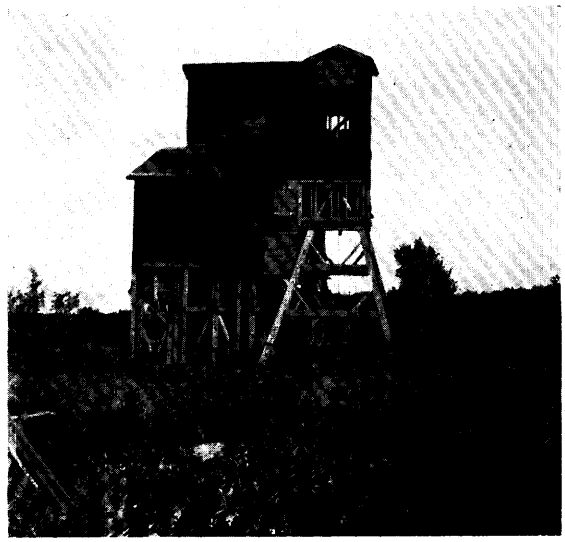


Pillow lava near Indian village, Shoal lake. The top of the flow is toward the hammer (see Fig. 1).

it becomes progressively finer, and eventually pillows and amygdules appear. It is safe to assume that the top of this flow is toward the south, an assumption which is confirmed by the pillow shapes. Along the south shore of Martineau island a little fragmental material is associated with much vesicular-rimmed pillow lava. When traced to the north the fragmental material and vesicular structure disappear and the pillows are less abundant. Apparently the top of this flow is toward the south, and the form of the pillows supports this conclusion.

Thirty-six exposures of pillow lava were found in the vicinity of the line A-B (see map 39*e*). At all but five the attitude of the flows could be determined by the method just outlined, and no contradictory results were obtained. The structure along the line A-B was inferred from the data so collected. Apparently the Canoe lake batholith determined the anticlinal attitude of the flows on its flanks, the axis of the anticline being nearly a mile north of Galt island. The axis of the syncline to the north passes through Indian bay about a mile north of the Indian village. The axes are

about 6¼ miles apart, and along the section the average dip of the flows is approximately 70 degrees. Disregarding faulting and drag-folding, the true thickness of this limb is about 5½ miles. The amount of thickening due to drag-folding and faulting cannot be estimated, but in all probability the series is actually between 4 and 5 miles thick. These figures hold true only for this section; in many places the thickness may be much less and in some cases, no doubt, is considerably greater. Probably the



Ruins of Cameron island mill, Shoal lake.

thickness of the flows is fairly uniform, but that of the sediments and agglomerates must vary widely.

Insufficient data was obtained south of Shoal lake to work out the structure with certainty. Near Picture Rock point, Lake of the Woods, an outcrop of pillow lava indicates that the tops of the flows are toward the south. Not far from here a drag fold in sediments suggests that it is on the south limb of an anticline. It may be that the series was folded anticlinally by the Portage bay granite mass acting in the same way as the Canoe lake batholith.

ECONOMIC GEOLOGY

Gold appears to be the only metal which occurs in important amounts. It is usually associated with rather narrow quartz veins in greenstone. Some sulphide fracture zones also carry gold. The first discovery on Shoal lake seems to have been made by an Indian in 1893. Subsequently this find became the Mikado mine. Between 1893 and 1910 the area flourished, but after this period interest waned. The Cameron island property is the only one on which extensive operations have been carried on since 1924, when Bruce visited the area. Accordingly, the reader is referred to the reports already cited for information about most of the prospects. Brief sketches are given of some of the more important properties.

Description of Properties

Mikado Mine

The Mikado mine is on Bag bay, Shoal lake. It is said to have produced over $500,000, having been operated intermittently between 1895

and 1924. The Canoe lake batholith lies a few hundred feet to the east, the country rock immediately around the mine being mainly greenstone. A large red pegmatitic granite dike cuts the greenstone, striking about east-west. About 400 feet west of the shaft it splits into two tongues. Doubtless it extends eastward to the main granite body.

The main vein cuts across the dike, striking N. 30° W. and dipping at about 85° N.E. Underground workings, nearly 600 feet in depth, show



Olympia mill, Shoal lake.

that the vein cuts across other smaller granitic dikes. The main ore shoot occurred at the intersection of the vein with the large dike, and for this reason an inclined shaft was sunk along the intersection. Bruce[1] states that while the vein improves physically where it passes through granite, it does not follow that the values are higher than where both walls are greenstone. The vein is lenticular in outline, and in places exploration must have been difficult. High values were obtained in the upper levels, but at depth results were less satisfactory. Pyrite, chalcopyrite, tetradymite, galena, malachite, molybdenite, and bismuthinite, as well as gold, were found.

No. 2 vein is about 500 feet east of the main shaft. It is much narrower than the main vein, but the geology appears to be very similar.

Olympia

The Olympia mine is situated on Helldiver bay, Shoal lake, about a mile south of the Mikado. In the greenstone, there are several narrow and moderately sheared zones impregnated with quartz and sulphides. The veins have been developed by 5 prospect shafts and 3 tunnels. Gold valued at a few thousands of dollars was recovered in the course of operations in 1912 and 1915. The ore was treated in a small stamp mill on the property.

Ventures Limited

Ventures Limited recently entered the area, optioning the Cameron island property. The island is in the approximate centre of Shoal lake and has an area of about 6 acres. It is entirely made up of massive greenstone,

[1]E. L. Bruce, op. cit., p. 7.

much of which has been changed to coarse amphibolite. Dark-grey felsite dikes several feet wide are common. The weathered surfaces of the felsite and greenstone are so nearly alike that it is difficult to distinguish the contacts.

According to Parsons,[1] who visited the property in 1910, there are 7 veins on the island with a general strike of N. 45° E. All of them are gold-bearing sulphide zones with some associated quartz. Of the sulphides, pyrrhotite is most abundant; pyrite, arsenopyrite, and chalcopyrite are also common. At the time of the present writer's visit it was difficult to trace the vein system, as clay and soil had slumped into most of the trenches and pits. The vein at the shaft can be traced for about 200 feet toward the southwest, but it seems to pinch out beyond this point. Another vein, apparently a branch of the first, appears here and can be followed for about 200 feet to the southwest, having widths ranging from one to two feet. At the portal of the tunnel on the east side of the island a 2- to 3-foot vein is exposed, the middle 9 inches being mainly quartz. This vein can be traced for only a short distance. Indications of other sulphide zones are revealed by trenches and stripping on various parts of the island, especially along the south shore. According to Parsons, crosscuts from the shaft encountered a parallel vein on each side of the principal vein.

Gold in commercial quantities is fairly common, and a 20-ton mill was operated for some time. Recovery was difficult, and eventually a chlorination plant was installed. No ore has been milled since 1915.

An interesting feature is the abundance along the south and east shores of large angular fragments of highly altered volcanic rock. This rock contains streaks of serpentine and quartz and is mineralized with much arsenopyrite and some pyrite. It is float that was transported during the last period of glaciation, and the angularity and abundance indicates that no great distance was involved. All samples containing arsenopyrite are reported to give a high gold content.

Ventures Limited began a diamond-drilling programme during the winter of 1928-29, and nearly 4,000 feet of drilling has been completed since then. Operations were suspended in August, 1929, but plans were made to drill more holes through the ice north of the island during the coming winter in an attempt to locate the source of the high-grade float.

Some diamond-drilling and trenching were also done on several narrow and very crooked quartz veins and crushed zones on the east side of Stevens island. None can be traced for more than a hundred feet or so.

Kenora Prospectors and Miners, Limited

Kenora Prospectors and Miners, Limited, explored a number of claims in the vicinity of the Mikado mine. On the Gold Coin property (D. 218) a number of trenches were cut at close intervals west of a prospect shaft sunk about 1897. At the shaft the greenstone is slightly schisted, crushed, and impregnated with quartz and pyrite over a zone about 20 feet in width. The crushed zone can be traced about 40 feet to the southwest, but to the northeast there are no exposures. The trenches west of the shaft explore similar though much narrower showings. An interesting feature is the way in which undisturbed-looking greenstone carries native gold along certain zones. A tongue of quartz porphyry outcrops immediately north of the workings.

Work was also done on the old Ontario Limited property, S. 74, D. 204, and D. 203. According to the 1897 report of the Ontario Bureau of Mines, these claims were staked in 1896; and by 1897, 13 veins had been explored by 4 prospect shafts and 420 feet of diamond-drilling. Seven veins were examined by the writer, some being recent discoveries. Most of them are

[1]A. L. Parsons, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, p. 106.

quartz veins, the quartz averaging less than 2 feet across, but in some cases a foot or two of the greenstone has been sheared and silicified and may carry gold. One vein appears to be a shear zone, the greenstone over widths of 2 to 8 feet being crushed and impregnated with tiny quartz stringers. Pyrite is the most abundant, and a little chalcopyrite also occurs. No gold was seen but it is believed to occur.

During the latter part of the season two men were employed on the old Cornucopia property (D. 212) on Cedar island, Bag bay. At the time of the writer's visit a shear zone, 5 feet wide, had been trenched at one place. The vein was mineralized with much pyrite and a little chalcopyrite and pyrrhotite.

Other Properties

A visit was paid to an enormous sulphide zone east of West Hawk lake. The property ties on to the Manitoba-Ontario line near mile post 35 and consists of 15 claims. Years ago a number of pits were sunk, apparently without satisfactory results. The property was restaked in 1929, and some trenching was done by Al. Nunni and his associates. Probably half of the rock is made up of pyrite and pyrrhotite over a zone having a maximum width of at least 350 feet and outcropping in a northwest-southeast direction across more than two claim lengths. A grab sample was taken from the dump beside one of the old pits and assayed for copper, gold, tin, and zinc. None was reported.

An old pit was found on the northernmost bay of High lake. At this place there is, in the granite, a greenstone inclusion, about 75 feet wide, striking almost east-west. The pit is sunk on a break approximately 6 feet wide, about one-third being quartz and the rest schist. Chalcopyrite is the chief sulphide, and there is also considerable pyrite and molybdenite. The vein appears to strike about east-west but cannot be traced more than a few feet. This showing is on S. 505.

Some recent prospecting has been done on High lake, but no staking had taken place prior to September 1. Values in gold and copper were reported.

Recommendations to Prospectors

The area is like most others in the pre-Cambrian shield in that veins are more likely to be found in greenstone or sediments than in granite. Prospectors realize that gold deposits are seldom found in regions in which there are large bodies of granite and relatively small areas of greenstone. Such a set-up indicates that most of the veins that may have existed at one time have been removed by erosion. On the other hand, small bosses or dikes of granite or porphyry in the midst of large greenstone areas indicate that erosion has been relatively less effective. Such an arrangement exists in part of the Shoal Lake area, and it is reasonable to expect gold-bearing veins extending to some depth.

More veins per square mile have been found in the country immediately west of the Canoe lake granite than in any other section of the area. It is an interesting fact that these veins are not more than a mile from the anticlinal axis, which strikes about N. 50° E. from the south shore of Dominique island. If, as was suggested, the injection of the Canoe lake batholith determined the anticlinal attitude of the flows, it is probable that the axis is directly above the highest points of the batholith. The top portion of magmas seems to be the part from which ore-bearing solutions are often derived. The whole question is highly speculative, but as a suggestion that can be taken for what it is worth, the islands and mainland within a mile or a mile and a half of a line passing through the Mikado mine and the south shore of Dominique island may be of particular interest to the prospector.

Most of the veins south and west of the Mikado have a northwest-southeast trend, i.e., are parallel to the trend of the granite contact and dip toward the granite. There is some evidence that the Mikado vein is of the fissure type, and probably the others have a similar origin. Probably, as cooling proceeded after the injection of the Canoe lake granite, tensional stresses were set up, the cracks so produced being filled by vein material. Whether this be true or false, all greenstone within a mile or so of the granite should be carefully searched for veins and special attention paid to those which parallel the granite-greenstone contact.

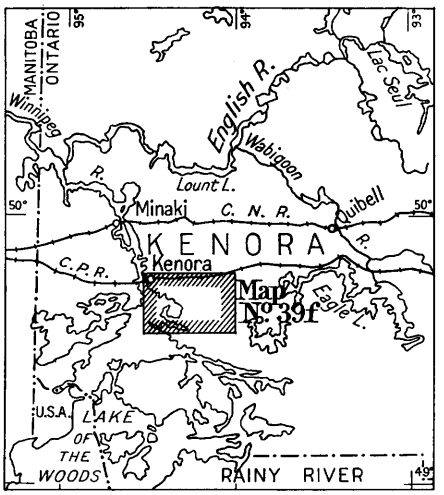
It must be admitted that the entire Lake of the Woods region is not as attractive to the prospector as it might be, because much of the best ground has been staked and can be prospected only by the lessees or patentees. A thorough search is proceeding on a few properties, but far more have lain idle for years.

Geology of the Bigstone Bay Area, Lake of the Woods, District of Kenora

By G. G. Suffel

INTRODUCTION

The primary purpose of this report is to present a geological map of that part of the Lake of the Woods area centring upon Bigstone bay. The only coloured geological map of this region was prepared by Lawson many years ago and is now quite rare and difficult to obtain. While its comparative accuracy has often been attested, detail is, of course, lacking, the base



Key map, scale 50 miles to the inch, showing Bigstone Bay area.

is poor compared to modern ones available, and the geology has not been carried inland to any extent.

The base for the present map was compiled from map No. 17B of the Ontario Department of Surveys, showing the shore of the Lake of the Woods; from maps showing the claim surveys; and from air maps. These have been fitted together and appreciably altered in numerous instances to accord with the writer's observations. Consequently the geology applied to this base is regrettably variable in accuracy and amount of detail. Some changes in classification and nomenclature of the rock types have been made.

Acknowledgments

For numerous courtesies and services the writer wishes to thank J. D. C. Smith, Mining Recorder, Messrs. Neal and Heath, Percy Mitchell, and James Fullford, all of Kenora. Thanks are due also to R. C. Lyons of the Department of Northern Development, particularly for the frequent services rendered by the Department boat *Arcola* and its crew.

The writer's party consisted of Neill D. Runnalls, Fred E. Towsley, and W. G. Beare, all of whom gave wholehearted assistance.

In preparing this report the writer had full use of the office facilities of the Horne mine of Noranda Mines, Limited, Noranda, Que.

Position and Means of Access

The area examined lies a few miles southeast of Kenora, which is situated at the outlet of the Lake of the Woods on the Canadian Pacific railway. It is bounded on the north by the north boundary of Indian reserve 38B; on the west by a line from Devils gap to a point 2 miles south of Allie island; and on the south by an irregular line from the latter point northeast to Gibi lake. The northeastern portion of this quadrangle is occupied by Laurentian granites and gneisses and was not examined.

The numerous islands and the great length of shoreline of the mainland are, of course, readily accessible by boat from Kenora. Short portages give access to Long, Blindfold, and Dogtooth lakes, from which lead canoe routes to the east and northeast. The road now under construction from Kenora to Fort Frances will open up this area from the interior. A portage from Blindfold lake gives access to Hollow and Oblong lakes. Clear lake, Islet lake, and the Black Jack and Gold Hill mines may be reached either by the road which starts in Bigstone bay east of Fish island or by the old "railroad" that ran from the end of Moore bay to the shaft and mill of the Gold Hill. Both are hard to follow. Short portages give access to Lily lake and Lac La Belle. An old but well-preserved road from the end of Andrew bay leads to Stella lake. Gibi and Andy lakes are reached by a portage of $1\frac{1}{2}$ miles from Cole lake, just east of the end of Witch bay; in wet weather it is easier to portage directly from Witch bay.

Topography and Drainage

The Lake of the Woods in this area provides the highly serrate shoreline and labyrinth of islands that is typical of the northern half of the lake. Rock shores and ridges predominate, but the relief is never great. The highest ridges are probably not over 150 feet above the lakes and most of them are under 50 feet, alternating with comparatively narrow strips of muskeg. In spite of the low relief, flat drift areas are small and uncommon.

The shape of the shoreline and the arrangement of the islands show a remarkable relation to the geological structure and do not appear to have been influenced to any appreciable extent by glaciation.

The only drainage of any consequence emptying into this section of the lake is at Blindfold rapids in Route bay, where the water from a large section of the granite area drains in through Dogtooth and Blindfold lakes.

Previous Geological Work

Some geological information of a fragmentary character appeared from 1823 to 1885, much of it due to R. Bell and G. M. Dawson. In 1885, the "Report on the Geology of the Lake of the Woods Region with Special Reference to the Keewatin (Huronian?) belt of the Archæan Rocks," by A. C. Lawson, appeared.[1] In it he first applied the name Keewatin to the schisted volcanic series and showed that the Laurentian gneisses were intrusive and not metamorphosed sediments. The accompanying map was the first and has remained the only geological map of the lake as a whole.

Subsequent work has consisted of additional observations and some changes in mapping by Parsons,[2] various reports on the mines and prospects, especially by Hopkins, Coleman, and Coste, and recently a report on the

[1] A. C. Lawson, Geol. Surv. Can., Vol. 1, pt. CC, 1885.

[2] A. L. Parsons, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, pp. 158-198; Vol. XXI, pt 1, 1912, pp. 169-204; Vol. XXII, pt. 1, 1913, pp. 210-232.

most important properties by Bruce.[1] Outside of some corroboration or qualification of previous statements, little reference is made to the work of other writers in this report.

As little new development has taken place since the properties in this area were fully reported on, a detailed description of properties will not be given.

Summary of General Geology

The area is largely occupied by typical Keewatin volcanic rocks, which may be conveniently divided into three parts: a basic series, a siliceous series, and a basic intrusive later than both.

The basic series consists of ellipsoidal greenstones, dark massive trap-like rocks, hornblende and chlorite schists, amphibolites, and some minor intrusives.

The siliceous series is composed of volcanic fragmental rocks, but flows are also present. It consists of altered quartz-feldspar porphyry commonly occurring as an agglomerate, which may be quite coarse. All phases, however, grade into sericite and sericite-carbonate schists, often very fissile.

The later basic intrusive is highly altered and varies from a diorite or gabbro to a fine-grained dark quartz porphyry, probably a quartz diorite, the latter occurring predominantly as a border phase. The Keewatin is intruded by the Laurentian gneiss and granite, which occupies the northeastern part of the area and also occurs in masses surrounded by schists, notably on Sultana and Quarry islands and in the central part of the Eastern peninsula. Probably more or less related to the granite are certain felsite and quartz porphyry dikes and the mineral-bearing quartz veins.

The youngest rock of the area is a quartz diabase dike, presumably Keweenawan, which cuts several of the islands in the southwestern part of the area.

The schists are all highly folded. The folds in the southern part strike east and west parallel to Andrew and Witch bays; those to the north strike slightly east of north.

In this area are several mines which produced a certain amount of gold at one time but are now in ruins. These are the Sultana, Ophir, Winnipeg Consolidated, Pine Portage, Keewatin, Golden Gate, and Gold Hill. There are numerous other prospects which have been explored to some extent. The latest, and the only one that has not previously been described, is the Cameron-Earngey copper discovery at the southeast corner of Bigstone bay. Several mineralized shear zones occur here, one of which is of appreciable size and gives good values in copper.

As may be judged from the numerous mines and prospects in the area, mineral-bearing veins are numerous, particularly near the granite contacts; but with the exception of the Sultana, which is said to have produced a million dollars in gold, no important mine has ever been developed. It is necessary, however, to remember that most of the activity took place many years ago and that much of the older work has been done on the most meagre of showings. Although a large number of shafts and pits have been sunk, trenching and stripping appear to have been neglected and the diamond-drill has never been used to any extent. It seems quite possible that modern methods of prospecting and development would accomplish much in this area.

GENERAL GEOLOGY

A basic and a siliceous series of volcanic rocks, largely extrusive, are intruded by a series of dioritic to gabbroic bodies, with a marked linear arrangement parallel to the schistosity. These bodies have not been mapped

[1] E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, pp. 1-42.

or specifically described before. All of these rocks have been intruded by granite of Laurentian age and many small granite, felsite, and quartz porphyry dikes and bosses, presumably related in origin. The intrusion was accompanied and followed by marked deformation. Much later the complex was intruded by narrow diabase dikes of great linear extent, probably Keweenawan. Subsequent erosion and moderate Pleistocene glaciation complete the main events in the geological history of the region.

Table of Formations

PLEISTOCENE and RECENT:	Alluvium and boulder drift.	
	Unconformity	
PRE-CAMBRIAN KEWEENAWAN:	Quartz diabase.	
	Intrusive contact	
LAURENTIAN:	Gneissic, porphyritic, and massive granites.	
	Intrusive contact	
KEEWATIN:	Coarse diorite or gabbro.	
	Basic quartz porphyry.	
	Intrusive contact	
	Siliceous series:	Rhyolitic or dacitic quartz and quartz-feldspar porphyry.
		Agglomerate, sericite schist, tuffaceous (?) banded sediments.
	Gneissoid biotite schists, etc.	
	Basic series:	Ellipsoidal greenstone.
		Massive "trap."
		Hornblende and chlorite schist.
		Altered basic intrusives of various types.

Keewatin

The Keewatin series covers practically the whole area not occupied by the main body of the Laurentian granites. The position of the contact between the two great divisions is best appreciated by a study of the map. From the south end of Hilly lake it follows roughly the contour of the shore of Lake of the Woods, actually touching it in Storm and Route bays, but at Stella lake swings sharply north of east and extends for several miles inland past Gibi and Andy lakes before it turns sharply back again toward the Adams River basin.

The intrusive diorite mapped is in a sense post-Keewatin, but there appears to be no evidence that it did not belong to the same general period of volcanic activity, and as it has been previously mapped with the Keewatin, no change has been made.

Basic Series

This series is undoubtedly the oldest in the area. Except for the section northeast and south of Andy lake it is the only type found in contact with the main body of the granite. It is exposed in the Indian Reserve and on most of the adjoining islands, on Pine Portage and Bigstone bays, on the north half of Hay island, in a strip from Andrew bay to Gibi lake, and in a strip across Allie island, French narrows, and Bottle bay.

Ellipsoidal Greenstones.—These dioritic rocks, which are exceptionally well developed and cover a large area, constitute the chief evidence of the extrusive character of the basic series. They may be seen almost everywhere around Matheson, Bald Indian, and Bigstone bays, in the northern part of Hay island, in the vicinity of French narrows, and in a few places

north of Witch bay. It was observed in many places that the hornblende or chlorite schists still retain traces of the ellipsoidal structure.

On island No. 206 north of Sultana island amygdaloidal greenstone occurs. The cavities have been partly or wholly filled with quartz and epidote. This is the only amygdaloid observed.

In numerous places the greenstone carries highly altered white feldspar crystals as large as 1½ inches in diameter, but mostly under half an inch. Most of these are rounded but some have typical feldspar outlines, and occasionally a crystal that has recognizable faces can be picked out of the soft schist. These crystals were not studied in detail, but they appear to consist of a fine felt of quartz and clinozoisite. Good exposures may be found on the small greenstone point in Witch bay south of the west end of Lac La Belle; at the end of Andrew bay north of the road leading to the



Spotted greenstone, Witch bay. The white spots are highly altered feldspar crystals.

Stella mine (see photograph above); and on the southeast tip of island No. 79, northeast of Middle island.

Massive "Trap."—Areas of massive, hard, fine-grained, dark rock, which shows little structure of any kind except jointing, were observed in the general vicinity of Islet lake as well as in many other localities. There is little doubt that they are flows, however, and some of the ellipsoidal rocks appear to be of much the same type.

Hornblende and Chlorite Schists.—The hornblende schists, which are particularly common, have been described by Lawson[1] and Parsons.[2] They are well exposed on Route bay. A study of this and other localities convinced the writer that they are due to the contact effects of the granite, confirming the observations of Parsons. At the contact occurs a fine-grained black hornblende rock, which grades into ordinary greenstone, the hornblende crystals becoming larger and fewer with an increase of chlorite.

True chlorite schists are not common. Around Bigstone bay they are chiefly noticeable as bands a few feet wide in a much more massive rock.

[1]A. C. Lawson, op. cit., p. 37.
[2]A. L. Parsons, Ont. Bur. Mines, Vol. XXII, pt. 1, 1913, p. 219.

While these are probably simple shear zones, it is possible that they have originated along easily altered lamprophyre dikes.

A marked schist zone extends through Heenan and Needle points. The schist contains considerable carbonate, much chlorite, and in places a large development of minute crystals of magnetite.

Altered Basic Intrusives.—At numerous places basic rocks that are probably intrusive were observed, and in some cases the contacts could be seen.

On island No. 230 and the adjacent southeast tip of Sultana island, a narrow dike occurs. The small basic bodies shown at the east end of Andy lake and on Gelley lake are almost certainly intrusive, and it may be that some or all of the south side of Gibi lake is an intrusive also. Several other coarse-textured bodies might be shown to be intrusive if studied intensively.

Gneissoid Biotite Schists

These schists are the equivalent of Lawson's "clay-slate, mica-schist, quartzite and fine-grained gneiss." The writer does not feel competent to draw any definite conclusions with respect to this series, as it was only hurriedly observed in the vicinity of Andy lake and in a few places south of Gibi lake. As this particular locality is difficult of access, a few observations may not be out of place.

Around Andy lake, the coarser gneissic phases almost invariably show small feldspar phenocrysts. Occasionally a trace of agglomeratic structure was seen. A fine-grained mica schist under the microscope was seen to consist almost entirely of biotite, quartz, and sericite.

No other type was observed except in a few spots south of Gibi lake where the series assumed the appearance of a sediment, banded in places, some types appearing to be fine greywackés or quartzites.

The character of the Andy lake schists, their position on the strike of a body of more or less siliceous agglomeratic porphyry, and the lack of a well-defined contact between them leads one to believe that they are identical in origin and that the gneissoid character has been induced by the intense pressure and movement suffered by being folded in the end of the sycline in which they lie and possibly by proximity to the granite. This confirms the opinion of Parsons.[1] If this is so, the presence of true sedimentary material in the series must mean that there are two divisions capable of separation or that this series grades into the siliceous series described hereafter and contains lenses of more or less true sedimentary material, as does the latter.

Siliceous Series

This series includes all the rhyolitic rocks of the area as well as more basic ones, which are probably dacitic or even andesitic. All of them appear to be extrusive or to have prominent extrusive phases. The division between this series and the basic one as shown on the map is thus rather arbitrary; and in many instances, particularly inland where exposures are poor, the position of the contact is doubtful. As a rule, the presence of feldspar phenocrysts was considered a sufficient criterion to place the rock in the siliceous series.

The siliceous series is found along the entire south shore of Witch bay and on the south side of Andrew bay west of Clam island. It occurs on the south side of Pipestone peninsula, the south side of Hay island, most of Middle island, all of Scotty island, and nearly all of the small islands to the south. An arm of the body extends into Bald Indian bay west of Sultana island. A smaller strip runs through the centre of Gibi lake and is apparently separated from the main body to the west by greenstones, the nature of which is somewhat doubtful.

[1]A. L. Parsons, op. cit., p. 217.

The series consists largely of quartz porphyry and quartz-feldspar porphyry, commonly quite massive but mostly occurring as an agglomerate or finer fragmental. Practically all types are somewhat sericitic and in places can be observed to grade directly into fissile sericite schist and even into slate. In the field an attempt was made to separate the different types, but it was soon found that although they occur roughly in bands more or less parallel to the strike, all types grade into each other and are not capable of separation.

Mapped with this series are a number of small intrusives. Some of these may be contemporaneous, but it is believed that many of them are post-Keewatin, very probably related to the Laurentian. They are commonly feldspar or quartz-feldspar porphyry.

The only masses of appreciable size that could have been separated are those found at Devils gap and within the Indian Reserve. It is probable that they should be distinguished from all other formations, as they do not resemble any of the granitic or gneissic rocks and their age is by no means certain.

Quartz-Feldspar Porphyry.—The porphyries may contain either quartz or feldspar, or both, as phenocrysts. From their appearance in the field, feldspar porphyry is more common.

The types of porphyries found are so numerous that it would be useless to attempt to describe them individually. A particularly fresh quartz porphyry with a dense greenish-grey matrix is found on the southwest tip of island No. 208 north of Sultana island; on islands Nos. 210 and 204, it is found associated with agglomerate. In thin section there are numerous large quartz phenocrysts and some feldspar crystals, the latter almost entirely altered and more deformed than the quartz. The groundmass is fine-grained sheared quartz with a little sericite and chlorite.

On the west side of island No. 192 is a particularly hard brittle type of quartz porphyry, with an almost black matrix, in sharp contact with the greenstone. Agglomerate was found on island No. 145, and flow structure was observed on the north tip of island No. 151. A very chloritic type of feldspar porphyry, which occurs on a number of the islands, may be seen on the east shore of Kipling island.

Typical sheared quartz-feldspar porphyry is found on the northwest shore of Square island. Phenocrysts are not prominent except on the weathered surfaces. The matrix is a light-green schist. In thin section the feldspars are highly altered. The groundmass is composed of quartz, sericite, and chlorite, highly sheared.

Agglomerate.—The fragments in the agglomerates appear to be of the same composition as their matrix. As this rock is practically always highly altered and the matrix alters much more readily than the fragments, it is rather difficult to determine the original character of the matrix. It is probably tuffaceous in most cases, but may be flow material in others. No evidence was anywhere observed to show that it is intrusive. The fragments in places are as large as 2 feet or more across, but ordinarily are only a few inches. All gradations in size doubtless exist, but the outlines of the smaller ones are more easily obliterated by shearing. In the coarser, unsheared agglomerates, the long axes of the fragments appear to show rough alignment. In most agglomerates the fragments are so deformed that the original shape and attitude is destroyed, and in extreme cases they appear as thin hard lenses in schist.

West of Middle island on island No. 553 is an excellent exposure of coarse fresh agglomerate. The fragments are not excessively distorted. Their long axes are roughly parallel and strike about N. 55° E. (see photograph on page 64).

Sericite Schists.—These schists are the direct result of the metamorphism of the porphyries and agglomerates of the siliceous series into which they grade. They are composed of sericite, quartz, carbonate, and other minerals. Some are probably talcose. Typically, they are various shades of greenish-yellow, but the weathered outcrops are commonly rusty, owing to the considerable amount of iron-bearing carbonate that they contain, often as small euhedral rhombs thickly scattered between the *laminae*. Quartz phenocrysts are commonly preserved. The schists derived from the darker types of porphyries appear to contain much more carbonate and some chlorite, resulting in a darker and less fissile type. The basic quartz porphyry described later appears to occur in places as a sericite-carbonate schist.

The fissility of these schists approaches that of slates in a few cases, and large thin slabs may be broken off, which ring when struck.

A narrow strip of fissile schist runs along the north shore of Witch bay, and good exposures are common on numerous points of Andrew bay and



Coarse volcanic agglomerate, comparatively fresh, island No. 553, west of Middle island.

the islands to the west. The outcrops of these schists usually show a flatter dip than the original, due to recent slumping.

Tuffaceous(?) Sediments.—Along Witch and Andrew bays and on some of the islands a few narrow banded lenses occur within the porphyries and agglomerate.

On island No. 339 in Witch bay a laminated cherty rock is interbanded with feldspar porphyry and strikes N. 85° E. On the mainland, south of the island, and in various spots to the west for over half a mile, dark shaly or slaty rocks, some quite black, are interbanded with rocks resembling fine greywackés and quartzites, striking east to southeast. Rocks with a rather coarse tuffaceous appearance occur on the east end of island No. 340. They are composed largely of highly altered crystals of feldspar, with some quartz, in a scanty matrix.

On the south side of Middle island between islands Nos. 26 and 129 is a similar series, which is most interesting. The beds are about vertical and are considerably distorted, showing drag folds and a fault, the south side having moved west relatively The beds strike from N. 45° to 75° W. The top of these beds is toward the southwest.

In the small bay south of island No. 553 and west of Middle island is a banded strip, striking about N. 85° W., which shows a fault plane, striking about N. 25° W., the west side having moved north.

Several other small outcrops of banded rock were observed, but the above are the most interesting.

Intrusive Diorite and Associated Quartz Porphyry

This intrusive extends in a more or less continuous band from a point near the granite contact east of Stella lake westward between Moore and Andrew bays and across Pipestone peninsula and Hay island. It constitutes most of the group of islands between Middle and Hay islands. Here the strike changes abruptly, as does that of the whole of the Keewatin. Similar rocks were noted on the northeast end of island No. 220 and along the west side of Bald Indian bay. Other bodies occur between French narrows and Bottle bay, and a long narrow strip lies inland south of Witch bay.

The coarse phase is an easily recognizable rock; bladed greenish amphibole crystals intersect each other and are set in a whitish matrix of highly altered feldspar, which gives a characteristic texture. It is undoubtedly the rock described by Lawson[1] as a "rather coarse-textured, mottled, green and white rock, from the north side of the east end of Andrew bay." In thin section it is described as follows, agreeing essentially with the writer's observations:—

> Very much altered. Plagioclase originally predominated, but this has almost entirely changed into saussurite. Now and then a very opaque crystal remains that has not been completely altered. The hornblende is in comparatively small quantity. It is very light green and feebly pleochroic. Associated with it are sphene and leucoxene. Considerable calcite occurs in the groundmass.

For some time the relation between this and the quartz porphyry was not suspected. On mapping the two types, however, their association became apparent, gradations toward each other were observed, and finally a few cases were found where the change from one type to the other could be traced without any question. The fine-grained porphyritic type, often recognizable only by its quartz phenocrysts, is most difficult to identify in places as the phenocrysts are not always present. When they are too small to be seen with a lens, the rock closely resembles the altered lavas. This is particularly true of Pipestone peninsula and Hay island.

As the coarse phase of this intrusive has little or no quartz, it must be regarded as a rather highly differentiated body. Some phases are probably more basic than a diorite. Certain coarse-grained, rusty-weathering magnetic bodies south of Magnet and Lodestone lakes may be related to it. On the other hand some of the porphyries are remarkably high in quartz, as, for example, those on the southeast side of island No. 83 in the group between Middle and Hay islands.

Typical, comparatively fresh, coarse-grained diorite may be readily observed on the west side of the northeast arm of island No. 71 and on parts of the islands to the south, along the south side of Moore bay east of Pipestone portage, and at several places on the north shore of Andrew bay and southeast of the portage. The altered and sheared phases are numerous. The body shown on the map east of Pipestone point is practically unrecognizable on the north shore, as a strong shear zone follows the shoreline and carbonate and chlorite schists only are to be seen. On the south shore and on top of the intervening ridge the diorite is fairly typical.

The quartz porphyry phases are of innumerable types, and there are all gradations into the coarse diorite. For the most part they lie along the borders of the intrusive bodies but may occupy its whole width. On the

[1] A. C. Lawson, op. cit., p. 46.

whole they are quite similar to greenstone or altered "trap" but are commonly massive and nearly always show small quartz eyes, which are often seen only with a lens but may be quite conspicuous. As most of the exposures on the shore are parallel to the strike and are commonly sheared, the gradation of these porphyries into the typical coarse intrusive is not easily observed without crossing the ridges inland, and there drift commonly prevents observation. It may be observed quite well at a point directly north of island No. 312 across Pipestone peninsula. An examination of the group of small islands just north of the deep bay in Middle island is quite convincing.

Porphyritic Intrusives

There are a few porphyritic intrusives, mostly small, which are certainly later than the fragmentals. Some of them cut the diorite. They are believed to be related to the Laurentian granites; as there is no proof of this relation and they are similar in appearance to many of the siliceous porphyries just described, they are included here.

Two outcrops on the Indian Reserve south of Devils gap and northeast of island No. 211 may be the same intrusive. The southern one is a sheared light-grey quartz porphyry. The northern one, also a quartz porphyry, is more granitic in appearance.

Just south of the entrance to Devils gap proper, mostly on the west side, a dark greenish-grey, fine-grained porphyritic rock with a somewhat granitic appearance is intrusive into ellipsoidal greenstone. The outcrops of porphyry shown in the north central part of the Indian Reserve are largely a light greenish-grey felsite.

Narrow acid dikes, usually only a few feet wide, are quite numerous. They have been observed cutting the basic quartz porphyry, e.g. on the east side of island No. 323 southeast of Pipestone portage and in the small bay on the north shore directly east of Pipestone point.

A rather remarkable quartz-feldspar porphyry occurs at the south end of the bay in Pipestone peninsula opposite island No. 312. The matrix is dark-grey and fresh. Feldspar phenocrysts up to a quarter of an inch in length are numerous. The intruded rock here is rhyolitic.

Ankerite Deposits

Besides the disseminated carbonate occurring in the schist, there are dikelike masses which have been well described by Lawson[1] and have also been mentioned by Parsons,[2] who cites one of them cutting across Square island. Although occasionally quite massive, they are simply an accumulation of dolomitic stringers between the *laminae* of the schist. The rusty outcrops have a characteristic rough surface with a raised network and ridges parallel to the schistosity.

A considerable mass of this rock occurs on Hay island south of island No. 97, and other outcrops are not uncommon.

Laurentian Gneisses and Granite

These rocks have been so extensively described and discussed in previous literature that only brief comment will be made here. The main body of the Laurentian shows many types of granite. They may be pink or grey, coarse or fine grained, porphyritic or granular, gneissic or massive, and may contain little or much biotite. This is doubtless the result of multiple intrusion. On the whole, the contacts are sharp, and contact breccias are remarkably developed in places (see photograph opposite).

[1] A. C. Lawson, op. cit., p. 59.
[2] A. L. Parsons, op. cit., p. 221.

The writer found no reason to believe that the outlying granite bosses are of a different age to the main body. One of these occurs in the interior of Pipestone peninsula, two about a mile east of Bottle bay, one at the narrows between Allie island and island No. 403 (considered as one island on older maps), and one on the east end of island No. 426. This last is a peculiar rusty altered type but undoubtedly granitic. The outcrop on the west side of Bottle bay was discovered to be quite small.

The porphyritic granite of Quarry and Sultana island appears to be unique in this area and deserves mention here.[1]

Keweenawan Quartz Diabase

One of the dikes described and traced by Parsons[2] cuts a few of the islands southwest of Hay island. It cuts the southwest tip of Scotty island and the east end of Slate island and runs across island No. 430 west of Queer



Breccia at the granite-greenstone contact, Route bay, west of Blindfold rapids.

island. It was not observed elsewhere by the writer's party, but Parsons[3] has mapped it just west of French narrows.

The rock has been well described by Parsons, who says it is a quartz diabase consisting of labradorite, augite, quartz, and ilmenite. On Slate island, where it cuts across the slaty sericite schists, it contains enstatite. On the east side it is in contact with a finely and regularly banded rock, which strikes east and west and dips about 85° N. At the north end the dike has a rather notable gneissic border. Although narrow it shows a remarkable gradation from a medium to coarse grained rock, with an almost granitic appearance and texture, through a dark, brittle, fresh diabase, prominently jointed, to a fine-grained black trap at the contact.

The lamprophyre dikes as described by Bruce[4] may be of nearly the same age as these quartz diabase dikes. Although no new ones were observed in granite, similar dikes are not rare. One in the southeastern part of Bottle bay is quite prominent.

[1]Ont. Bur. Mines, Vol. XXXIV, pt. 6, 1925, p. 16.
[2]A. L. Parsons, op. cit., pp. 222-225.
[3]Ibid, p. 211.
[4]E. L. Bruce, op. cit., p. 15

Glacial Deposits

The glacial deposits of the area are unimportant in extent and consist of boulder drift. The southwestern portion of Hay island is largely drift covered, and an appreciable area of drift with scarcely any outcrops was encountered northeast of Gelley lake.

There is little evidence that glaciation removed much unweathered rock from this region. At the water level on island No. 313, south of Pipestone point, a small patch was observed which entirely escaped the latest glaciation.

Structure

Other than the general strike of the formations and contacts, the only positive evidence as to structure is obtained from the banded lenses found in the siliceous rocks already described. The basic rocks show practically no large-scale structure of any kind. There is every reason to believe, however, that the schistosity is practically parallel to the contacts of the flows and fragmental beds, and the granite appears to have invaded the schist zone along the axes of anticlines farther than along synclines.

Considered as a whole, the schists bordering the granite appear to be the southwest end of a large truncated anticline. According to Lawson, the Eastern peninsula is occupied by an anticline. If this is so, a long, tightly folded syncline follows Andrew and Witch bays, parallels the portage to Gibi lake, and continues through Gibi, Andy, and Gelley lakes toward the granite, swinging from east and west to almost northeast-southwest. Pine Portage bay appears to lie in a syncline, and it seems probable that the granite of Quarry and Sultana islands occurs in an anticline, both having a trend somewhat east of north.

Along the west side of Scotty island at the contact between ellipsoidal lava and a banded rock, good evidence was obtained that the formations strike about N. 10° E. and are on the east arm of an anticline, possibly extending through Bare point, in which case Bald Indian bay occupies a syncline.

The strike of the formations changes abruptly along a line from the centre of Hay island past the south end of Middle island. This is probably due to faulting. In this vicinity the strike of the schists may give little clue as to the general strike of the formations. A more thorough study of the banded lenses of the siliceous series might throw further light on the structure.

ECONOMIC GEOLOGY

This region has periodically attracted the attention of geologists and the mining fraternity since the earliest days of gold mining in Ontario. The literature contains many references to properties around Bigstone bay. Many of these were of little importance, and even their location would be difficult to find now. The more important ones mentioned in the early literature are Sultana, Ophir, Pine Portage, Keewatin, Winnipeg Consolidated, Gold Hill, Golden Gate, Black Jack, Stella, Jenny Leigh. Later the Wendigo mine and the veins on the Gauthier claims of Pipestone peninsula were discovered.

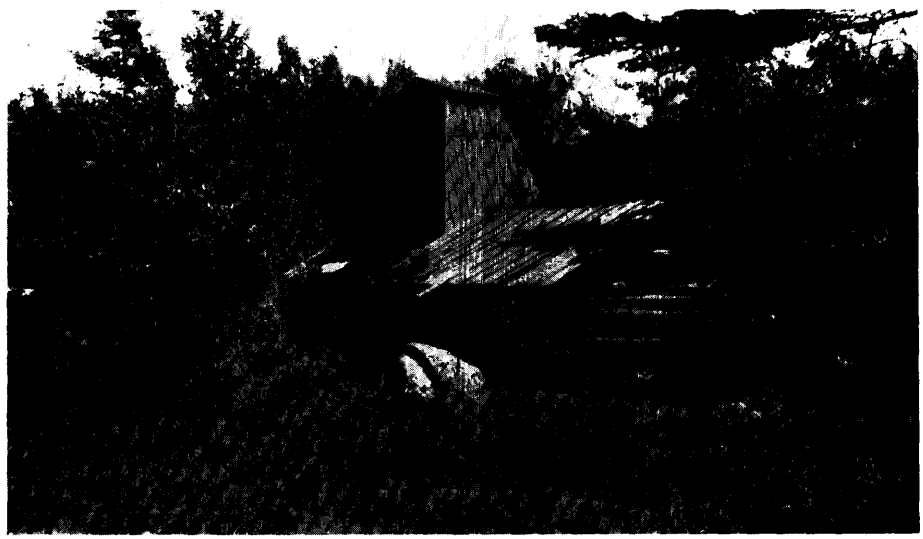
In 1925, Bruce reported on the Sultana, Ophir, and Wendigo mines, and the Gauthier claims. Since that time there appears to have been only one discovery, that known as the Cameron-Earngey copper prospect, and little or no work has been done on any of the other properties. Except for this discovery, little more can be said about these properties, but some comment will be made on a few which were visited by the writer.

During the summer of 1929 interest in the area did not appear to be entirely dormant, but there was practically no activity on any of the pro-

perties. The exceptionally dry weather was doubtless responsible in part, all travel in the region being forbidden on account of the fire hazard.

Most of the gold-bearing veins in this region are closely associated with the contact between the granite and basic schists, many showings being in the schist but some in the granite itself. A few veins are some distance from any granite. These veins are of quartz, usually with more or less dolomite, and are commonly narrow and lenticular in form. Gold may be readily seen with the naked eye in many veins, and such minerals as silver, pyrite, arsenopyrite, chalcopyrite, sphalerite, galena, and tellurides have been reported. Mineralization of the walls of these veins appears to be slight as a rule.

It may be noted that the veins on the Cameron-Earngey claims and at the Wendigo mine that show an appreciable amount of chalcopyrite are



Shaft-house at the Gold Hill mine, Islet lake.

some distance from the granite and probably carry little or no gold. The native copper deposit on Allie island[1] appears to be directly related to a basic intrusive.

Cameron-Earngey Copper Claims

The main showing is in the southwest corner of claim X. 45, just north of K. 2,279, on the mainland just east of Eagle passage. The most important mineralization occurs in a shear zone, about 130 feet long as exposed by trenching, which strikes at 45 degrees and dips about 75° S.E. This zone is more or less heavily mineralized for about 75 feet. The richest part is lenticular and not over 5 feet wide. The walls of the shear zone are composed of a dark, hard, fresh variety of greenstone, which is disturbed and brecciated but not appreciably mineralized.

The mineralization consists of networks of pyrite, chalcopyrite, and probably some pyrrhotite, associated with lenses and veinlets of quartz and dolomite. Quartz occurs in a fine granular state as well as in coarse eyelike bodies in sugary carbonate, which, in places, contains numerous elongated crystals of epidote. The carbonate, however, also occurs as crystals as much as an inch across. Malachite and other secondary copper minerals

[1]Ont. Bur. Mines, Vol. XX, pt. 1, 1911, p. 175.

are abundant and form crusts of appreciable thickness. Although the lens had been blasted out to a depth of 10 feet in places, the bottom of the oxidized zone was not reached.

A grab sample of the richest-looking and freshest material from several places on this showing assayed copper, 12.66 per cent.; gold, none. A sample of the oxidized ore showed copper, 5.92 per cent.; gold, none.

Two sheared or brecciated zones have been exposed in trenches to the southeast, but there the mineralized portions are quite small. Other workings to the east have revealed little or no mineralization.

Sultana Mine

The Sultana mine[1] was for some years the foremost gold mine in Ontario and operated continuously from 1891 to 1906. At the time the writer



Main shaft, Wendigo mine, Witch bay.

visited this mine, it was in the hands of a caretaker and in the same condition as it has been for some years. Practically all the hoisting machinery has been removed, but the stamp mill is still intact. Interest in this property is far from dormant and it seems probable that it will be reopened eventually.

Wendigo Mine

The Wendigo mine[2] is located 20 chains south of the east end of Lac La Belle and is reached from the north shore of Witch bay by a road nearly three-quarters of a mile long. During the previous year, the property had been sampled both on the surface and in the shaft, and the vein had been cleaned off fairly well for this purpose.

The vein as exposed between the west and east shafts strikes about N. 80° E. and is about 260 feet long. From the main or east shaft it continues due east for another 100 feet and apparently pinches out. The best showings are in the latter section, the vein being $2\frac{1}{2}$ to 3 feet wide in places. The average width of actual vein material, however, is considerably less. The vein is of quartz with pyrite, pyrrhotite, and chalcopyrite, the

[1]E. L. Bruce, op. cit., p. 15.
[2]Ibid, p. 20

sulphides being almost massive in places. Locally, the country rock contains much quartz, but it appears to be barren.

Pine Portage Mine

This mine is situated about half a mile east of the north end of Pine Portage bay. It was at one time (1884) the most important development in the Bigstone bay region.

In a cut north of the shaft, the writer observed a shear zone, about 7 feet wide, striking due north and dipping vertically or very steeply to the east. About 2½ feet of white quartz was exposed, but it seemed lenticular. The country rock is a dark, fine-grained greenstone. The granite contact is found a few chains to the south. The ruins of the mill may still be seen.

Stella Mine

This property is situated west of Stella lake and is reached by an old road from the extreme east end of Andrew bay. About 30 chains west of the lake is a shaft and a tunnel, which strikes about N. 50° W. Here a vein of quartz about 2 feet wide carrying sulphides is exposed; it has a steep dip to the south.

About the middle of the west side of the lake is a rather heavily pyritized shear zone, from 10 to 15 feet wide, striking N. 55° W. Quartz is not prominent. A small shaft has been sunk.

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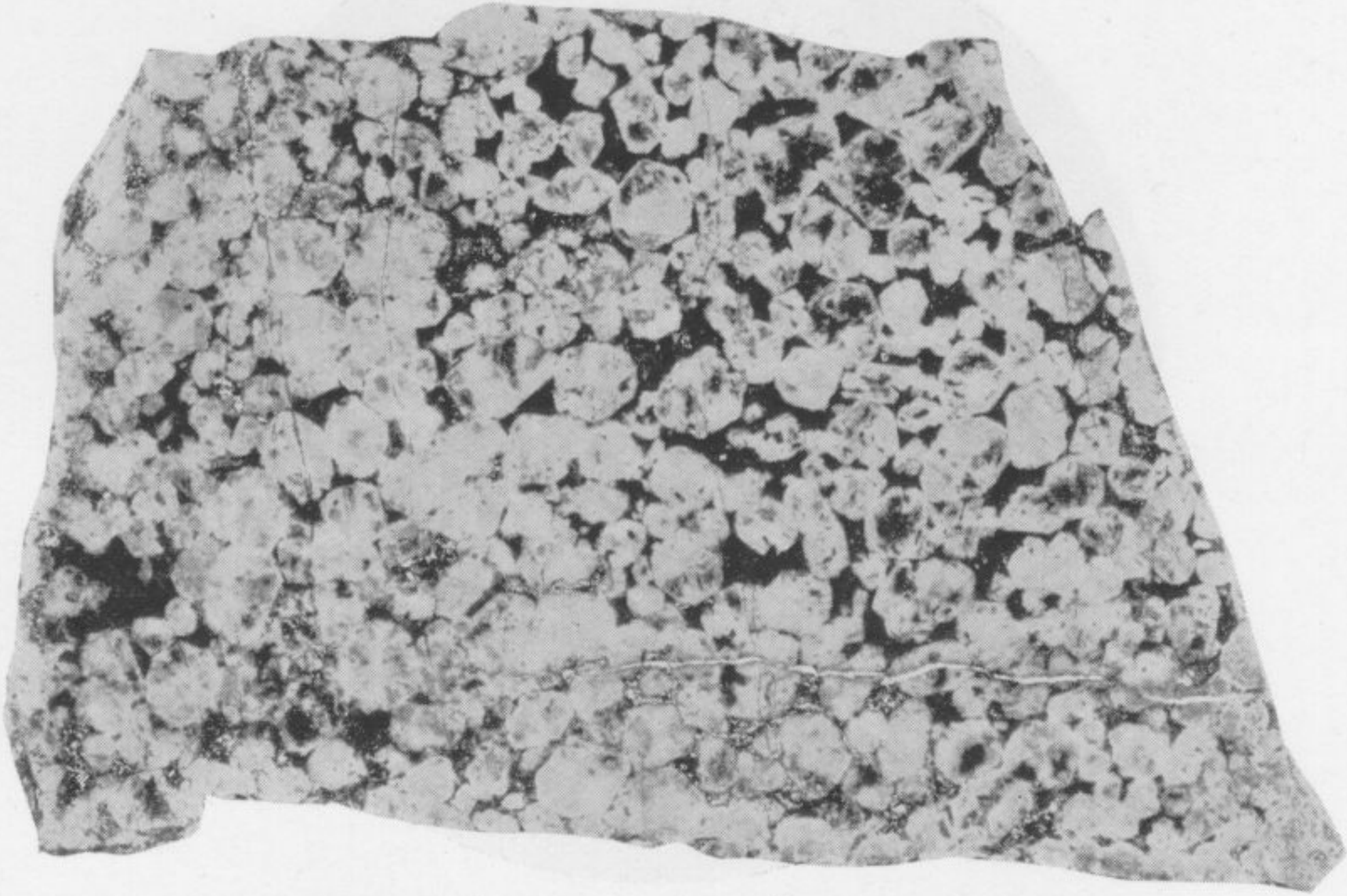
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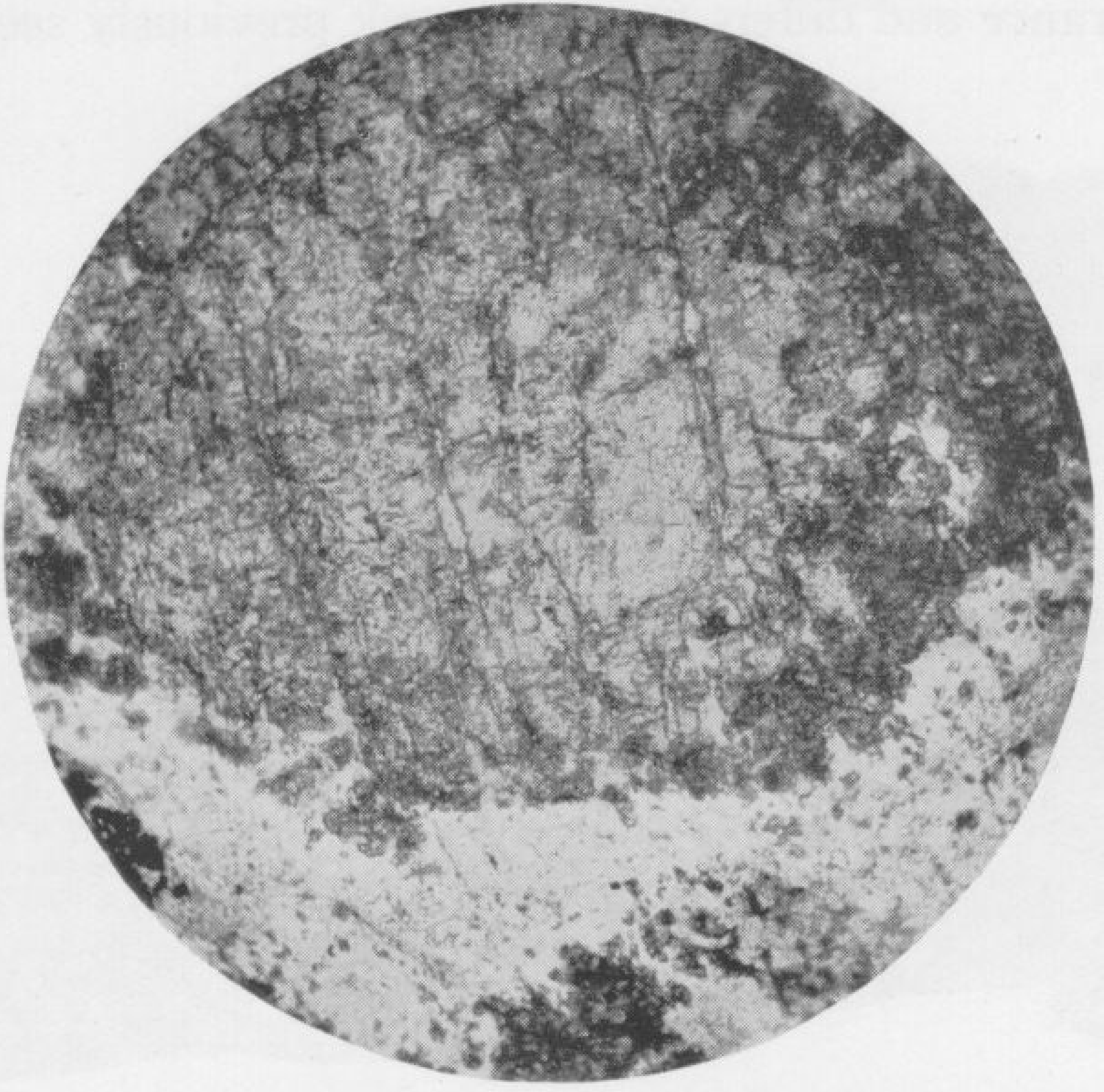
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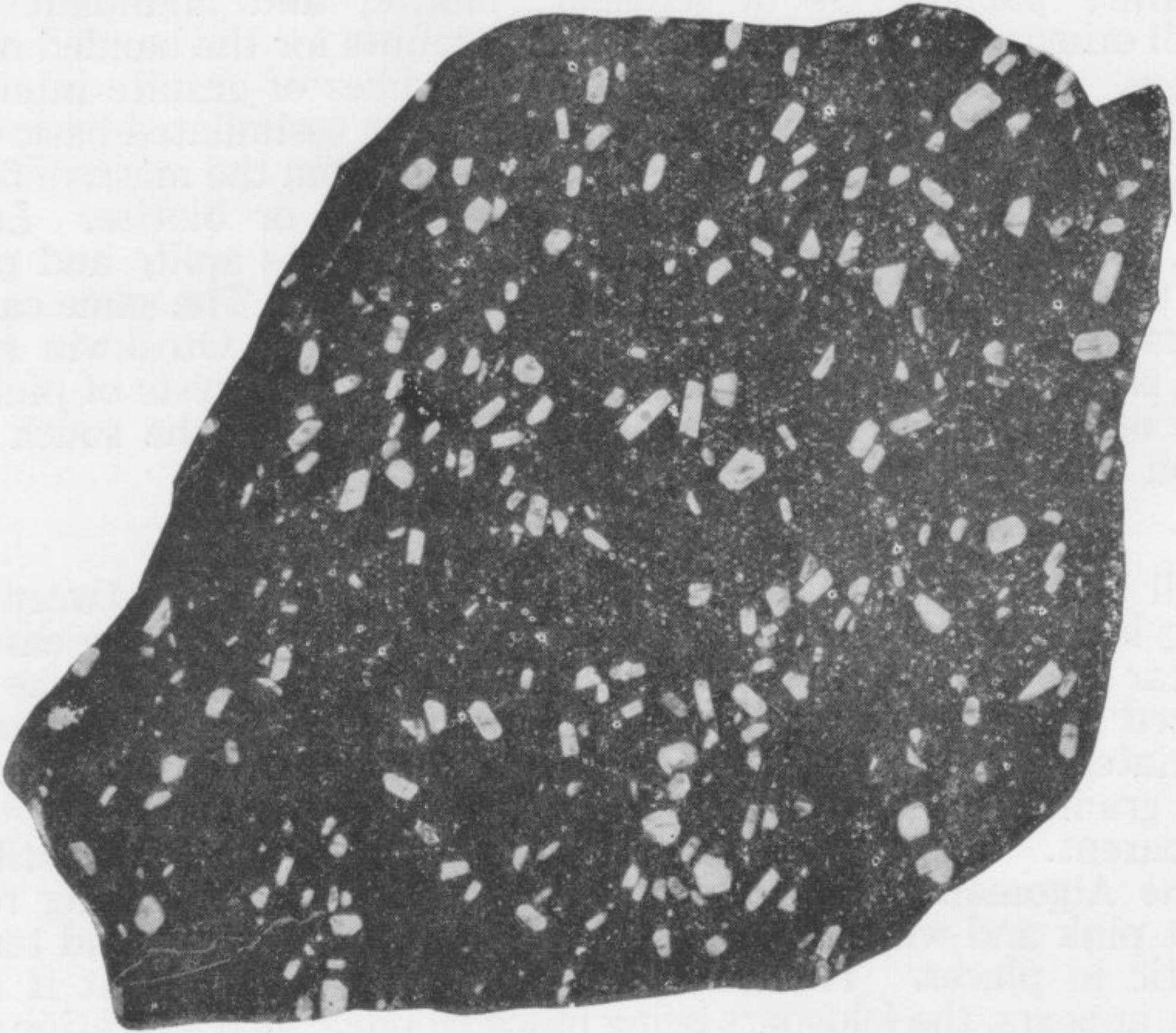
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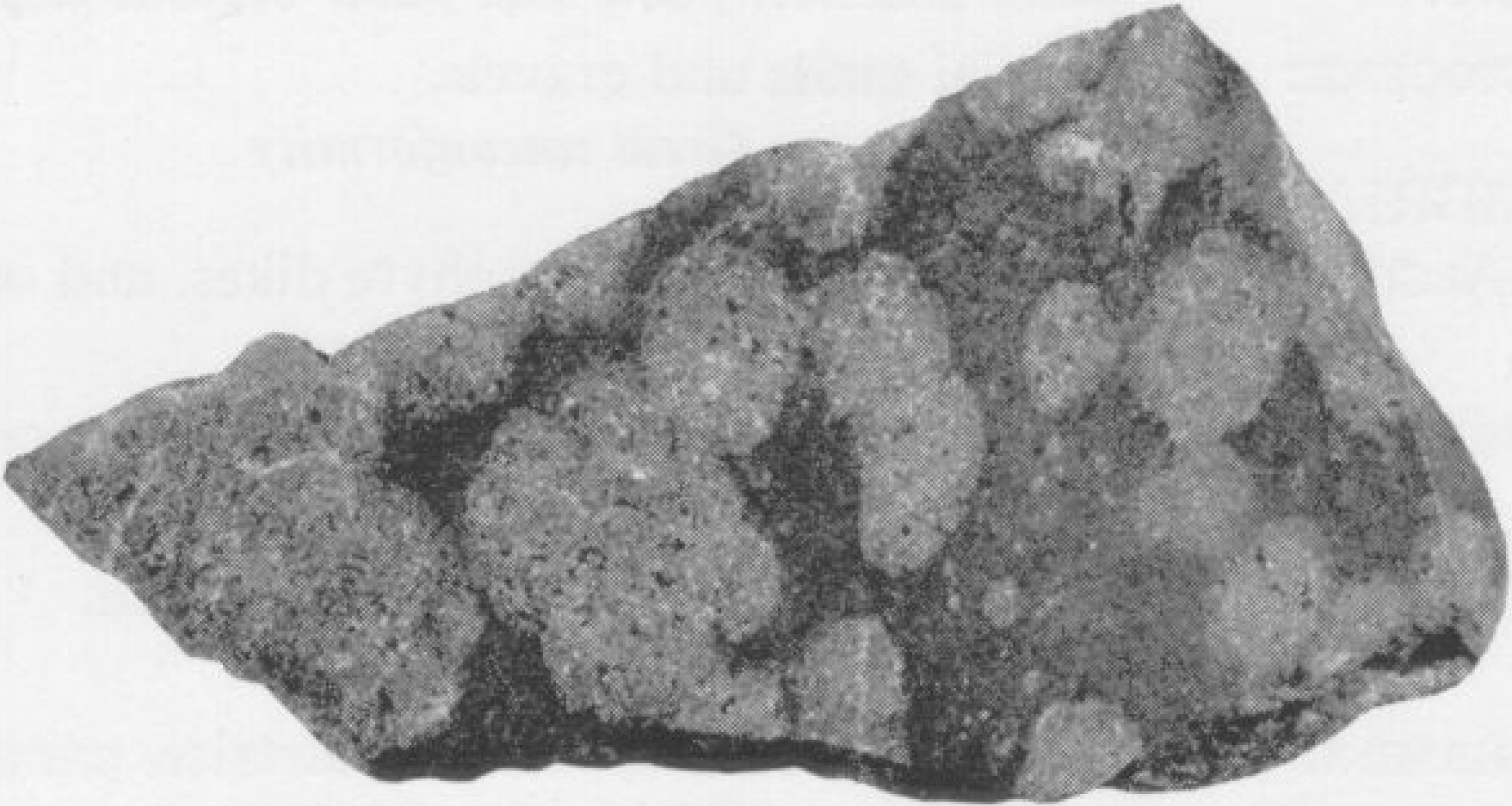












Box #2



PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

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OF THE

ONTARIO DEPARTMENT OF MINES

BEING

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The Ceramic Industry of Ontario

BY

Robert J. Montgomery

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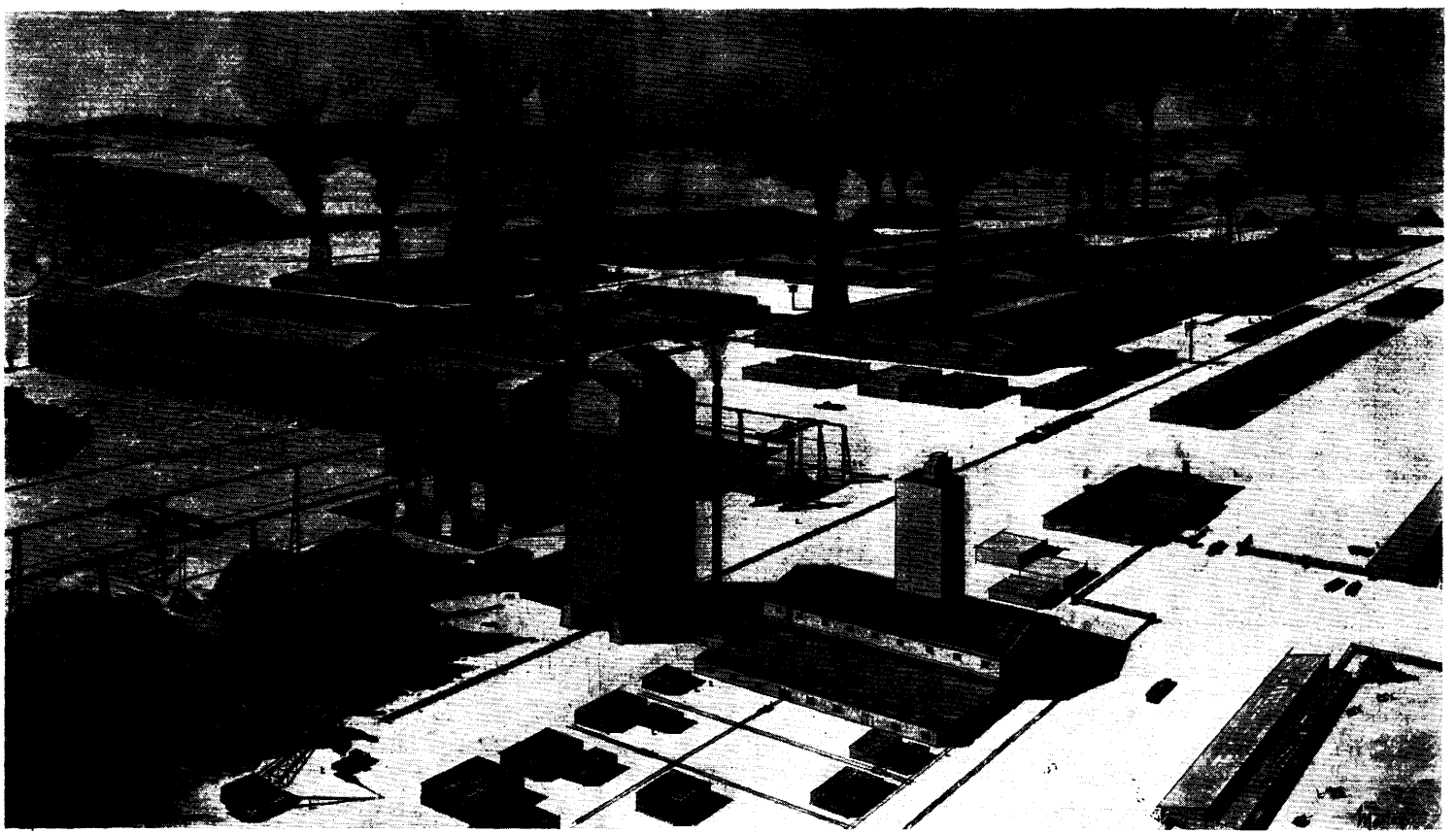
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KEY MAP

(In pocket at back of report)

Map No. 39*c*.—Key map of part of the Province of Ontario, showing location of plants for the production of Heavy Clay Products. Scale, 16 miles to the inch.



A general view of a modern clay- and shale-working plant, Cooksville Company, Cooksville.

THE CERAMIC INDUSTRY OF ONTARIO

By Robert J. Montgomery

INTRODUCTION

In 1906 a survey of the clay-working plants of Ontario made by M. B. Baker was published by the Ontario Bureau of Mines under the title "Clay and the Clay Industry of Ontario."[1] Since that time many changes have occurred and improvements have been made in the industry. A resurvey was suggested to the Ontario Department of Mines by the Canadian National Clay Products Association. As the time was opportune, such a survey was arranged.

The manufacturers of clay products, realizing that more technical knowledge was needed in their industry, through their association, the Canadian National Clay Products Association, asked the University of Toronto to inaugurate a Ceramic Department. The request was accompanied with an offer to help finance it for the first three years. The outcome was the inauguration of the Ceramic Division of the Department of Metallurgy in 1925. Already several graduates have entered the local plants, and the clay industry will not now have to go beyond the province for technical men.

The members of the Canadian National Clay Products Association are largely manufacturers of heavy clay products, including brick, hollow building-block, drain tile, and sewer pipe. The ceramic industry covers a much wider field than this and includes the manufacture of most of the non-metallic mineral products such as refractories, pottery, whiteware, terra cotta, glass, and enamelled iron, as well as abrasives, cements, lime, and plaster.

The entire field is too extensive to cover in one report, and the object of this survey was to cover the heavy clay products industry in some detail and to give general information on the other branches of the ceramic industry. The information in this report is drawn from a wide variety of sources, including Dominion and provincial government reports and ceramic text-books and literature, as well as from personal notes and observations obtained in visiting the various plants and talking with the manufacturers. As far as possible reference is made to the source of the information, and credit is given for material copied.

In this introduction I want to acknowledge the co-operation of the Canadian National Clay Products Association through its Committee on Ceramic Education, its secretary Gordon C. Keith, and its members. All the manufacturers, superintendents, and men at the various plants, whether members of the association or not, were most generous in giving of their time to further the object of this survey. I hope the finished report will contain information that will be of value to them.

Ceramics

The word "ceramics" is derived from the Greek work "keramos," which refers to "a potter," "potter's clay," or "pottery." The Greek word is related to an older Sanskrit root meaning "to burn."[2] Modern usage has extended the meaning to cover non-metallic mineral products. The following classification of ceramic products given by Hewitt Wilson[3] is fairly complete.

---

[1]Vol. XV, pt. 2.

[2]W. A. Oldfather, Etymology of the Word Ceramics, Jour. Amer. Cer. Soc., Vol. 3, 1920, p. 537.

[3]Ceramics—Clay Technology, McGraw-Hill Book Company, New York, 1927, p. 2.

CLASSIFICATION OF CERAMIC PRODUCTS

STRUCTURAL CERAMICS:
1. Common brick.
2. Paving brick.
3. Face brick.
4. Sewer pipe.
5. Drain tile.
6. Hollow block.
7. Terra cotta.
8. Conduits.
9. Roofing tile.
10. Flue linings.
11. Floor tile.
12. Wall and fireplace tile.

REFRACTORIES:
13. Fire-clay brick.
14. Magnesia brick.
15. Silica brick.
16. Chromite brick.
17. Bauxite and diaspor brick.
18. Special refractories.

POTTERY:
19. Tableware.
20. Kitchen ware.
21. Art pottery.
22. Sanitary ware.
23. Stoneware.
24. Chemical stoneware and porcelain.

GLASS:
25. Household.
26. Window.
27. Bottle.
28. Lighting.
29. Optical glass.
30. Glazes, enamels, and artificial stones.
31. Quartz glass.

ENAMELLED METALS:
32. Household and kitchen.
33. Sanitary.
34. Chemical.
35. Advertising.

ABRASIVES:
36. Silicon carbide.
37. Aluminous abrasives.

CEMENTS, LIMES, AND PLASTERS:
38. Portland cement.
39. Building, agricultural, and chemical lime.
40. Calcined gypsum products.
41. Magnesia cement.
42. Dental cement.

INSULATION:
43. Electrical insulators.
44. Thermo insulators.

All of the above list of products are not manufactured in Ontario, but all are used. There is, therefore, a large potential industry yet to be developed. Government statistics for 1929 are given below for the main items for both the Dominion and the province.

CLAY PRODUCTS MARKETED, 1929

	Ontario[1]	Canada[2]
Brick:		
Soft-mud process — Face	$522,191	$361,063
Soft-mud process — Common	606,714	1,922,657
Stiff-mud process — Face	1,333,723	2,378,779
Stiff-mud process — Common	505,958	1,721,493
Dry-press process — Face	611,625	717,141
Dry-press process — Common	76,016	351,084
Fancy or ornamental	9,012	21,986
Sewer	92,316	82,598
Paving	.....	7,085
Fire	.....	247,908
Fire clay	.....	34,042
Fire-clay blocks and shapes	.....	95,319
Hollow blocks	972,993	2,068,206
Roofing tile	4,628	4,628
Floor tile (quarries)	70,186	45,679
Drain tile	629,322	687,955
Sewer pipe, copings, flue linings, etc.	1,167,463	2,002,830
Pottery, glazed and unglazed	96,394	327,650
Haydite	131,621	.....
Other clay products	.....	142,566
Total	$6,830,162	$13,222,476

[1]Statistical Review of Ontario's Mineral Industry in 1929, Ont. Dept. Mines, Vol. XXXIX, pt. 1, 1930.
[2]Preliminary Report on the Mineral Production of Canada, 1929, Dom. Bur. Statistics.

OTHER CERAMIC PRODUCTS MARKETED, 1929

	Ontario	Canada
Refractories (from imported clay)	$156,764	$374,555[1]
Porcelain insulators (from imported clay)	2,065,404	2,065,404[1]
Silica brick	80,374	173,581
Artificial abrasives	[2]	7,551,822[1]
Abrasive products	1,410,129	1,410,129[1]
Glass, pressed and blown	[3]	11,197,338[1]
Glass, cutting and bending	3,467,908	4,399,476[1]
Gypsum	832,689	3,345,696
Feldspar	206,979	340,471
Lime	3,364,412	5,908,610
Cement	6,608,246	19,337,235

[1]Preliminary figures.
[2]Figures not available.
[3]Only 2 plants in Ontario.

Figures for enamelled metal are not included as the enamel only and not the metal is classed as a ceramic product.

Importations of clay products into Canada amounted to $12,159,566 in 1929. Some of the larger items are:—

Earthenware and chinaware	$6,257,954
Fire brick	1,876,585
Fire clay	322,508
China clay	292,980
Electric insulators	556,535
Silica brick	330,592

Exports of clay products in 1929 amounted to $375,506, porcelain insulators accounting for $268,109 of this amount.

The Heavy Clay Products Industry

HISTORY

The general term "heavy clay products" includes brick, drain tile, and hollow building-block. The first of these to be made in Ontario was brick and its manufacture was started at least a hundred years ago. Curtis Brothers, of Peterborough, showed me samples of brick more than a hundred years old made by hand by Lazarus Curtis, grandfather of the present owners of the plant, who made brick in England and started a plant about 1825 when he came to Canada. His son Mark carried on after his death, and now three grandsons own the business.

One of the older brick churches is at Woodstock, Oxford county. Old St. Paul's Anglican church on Dundas Street was built in 1834, using a hand-made red soft-mud brick from a local brickyard. Among the older churches in Toronto is the Church of St. George, 197 John Street, built in 1844 from soft-mud brick, which shows little effect of time.

Many of the older brick plants have been handed down from father to son. In many cases the business of such plants has increased very little, each generation being content with a reasonable output, which would afford a comfortable living, and changing the production and equipment just enough to hold a reasonable amount of business. In only a few cases has the older plant developed with the country, increasing steadily with its increased growth. Many have failed to modernize equipment, business methods, or type of products. The newer companies, often incorporated to give more capital, have taken care of the changing and increasing demand for structural products. We are now entering into a period of consolidation

of plants. The recent consolidation of several sewer-pipe plants and the grouping of the brick plants in the Toronto area are examples.

The family or personal plant is passing to a large extent. The buiidings of to-day, such as public schools, are larger, and the small local plant often cannot produce brick fast enough to keep up with construction. Shipping from centres of large production has become common. The business of meeting the demands of the public is now the dominant factor, and the clay plant is no longer just a means of livelihood for the artisan. This new outlook on business demands modernization, including more technical knowledge of raw material and finished product, modern methods of production, cost accounting, sales promotion, standardization, and co-operation through trade associations.

From 1830 to 1840 brick were made by hand, using the slop-mud method. Mechanical power or machinery of any kind was not available. Brick were made to meet local needs, and there were few facilities for transporting such heavy products. In 1840, the population of Upper Canada was only 432,159 and was quite widely scattered.

POPULATION OF ONTARIO, 1791-1928[1]

1791	(Upper Canada)	about 15,000
1806	" "	70,000
1824	" "	150,069
1840	" "	432,159
1871		1,620,851
1881		1,926,922
1891		2,114,321
1901		2,182,947
1911		2,527,292
1921		2,933,662
1928		(estimated) 3,229,000

Very little manufacturing was done in the early days, outside of the grinding of grain. Weaving was a home industry, as was brick-making. Factories did not appear until about 1860,[2] and there were very few plants of any size before 1890. Probably the first clay-working auger machine made in Canada was manufactured in 1875 by Mr. Darville, of London, Ont. The machine was similar to the Tecumseh auger machine made in Tecumseh, Mich. An old clay worker told me that Mr. Darville was in business only about 10 years.

In 1884, H. C. Baird, Son, and Company, Limited, of Parkhill, Middlesex county, made their first Kells auger machine, which is now so widely used. The son, Oliver Baird, was particularly interested in clay-working machinery. He died in 1929 in his seventy-first year, and the business is now in charge of the grandson, A. O. Baird. Oliver Baird also made soft-mud machines about the same date, 1885. These included two types, the Iron Quaker and Martin. The Martin machine was originally made in the United States by Henry Martin, starting in 1858.[3] The dry-press method of making brick was introduced about 1890, the machine being made in Toronto by the Berg Machine Company. The Don Valley Brick Works, now owned by the Toronto Brick Company, and the Milton Brick Limited, of Milton, being among the first users.

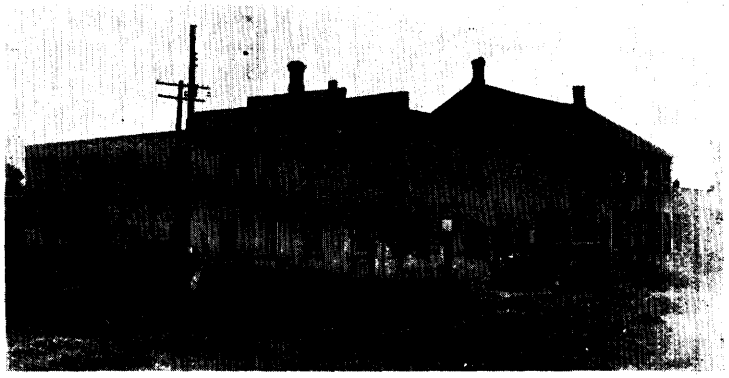
The hand-moulding method, which is no longer in use, had practically disappeared by 1905. The dry-press method remains unchanged. The soft-mud machine has changed very little except for increased capacity and a limited amount of automatic handling. There has been a remarkable advance in the production of the auger machine, and in the larger plants the heavy modern auger, imported from the United States, will

[1]The Canada Year Book, 1929.
[2]Ibid.
[3]Ceramic Products Cyclopedia, 1928, p. 333L.

easily produce 60,000 to 70,000 brick in a 9-hour day and has an estimated capacity of considerably over 100,000 brick a day. These larger machines are not made in Canada, the Baird company only making the smaller ones.

There has been a change in the kind of brick made, and there has been a change in the type of structural materials demanded. Government figures for the value of structural materials in Ontario are divided between clay products and cement, lime, sand and gravel, and stone. The curve sheet on page 6 gives these figures from 1891 to 1928.[1]

Statistics on the value of structural materials are not available before 1891, and up to 1907 clay products was not separated from cement, lime,



Foundry of H. C. Baird, Son, and Company, Parkhill, Middlesex county.

sand and gravel, and stone. The curve sheet shown is an approximation from 1891 to 1907, assuming equal values for the two divisions, which probably is very near to being correct as the two curves parallel each other until about 1914. They have separated markedly since then, indicating the change in demand referred to. The war period, 1914 to 1918, is very noticeable in both curves. Clay products showed a greater loss during this period and has never regained its relative position. The building of cement highways and the exportation of sand and gravel to the United States were outlets for the sale of these materials and are partly responsible for the rapid increase in production.

Common brick are not so widely used now as before the war. Statistics indicate that the production of common brick reached a maximum in 1913.[2]

VALUE OF CLAY PRODUCTS SOLD OR USED, 1913 AND 1925-1929

Year	Brick		Pottery	Drain tile	Sewer pipe	Total
	Common	Pressed fancy, building tile, etc.				
1913	$3,283,894	$1,162,860	$52,875	$292,767	$600,297	$5,392,693
1925	733,693	3,074,780	86,000	360,710	893,443	5,148,626
1926	768,734	3,324,526	87,600	340,403	835,206	5,356,419
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[3]	572,577	974,157	6,177,664[4]
1929	1,281,004	3,524,358	96,394	629,332	1,167,463	6,830,162

[1]Ont. Dept. Mines, Vol. XXXVIII, pt. 1, 1929, p. 4.
[2]Ibid, p. 50.
[3]Includes $400 worth of other products.
[4]Includes Haydite valued at $131,621.

In 1913, the value of common brick was three times that of face and fancy brick, whereas the reverse is true in 1929. The recent increase from 1925 to 1929 must be largely due to the increase in building and the general prosperity of the country. Several factors enter into this change, some of which will be considered in the following paragraphs.

The old soft-mud common brick, made in the eighties and nineties, were used both for the face of the building and for backing up. These

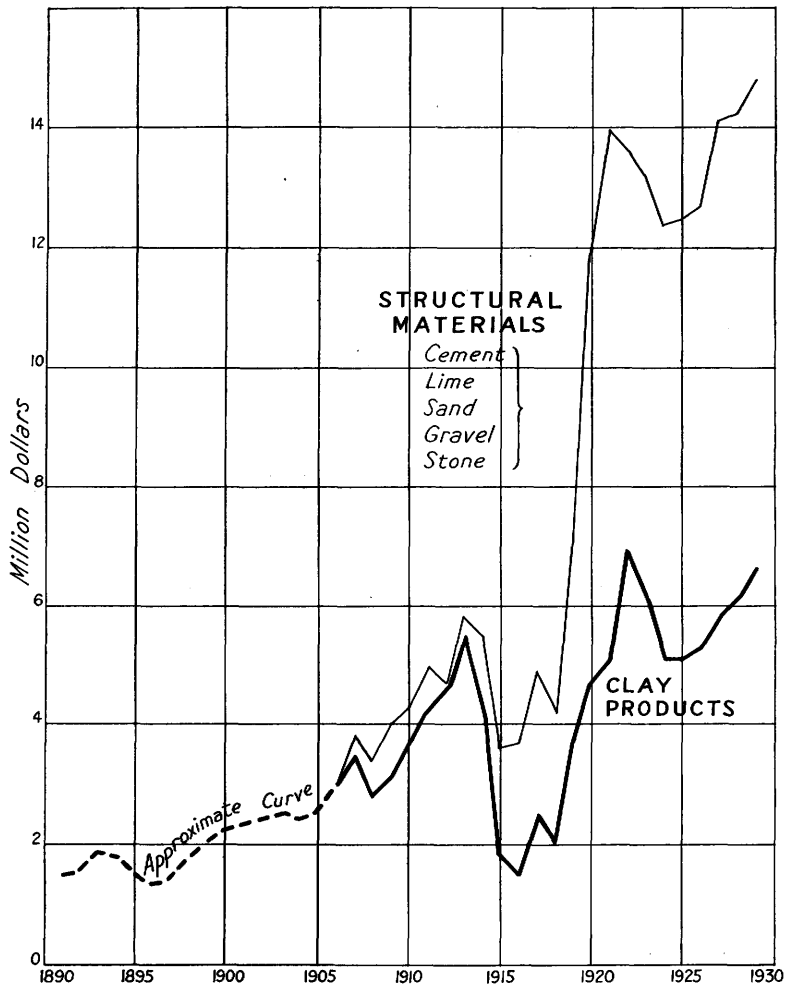


Diagram showing value of production of clay products and structural materials of Ontario, 1891-1929.

brick were burned, and still are in some sections, in the old-fashioned scove or up-draft kiln. This type of kiln usually produces about 60 per cent. well-burned brick and 40 per cent. that are often too soft to be used in exposed positions. Somewhat better burning can be done, but at best the scove kiln gives many soft brick. Due to lack of proper selection many buildings were erected with enough of the softer brick mixed with the others to give partial failure and a disfigured wall after forty or fifty years. Such failures are aggravated where water from the roof is allowed to run down

over the brick work in the winter and where snow is piled against the wall, alternately melting and freezing. These failures have not made a good impression. When the common soft-mud brick were well burned failure did not occur, and we have examples of brick exposed on the outside face for a hundred years and more without any sign of failure.

Down-draft kilns are now generally used to burn the better grades of soft-mud brick. As examples of this we might mention the Greenwood Avenue plants in Toronto and the plants of Curtis Brothers in Peterborough and Fred R. Paxton in St. Catharines. We find that this type of brick, when well burned and of good colour, is still used in some of our best structures. However, such cases are the exception, and we find there is a shift in popular demand from the soft-mud brick to the wire-cut and dry-press brick for face use; the common brick being used only for backing.

Soft-Mud Brick.—Soft-mud brick grades in colour from a good dark-red to almost white or light-cream. A clay low in lime content and high in iron gives the red, and the clays high in lime and relatively low in iron content give the light-buffs or cream. While the cream brick is often called white, it is not white like porcelain or light-buff like some fire clays; in this report such brick will be called cream-coloured. These cream-coloured brick have stood the test of time as well as the red, and some brick men contend that they stand weather better; but they discolour badly when exposed to smoke or dust. The brick are porous and absorb the dust, and cleaning is difficult. Cream-coloured brick when used in the country away from factories and railways give very delightful architectural effects and a pleasing appearance even after years of exposure.

Dry-Press Brick.—Dry-press brick are red, buff, and flashed, and are made of shale. Clay has never been used successfully. The red dry-press brick first appeared about 1890, and was widely used; it reached its greatest popularity about 1910. It was about this date that the rug or tapestry brick came into vogue.

The shale used in the dry-press brick is not so plastic as the surface clay used for wire-cut brick, nor so sandy as the clay used in the soft-mud brick. Shale can, however, be used for wire-cut brick when it is properly tempered and worked. Dry-press brick are made under high pressure in a steel mould, which gives exact size and smooth surfaces. Such brick lay up well with a small joint and when well burned stand weather indefinitely. In the earlier brick only red-burning shale was used, but since rug brick has been manufactured in a wide range of colours, including browns, buffs, flashed, and clear, the same ranges of colour are now available in the smooth-face dry-press and have a considerable sale. It has been only in the last few years that a variety of colours have been produced in dry-press brick.

Stiff-Mud Brick.—Rug or tapestry brick is made by scratching the surface with steel points as it is extruded from the auger machine. Lately several other textures, made by scratching and applying rollers to form the clay on the surface of the brick, have been placed on the market, and very attractive combinations of "bark" effect with "autumn" colours are produced. Most rug brick are made from shale, but in the sections of the province where shale is not available, very good rug brick are made with clay. Rug brick came into use about 1910 and is still very popular. M. B. Baker, in his 1906 report, speaks of stiff-mud brick but not of their being rugged. Stiff-mud brick was made at an early date, probably between 1880 and 1890, at the time the auger machine was first used for tile, but it was never very popular until the rug surface was developed.

PLANT DEVELOPMENT

As already indicated the early plants were family affairs. Government statisticians did not class them as factories unless 5 or more men were employed. The making of brick or drain tile was often carried on in conjunction with farm work during the summer. There was no sales organization or delivery. The business was a cash-and-carry one, sometimes without the cash, the purchaser driving in to get the product. Such plants are still running and operate only three or four months in a season, turning out under 500,000 brick or tile a year. Such plants are not near centres of population, and only local trade is taken care of, success or failure depending upon local prosperity. In many cases, especially in eastern Ontario, where the small towns are not growing in population and there is little tile used on the farms, the plants are abandoned or run on small production. In a few cases, the plants have survived such conditions by widening their market and shipping to more distant points. Such a widening of the market calls for suitable location, suitable clay, and a business and executive ability that is uncommon among the small plants. Comparatively few of these plants now remain under the same ownership for a long time. The success of the plant seems often to depend upon the ability of the one man who operates it; when this man dies or becomes old the plant usually passes to other hands, unless he has a capable son who is interested in the work. Apparently, then, the average plant is not a well-founded and well-financed institution, planned to serve the needs of the public through the years, but is only a means of livelihood for a man who knows the trade of brick-making. There is no organization to live after the skilled brick-maker has passed on, and the earnings do not create an estate or business to be administered.

Since 1925, plants have been consolidating into groups, managed and administered from one office. They are well financed, are making plans for service over a period of years, and are taking more interest in the technical side of the subject as a means of making more rapid advance. These plants operate the year round instead of just during the summer months.

In 1906, M. B. Baker reported on 192 plants in operation. Of these, 123 are not in operation in 1929. Of the 69 still in operation, 38 have changed the company name, meaning a sale of the property. Only 31 are still operating without change of ownership. The following table shows the number of plants started in each decade.

	No. of plants
Before 1860	4
1860-1869	9
1870-1879	13
1880-1889	26
1890-1899	25
1900-1909	26
1910-1919	35
1920-1929	7

The more progressive plants are the newer ones. Of the 17 plants now running 12 months a year, only one, Milton Brick Limited, has been operating under the present ownership for more than 20 years, or before 1910. Of the 25 plants now running more than 7 months a year but less than 12 months, only 7 have been operating under the present ownership for more than 20 years, or before 1910.

The average modern and progressive plant, then, is not over 20 years old, and the present phase of industrial development and plant administration does not go back very far. The tables below give some of the facts about the 145 plants now manufacturing brick, drain tile, and hollow-building block. In addition, there are 60 or 70 plants either idle, recently abandoned, or recently dismantled.

In estimating the age of the plant, change of ownership was not considered but only the date of commencement of manufacture.

The following table classifies the plants according to number of months of operation per year.

	No. of plants
7 months or less per year	103
Over 7 but less than 12 months per year	25
12 months per year	17
Total	145

The 17 plants operating 12 months a year would be reduced to 10 if consolidation under one management were considered.

The following table divides the plants according to their normal yearly production.

Group	No. of brick[1]	No. of plants
No. 1	Over 5,000,000 brick	16
No. 2	1,000,000 to 5,000,000	47
No. 3	500,000 to 1,000,000	22
No. 4	Under 500,000	60
Total		145

In each case the production of the individual plant and not of any consolidation under one management is considered.

The following table shows a comparison of the 192 plants in operation in 1906 and the 145 operating in 1929 according to their products; it must be remembered that one plant may make more than one product.

Product	1906	1929
Brick	186	97
Drain tile	51	84
Hollow building-block	19	23
Paving brick	1	0
Terra cotta	1	0

The manufacture of brick is being concentrated into fewer plants of larger production. The production of drain tile is increasing, especially in the Interlake peninsula, and hollow building-block has increased a little. Paving brick made from local clays were never of good quality and have been discontinued. Terra cotta made from local clays has found a very small demand and has been discontinued. The local clay is not well suited to this product, although certain types could be made.

Brick Plants

The 186 plants making brick in 1906 were distributed among 43 counties, while only 33 counties are represented in 1929, with 97 plants. Many smaller plants have discontinued manufacturing, and the business has gone to the larger ones well situated for shipping. Algoma district and Brant, Carleton, Huron, Middlesex, Oxford, Perth, Simcoe, Wentworth, and York counties lost 4 or more plants from the 1906 total. York county was the greatest loser, the production now being concentrated in 14 plants, as compared to 30 in 1906. The loss is partly due to the change from the use of

[1]Drain tile and hollow block are estimated on brick equivalent.

surface-clay to shale brick. In some cases, as in Middlesex county, the plant production has changed from brick to drain tile, keeping pace with the local demand. Peel county shows a decided increase in number of plants due to the increased use of shale and to its proximity to Toronto. The types of brick are too numerous to describe in detail. Both surface clay and shale are used, and they burn from dark-red to buff and cream with blends obtaining clear and flashed colours. The result is a large list of reds, browns, blacks, buff, greenish buff, etc.[1]

The table below gives the distribution of plants by districts and counties for the years 1906 and 1929.

DISTRIBUTION OF BRICK PLANTS IN 1906 AND 1929

District or county	1906	1929	District or county	1906	1929
Algoma	5	1	Nipissing and Timiskaming	5	2
Brant	5	1	Norfolk	1	0
Bruce	3	2	Northumberland	2	1
Carleton	6	2	Ontario	2	1
Dufferin	1	0	Oxford	5	0
Durham	2	1	Parry Sound	3	0
Elgin	3	2	Peel	3	7
Essex	6	7	Perth	6	1
Frontenac	1	0	Peterborough	1	1
Grenville	2	0	Prescott	0	2
Grey	5	3	Prince Edward	1	0
Haldimand	1	0	Renfrew	5	4
Halton	2	4	Russell	2	0
Hastings	4	2	Simcoe	6	1
Huron	13	3	Thunder Bay	0	2
Kent	6	7	Victoria	2	2
Lambton	3	1	Waterloo	4	4
Lanark	3	1	Welland	2	0
Leeds	2	0	Wellington	3	0
Lennox and Addington	2	2	Wentworth	12	7
Lincoln	3	2	York	30	14
Middlesex	11	5			
Muskoka	2	2	Total	186	97

Hollow Building-Block Plants

In his report of 1906, Baker does not discuss hollow building-block under a separate head but states that this product was made in 19 plants in conjunction with drain tile and brick. In 1910, the plant of the National Fireproofing Company was built at Aldershot, Wentworth county, to manufacture the more complicated shapes required in large steel-building construction. In 1911, the Sun Brick Company, Todmorden, York county, started making a general line of fireproofing materials. These two plants manufacture hollow block exclusively. The Heath Cube, a special shape easily laid in a wall, is made by Milton Brick Limited in its Streetsville plant, Peel county. Brick is also made here. The Cooksville Company also make hollow block in large quantities at their Cooksville plant. In the Interlake peninsula,[2] the Denison Tile Company make a considerable quantity of hollow block. In all, there are now 23 plants making hollow tile. Three of these make very few, 18 manufacture other products as well, and 2 make hollow building-block only. The larger plants are in the Toronto and Windsor areas where larger buildings are being constructed. The table below gives the distribution of plants by districts and counties in 1906 and 1929.

[1] *See* colour charts inserted between pages 36 and 37.
[2] Otherwise known as southwestern Ontario.

DISTRIBUTION OF PLANTS MAKING HOLLOW BUILDING-BLOCK IN 1906 AND 1929

District or county	1906	1929	District or county	1906	1929
Algoma	1	0	Oxford	2	1
Bruce	1	0	Peel	0	2
Elgin	4	1	Renfrew	0	2
Essex	3	6	Waterloo	1	1
Huron	1	0	Welland	1	0
Kent	3	5	Wentworth	0	1
Lambton	0	1	York	1	2
Middlesex	0	1			
Nipissing	1	0	Total	19	23

Both Queenston and Lorraine shales, as well as the surface clays, have been found to be satisfactory for hollow block. A mixture of softer weathered shale from near the surface with the harder shale of the lower levels makes a satisfactory blend for the auger machine and the complicated dies used for making this product. In one case, clay and shale are blended to obtain the required working properties.

Drain-Tile Plants

In 1906, Baker reported 51 plants which made drain tile. They were rather well distributed in 25 counties. In 1929, only 22 counties were represented, but the number of plants making tile has increased to 84. At present, a few of the plants make only tile, but many of them make both tile and brick. The production varies between these two products, depending upon the demand.

The increase in number of plants is pronounced in Essex, Kent, Middlesex, and Lambton counties. In general, the increase is in the Interlake peninsula, while eastern Ontario is standing still or losing ground. The tile are made from surface clay, except in two plants, one of which uses Queenston red-burning shale and the other Devonian shale from Lambton county, which also burns red. The surface clays used burn both red and cream. Often the two are blended to give a better grade of tile. The following table gives the distribution of plants by districts and counties in 1906 and 1929.

DISTRIBUTION OF DRAIN-TILE PLANTS IN 1906 AND 1929

District or county	1906	1929	District or county	1906	1929
Algoma	1	1	Muskoka	0	1
Brant	1	1	Nipissing	1	0
Bruce	2	3	Norfolk	0	1
Carleton	0	1	Ontario	2	2
Durham	1	0	Oxford	3	3
Elgin	4	6	Perth	3	3
Essex	3	11	Peterborough	1	0
Grey	1	2	Renfrew	3	3
Haldimand	1	0	Simcoe	1	1
Hastings	1	0	Victoria	1	0
Huron	3	5	Waterloo	3	3
Kent	3	15	Welland	1	0
Lambton	3	9	Wellington	3	2
Lennox and Addington	1	1	Wentworth	0	1
Middlesex	4	9			
			Total	51	84

The Sewer-Pipe Industry

The oldest sewer-pipe plant now in operation, known as the Toronto and Hamilton Sewer Pipe Company, of Hamilton, was established about 1860[1] and was controlled and managed by the New family of Hamilton. This plant combined with three others in 1928 to form the National Sewer Pipe Company, Limited, with Ryland New as president. The other three taken into the merger were the Ontario Sewer Pipe and Clay Products Company, started in 1892; the Dominion Sewer Pipe Company, Aldershot, Wentworth county, started in 1904; and the Dominion Sewer Pipe Company, of Swansea, York county, started in 1905. All of these plants have had a long and profitable career with products valued at $974,157 for 1928. The consolidation should result in greater efficiency.

A new company was organized in 1929 under the name of the Ontario Vitrified Products, Limited, and expects to manufacture sewer pipe at the present location of the Price and Cumming brick plant, Salisbury Avenue, Humber Bay, Toronto. Clay suitable for the purpose will be shipped in a distance of some 20 or 30 miles from another property owned by the company.

There has been little change in this industry, partly due to the difficulty of obtaining a satisfactory clay supply. Surface clay only is used, and that from a limited area near Aldershot and Hamilton, Wentworth county, because of its freedom from lime. It is, of course, red-burning.

Other Ceramic Industries

In addition to the plants manufacturing heavy clay products and sewer pipe, there are those manufacturing other ceramic products, such as refractories, pottery, porcelain, glass, enamelled iron, abrasives, and feldspar. Cements and plasters were not included in this survey.

Ceramic Education

Ceramic education in Ontario dates back to about 1914 when Joseph Keele, of the Canadian Geological Survey, spent considerable time at the University of Toronto while studying the clay deposits of the province. He gave a certain amount of instruction to advanced students in the University and also carried on an evening lecture course at the Central Technical School, of Toronto. In 1924, Mr. Keele's report, "Preliminary Report on the Clay and Shale Deposits of Ontario," was published as Memoir 142 of the Geological Survey of Canada.

The Canadian National Clay Products Association for many years was interested in the establishment of a Ceramic Department at the University of Toronto. The men of the association appreciated the value of the work done by Keele and the Ceramic departments of the various universities in the United States. In 1925, such a department was inaugurated at the request of this association and they gave substantial financial aid for the first three years of its life. The ceramic instruction is done in the Ceramic Division of the Department of Metallurgy, under the direction of the writer. The present course is equivalent to a four year ceramic course and leads to the degree of Bachelor of Science. The first two years cover general engineering, which is taken in the Department of Metallurgy. The third and fourth years are given over to ceramics and other engineering courses dealing directly with the subject. General ceramic technology is also covered, dealing with fundamentals of mathematics, chemistry, geology, and mineralogy. Opportunity is given for advanced work, with scholarships, in the School of Engineering Research, leading to a Master's degree.

[1]C. A. Miller, Jour. Amer. Cer. Soc., Vol. 8, p. 452.

CLAY, ITS COMPOSITION AND PROPERTIES

Introduction

The following sections give a brief discussion of clay, touching only on the main points but accompanied by references to books, easily obtained, which will allow the reader to study the subject in more detail. Nothing is gained by repeating at length matter printed elsewhere. The student of the subject should be familiar with the general literature, and the layman will be introduced to it in the following pages. Three books have been drawn upon for considerable material in this report, and all three could be added to every clay worker's library with profit. Acknowledgement is here made without attempting to give credit for each point by referring to the original source of information.

JOSEPH KEELE, Preliminary Report on the Clay and Shale Deposits of Ontario, Geol. Surv. Can., Mem. 142, 1924.
HEWITT WILSON, Ceramics—Clay Technology, McGraw-Hill Book Company, New York, 1927.
HEINRICH RIES, Clays—Their Occurrence, Properties and Uses, 3rd edit., John Wiley and Son, New York, 1927.

Wilson gives the following definition of clays: "Clays are weathered products of silicate rocks, containing sufficient hydrous silicate of alumina in the softened condition to produce a plastic or semi-plastic mass when tempered with water."

The purer clays are considered to be the decomposition product of feldspar or feldspathic rocks. Such feldspars usually occur as pegmatite dikes and veins in igneous rocks of the granite family. The process of rock decay and clay formation is called kaolinization and, if pure, the product is kaolin. A primary kaolin is one which remains in place associated with silica sand which is present in excess of the amount required to form kaolin. A secondary kaolin is one which has been transported by natural agencies, usually water, and redeposited. It is separated from the silica during transportation and may be almost pure kaolin, being white in colour.

If, during transportation or due to the composition of the parent rock, impurities are introduced, the white colour will be lost and all the properties of the clay will be altered, depending upon the kind and the amount of the impurities. The clay particle is of colloidal dimensions (very small). Such particles are easily floated in running water, and clay beds are usually found in the bottom of ancient seas, lakes, swamps, or along rivers. When the water becomes quiet and without movement, the clay settles out. Materials dissolved in the water have some effect upon its settling and on the physical condition of the colloidal particles.

Classification of Clays

Clays are roughly classed as kaolins, ball clays, fire clays, stoneware clays, common clays, and shale, depending upon their purity and physical condition.

Kaolin.—The change from feldspar to kaolin is shown by Wilson as follows:—

Potash feldspar		Crude kaolin		Washed kaolin
SiO_2 ..... 64.8 Al_2O_3 .... 18.3 K_2O 16.9 100	+ weathering =	Silica... 43.2 SiO_2 Kaolin. 21.6 SiO_2, 18.3 Al_2O_3, 6.5 H_2O	+ washing =	46.3 SiO_2 39.8 Al_2O_3 13.9 H_2O 100

That is, on weathering the feldspar breaks down into silica and kaolin. The kaolin has taken up some water (H_2O) in combination which is not

in the original feldspar. When this crude kaolin is prepared for the market it is washed to separate the silica sand from the clay material, and there is left pure kaolin composed of silica, alumina, and combined water in the percentages indicated. The alkali (K_2O) is dissolved and carried away during the process of weathering.

Kaolin, often called china clay, is used in the manufacture of white tableware, porcelain, sanitary goods, floor tile, wall tile, etc. In the paper mills it is used as a filler for the best grades of white paper and for wall-paper. It is also used in the manufacture of rubber tires. Kaolin is refractory and will soften at about cone 34 or 1,760° C. (3,200° F.) This is usually designated as P.C.E. 34 and means that the pyrometric cone equivalent is cone 34.

Ball Clay.—Almost all white porcelain and pottery bodies contain kaolin, feldspar, ground silica (called potter's flint), and ball clay. The ball clay is not so pure as the kaolin and not so white in colour, but it is more plastic and adds to the strength of the product both before and after being fired. Ball clay is also refractory and will soften at about cone 32 to 33, or 1,700° to 1,745° C., or 3,092° to 3,173° F.

Fire Clay.—Clays of this type are usually still more impure, burning to a buff instead of white. Iron spots often show when the clay is burned to higher temperatures. These clays grade in refractoriness from that of the better grade ball clay, cone 33 (1,745° C. or 3,173° F.), down to about cone 19 (1,515° C. or 2,759° F.). They are not so plastic as the ball clays. The amount and kind of impurities control the refractoriness, which is used as a rough means of classification. The classification, proposed by the American Society for Testing Materials, for clay fire-brick is as follows:—

No. 1—Heavy heat duty, softening point not lower than cone 31, 1,680° C. or 3,056° F.
No. 2—Intermediate heat duty, " " " " cone 28, 1,615° C. or 2,939° F.
No. 3—Moderate heat duty, " " " " cone 26, 1,595° C. or 2,903° F.
No. 4—Low heat duty, " " " " cone 19, 1,515° C. or 2,759° F.

While fire brick is the product most often made from fire clays, there are many other uses for them.

Stoneware Clay.—The stoneware clays overlap with the fire clays in refractoriness and may extend to a somewhat lower temperature. In addition to being fairly refractory, they must be of good plasticity, smooth and fine grained in texture, of good tensile strength in the unburned state, and must vitrify without excessive burning shrinkage. Blends of several clays are often used to obtain the required properties in the finished body.

Sewer-Pipe Clay.—This clay is not a separate type but is usually a subdivision under fire clay, stoneware clay, or shale. It should burn to a vitrified body, or at least to a very low porosity with a reasonable firing shrinkage, and should allow salt glazing. The Ontario sewer-pipe clay is a surface clay and does not come under the above heads. It will be discussed in more detail later on in this report.

Paving-Brick Clay.—This kind of clay is also not a separate type. Paving brick are usually made from red-burning shales, which are low in lime, have a long vitrification range, and a vitrified tough body. Ontario clays, largely because of a rather high lime content, are not suitable.

Pottery Clay.—This clay is also not a separate type. Almost any clay that will work well in moulding and drying can be made into some type of pottery. When an opaque glaze is used, the colour to which the clay burns is often not essential. Good plasticity and strength to allow working on the potter's wheel and freedom from surface defects when burned are of prime importance.

Common or Brick Clays.—These are usually soft, young, surface clays, being very impure and having low refractoriness. The softening point is seldom above cone 7 (1,210° C. or 2,210° F.). Such clays, which may be manufactured into soft-mud or stiff-mud brick with satisfactory burned properties, are used for both common and face purposes.

Shales.—Shales are older clays, often of the same purity and refractoriness as common surface clays, but may be more refractory. The more refractory types are not found in Ontario. During geological time, shales have been hardened to some extent by heat and pressure and have developed a characteristic stratified structure. A portion of the combined water has been expelled. Owing to their hardness they have little plasticity as compared to clays. Fine grinding and mixing with softer surface material allows them to be worked. They make excellent face brick.

Composition of Clays

All clays, including commercial china clay, contain other constituents than silica, alumina, and combined water. The amount and kind of these other constituents, often called impurities or fluxes, are responsible for many of the properties of the clay during the process of manufacture and burning. The following table of compositions gives a general idea of the kind and amount of these impurities in the different types of clay.

	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Silicon oxide.....	46.3	45.39	45.57	59.92	62.89	60.34	59.21	69.12	46.16
Aluminum oxide...	39.8	39.19	38.87	27.56	21.49	20.55	18.42	14.03	13.76
Ferric iron oxide...	.....	.45	1.14	1.03	1.81	5.02	5.37	4.81	5.58
Calcium oxide.....	.....	.51	trace	trace	.38	.38	3.32	1.94	15.74
Magnesium oxide..	.....	.29	.11	trace	.56	1.12	3.30	1.10	3.78
Potassium oxide...	.....	.83	.16	.67	2.52	3.62	1.60	3.58	2.70
Titanium oxide....	.....	.....	1.30	.....	1.82	.93	.....	.....	.....
Ignition loss.....	13.9	14.01	14.10	9.70	7.58	6.42	9.16	4.80	17.48

No. 1—Theoretical kaolin.
No. 2—Reis, Clays, 3rd Edition, p. 407, Florida kaolin.
No. 3—Reis, Clays, 1st Edition, p. 169, New Jersey ball clay.
No. 4—Reis, " " " p. 178, Ohio flint fire clay.
No. 5—Reis, " " " p. 178, Penn., Lower Kittaning, second quality fire clay.
No. 6—Reis, " " " p. 181, West Virginia stoneware clay.
No. 7—Keele, Memoir 142, p. 19, Lorraine shale.
No. 8—Keele, " " p. 108, red-burning glacial clay.
No. 9—Keele, " " p. 108, buff-burning glacial clay.

Characteristics of Clay in the Plastic and Dry Condition

We think of clay as being kaolin, often called clay substance, and impurities. The impurities affect the colour, and reduce the plasticity and the refractoriness of the clay. The impurities may be present as coarse material like sand, mica, and undecomposed rock fragments that will be retained on a 200-mesh screen when making a sieve analysis of the clay. The impurities may likewise be fine, silty material, as fine as the clay itself, evenly distributed and difficult to identify but they are usually considered as non-plastic. There may also be in the clay soluble material, which will dissolve in the water added to make the clay plastic in the process of manufacture. This soluble material will affect the tendency of the clay substance to settle from a water suspension, its plasticity, its ease of drying, as well as its drying shrinkage and other properties. Soluble materials tend to form scum on the surface of the clay during drying.

The plasticity of clays is considered to depend upon the following points:[1]—

1. Fundamental theories:
   a. Colloidal condition or size of particle.
   b. Molecular attraction of the particles one for another.
   c. Surface tension of the water film.

2. Secondary influences:
   a. Organic or bacterial action.
   b. Shape, size, and distribution of sizes of non-plastic grains, and the comparative amount of non-plastic material present.
   c. Soluble material.

Wilson[2] defines a plastic clay as consisting of "a colloidal substance of variable composition, complex hydrous aluminum silicates, with small amounts of hydrous silica, hydrous alumina, hydrous iron oxide, and water films, which surround the larger clay particles and non-plastic grains and bind the whole into a plastic mass, which will remain plastic as long as the water is present." Aging and weathering clays improve plasticity.

Non-plastic material may occur naturally in clay or may be added to control the properties during the drying and burning. Natural non-plastics are silica, feldspar, mica, limestone, pyrites, silt, etc. Added non-plastics may be flint and spar as in a porcelain body, sand in a soft-mud brick mix, or burned fire-clay grog in a fire brick. The amount which can be added will depend upon the grading of size, as in a mixture of sand and gravel in concrete. A coarse grog with a fine grog and clay will require less clay to fill the open spaces than if all coarse or all fine grog were used. The amount of plastic clay in a mix is seldom less than 35 per cent., although as low as 10 per cent. has been used in properly graded batches.

Effect of Heat on Clays

When a clay is heated, the reactions which take place depend upon its chemical composition and physical condition. Chemical composition will be considered first.

When kaolin is heated, the following reactions take place at the temperatures indicated.[3]

70° to 225° F.—Mechanical water is lost. The last traces of water, called hygroscopic water, being expelled at about 750° F.

750° to 1,100° F.—The 13.9 per cent. of combined water in kaolin is driven off and the plasticity of the clay is lost.

1,560° to 1,920° F.—The kaolin dissociates or breaks down to form a non-crystalline compound called mullite and free silica in the crystalline form of tridymite.

About 2,460° F.—The non-crystalline mullite will start to crystallize.

2,675° F.—The free silica present changes its crystalline form from tridymite to cristobalite.

2,810° F.—Part of the kaolin will start to melt. The active part which forms the melted glass will have the composition of 5.5 per cent. alumina and 94.5 per cent. silica.

3,170° to 3,250° F.—All the kaolin will melt.

When impurities are present the reactions are much more complicated and take place at much lower temperatures.

Sulphur.—Sulphur will start to oxidize or burn to sulphur dioxide at 480° F. and will not be completely oxidized until 2,190° F. is reached, although most of it will be oxidized by the time 1,340° F. is reached.

Iron Carbonate.—Iron carbonate will break down, giving off carbon dioxide gas at 680° F.

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[1]Hewitt Wilson, op. cit., p. 60.
[2]Ibid, p. 84.
[3]Ibid, p. 144.

Iron Sulphide.—Iron sulphide gives up some sulphur as sulphur dioxide gas at 662° to 932° F., and the remainder may form iron sulphate.

Iron Sulphate.—Iron sulphate breaks down to form iron oxide and sulphur trioxide gas at 1,040° to 1,427° F.

Limestone or Calcium Carbonate.—Limestone forms calcium oxide and carbon dioxide gas, starting at about 1,120° F. and extending to 1,904° F. The theoretical temperature of dissociation is 1,648° F.

Magnesium Carbonate.—Magnesium carbonate forms magnesium oxide and carbon dioxide gas, starting at 752° F. and being about complete at 1,472° F.

Gypsum or Calcium Sulphate.—Calcium sulphate breaks down into calcium oxide and sulphur trioxide gas, starting at about 2,210° F.; the action is quite rapid at 2,417° F.

Carbon.—Carbon, as wood, roots, lignite, etc., will start to oxidize or burn at about 662° F., but some forms are not all driven off until about 1,967° F. is reached.

Feldspar.—Feldspar forms the chief source of the alkali and some of the lime found in clays. It will start to react with clay materials as low as 1,700° F., but it does not melt until about 2,300° F.

When these compounds of iron, lime, magnesium, etc., break down to form the oxides, they combine chemically with any alkali (sodium or potassium) or other elements present, as well as with silica and alumina, to form increasing amounts of melted material, or glass, with increasing temperature. The first glass formed tends to increase the density and lower the porosity of the clay body. As the amount of glass increases, the body will gradually soften and distort under its own weight: Its fusion or softening point has been reached. Owing to the breaking down of limestone, gypsum, and other minerals, a gas is given off such as carbon dioxide, sulphur dioxide, etc. If the body is porous, this gas will escape through the pore openings to the air. If the melted material or glass blocks the pore space and prevents the gas from escaping, an internal pressure will develop and the body will swell and "overfire."

The temperature at which these reactions take place depends upon the kind and amount of the glass-making material. In the impurer clays it starts at about 1,650° F., and the clay will soften or melt at about 2,200° F. In the purer clays, such as ball clay, fire clay, and kaolin, there is very little action at 1,650°F., and melting does not occur until 3,100° to 3,250°F. is reached. The effect of any one constituent on the softening point of a clay cannot be judged by the melting point of that material when tested by itself. Combinations of materials melt at a lower temperature than that of the pure material. The combinations in impure clays are very complicated. As an example, lime is very refractory by itself but is a very active flux in clay.

Laboratory Testing of Clays

Laboratory testing of clays is of value when care is taken in the interpretation of the results.

Screen Test.—A set of screens running from 4 to 200 openings to the linear inch is used to separate the fine from the coarse material. The clay substance will all go through the 200-mesh screen, as will also any very fine silt or rock dust. The coarser materials may then be examined and an idea obtained as to the character of the impurities present. The residue on the screens may vary from less than 1 per cent. to 20 per cent. or more.

The residues may be clean silica sand or may contain small pebbles of limestone, iron-bearing minerals, organic matter, or miscellaneous rock fragments, which may or may not contain alkali. Lime may be identified by testing with dilute hydrochloric acid. If a gas is given off when the acid is applied, carbonates are almost sure to be present; lime carbonate is the one most apt to be present in Ontario clays. In making the test the clay is washed with water through the screens to give a clean separation of sizes.

Plasticity and Drying Behaviour.—The plasticity of the clay is judged by the amount of water required to make it plastic and by the feel of the plastic mass after mixing with water. The drying shrinkage is usually obtained by measuring a test piece before and after drying from the plastic condition. Whether a clay will dry safely or not is determined by rapid drying of a 4-inch cube under severe conditions.

Burning Behaviour.—The pyrometric cone equivalent, or fusion temperature, together with the appearance of the fused material will serve to classify the clay as refractory or non-refractory and gives some idea as to the nature of the impurities present. From the fusion temperature is estimated the temperature to which the clay can be burned to give a commercial body. A series of burns at several temperatures gives the commercial burning temperature more exactly and allows the determination of the change of properties, such as colour, shrinkage, and density, with increasing temperature. Such laboratory data does not always indicate good commercial practice. The colour of the small sample burned in the laboratory furnace in 6 to 8 hours will not always be the same as that obtained in a commercial burn of 5 days. A clay can be classed as red- or buff-burning in general terms, but the quality or depth of the colour can only be determined by burning under commercial conditions. The vitrification and overburning are affected by the rate of heating. A higher temperature for a short time is often equivalent to a lower temperature for a long time; a difference of two to three cones, or 70° to 100° F., may be found. Clays high in lime are affected less by time than those low in lime and high in iron and alkali.

Chemical Analysis.—The chemical analysis has its value in clay-testing, but often the physical properties mentioned above indicate all that is required for a general test of the clay. The laboratory tests combined with a trial burn of a fairly large amount of the clay in a commercial kiln will give a fair idea of its commercial value. In testing a clay from a new location an analysis is often desirable, as it will give the kind and amount of impurities, while the physical tests will only show them indirectly. When the amount of a certain impurity, such as lime, iron, or sulphates is important, the chemical analysis is the only way to obtain the required information.

Sampling.—The utmost care should be taken in sampling a piece of property. Preliminary samples should be taken with the idea of showing the variations in the bank. Several test holes or auger holes at different points with samples from different depths will give a fair idea of the quality. Final sampling should be more extended. It must be remembered that clays often change rapidly in quality from the surface down, and that shales have strata that may vary widely from the rest of the material. Changes also take place from one part of a field to another. This is especially true of glacial surface clay. Gravel or sand is apt to appear in spots in such surface deposits. Lack of thorough sampling and testing of a clay deposit before building a plant has often caused heavy losses.

GEOLOGICAL DESCRIPTION OF ONTARIO CLAYS[1]

INTRODUCTION

The main divisions of geological time (in order from the most recent to the most ancient) are:—

ERA	PERIOD
Cenozoic	Quaternary.
	Tertiary.
Mesozoic	Cretaceous.
	Jurassic.
	Triassic.
Paleozoic	Permian.
	Carboniferous.
	Devonian.
	Silurian.
	Ordovician.
	Cambrian.
Pre-Cambrian.	

Ceramic raw materials are found in all the eras. The older deposits, in the pre-Cambrian, are either not weathered and broken down, as feldspar and quartz, or are consolidated again, as Animikie shale. The more abundant shales of Ontario are younger, being of the Paleozoic era. The unconsolidated plastic clays, including fire clay and surface clay, are of the Mesozoic and Cenozoic era. The following table is compiled from Keele's report:—

QUATERNARY	Eastern Ontario: Marine or Champlain clay.
	Interlake peninsula: Iroquois clay.
	Toronto formation clay.
	Miscellaneous glacial and post-glacial clay.
	Northern Ontario: Ojibway clay.
	Algonquin clay.
	Western Ontario: Miscellaneous glacial and post-glacial clay.
CRETACEOUS	Mattagami formation, fire clay.
DEVONIAN	Huron shale.
	Hamilton shale.
SILURIAN	Salina shales.
	Cabot Head shale.
ORDOVICIAN	Queenston shale.
	Lorraine shale.
	Utica shale.
	Chazy shale.
PRE-CAMBRIAN	Animikie shale.

The greater part of the province is underlain with ancient crystalline rocks, principally granite, gneisses, and various schists. The portions not having these pre-Cambrian rocks at a short distance below the surface are few. The whole is covered with a blanket of glacial drift or till except where the pre-Cambrian or other formations break through in outcrops. The more important of these formations and outcrops are given below.

[1]J. Keele, Geol. Surv. Can., Mem. 142, 1924.
W. S. Dyer and R. J. Montgomery, Ont. Dept. Mines, Vol XXXVII, pt. 6, 1928.

Eastern Ontario Clays.—The region between the St. Lawrence and the Ottawa rivers is a lowland underlain by nearly flat-lying limestone, dolomite, sandstone, and a little shale, all of Ordovician age. To the west of this area the pre-Cambrian rocks rise from beneath the Ordovician and reach the surface. The bed rock is almost wholly covered by glacial drift containing some glacial clay, or by Champlain clay of marine origin.

Interlake Peninsula Clays.—The section to the east from Lake Nipissing to Lake Ontario is underlain by pre-Cambrian rocks. A smaller area, underlain by Paleozoic limestone and shale, extends from the pre-Cambrian upland to Lake Ontario, and similar rocks underlie the Lake Simcoe basin and the region near the southern part of Georgian bay. Glacial drift including glacial clays spread over this region with few outcrops of the lower formation.

The section to the west extending to Lakes Erie and Huron is entirely underlain by Paleozoic rocks, comprising limestones, shales, dolomites, and sandstones. These rocks range from Devonian to Ordovician. They are softer than the pre-Cambrian rocks, have been considerably affected by weathering and glaciation, and have furnished large amounts of material for the glacial and post-glacial clays which cover this region to a considerable thickness. The lowest shale used commercially is the Lorraine, of Ordovician age. It dips to the west and outcrops in York county, near Toronto, at Don Valley, New Toronto, Port Credit, and Cooksville. The Utica shale underlies the Lorraine and outcrops in eastern Ontario near Ottawa. The Queenston shale overlies the Lorraine shale and outcrops at Hamilton, Streetsville, Milton, Credit Forks, and all along the Niagara escarpment. Both the Lorraine and Queenston shales are widely used in the manufacture of clay products.

The Cabot Head, Salina, Hamilton, and Huron shales overlie the Queenston in the order named and form part of the bed rock of the Interlake peninsula, but are of little economic importance at present.

Northern Ontario Clays.—The region lying between Lake Nipissing and James bay is underlain chiefly by pre-Cambrian rocks except for a strip of Paleozoic limestone and shale overlain by Cretaceous fire clay. The whole is covered by glacial till.

Western Ontario Clays.—This region is underlain by pre-Cambrian rocks except for a narrow band of flat-lying Silurian limestone bordering Hudson bay and shale that outcrops at Thunder bay. The hollows between the pre-Cambrian outcrops are filled with glacial drift.

PRE-CAMBRIAN SHALE

Animikie Shale.—This shale outcrops along the shore at Thunder bay and reaches a thickness of 40 feet in some places. It is greenish-grey in colour. Keele states[1] that tests in the Mines Branch laboratories at Ottawa indicate that it would be satisfactory for brick and hollow-ware. It is fairly plastic, dries well, and burns to a fine red colour with a strong body. A tendency to scum could be overcome by adding barium carbonate. It is not used commercially at the present time.

ORDOVICIAN SHALES

Chazy Shale.[2]—This shale is a minor formation of the lower Ordovician period and is not used commercially at present. It is found near Ottawa along the Ottawa river. Other outcrops are in Gloucester township, Carle-

[1]J. Keele, op. cit., p. 133.
[2]Ibid, p. 13.

ton county, at Cumberland; Russell county, at Tamworth; Lennox and Addington county; and at Longford Mills, Ontario county. The thickness is about 110 feet. The shale is grey in colour with tints of red and green. It is often sandy in structure but varies in quality with the location. It burns buff and has a very porous structure.

Utica Shale.[1]—This shale is the lowest member of the Ordovician that is worked for brick-making. It is thin-bedded, almost black shale, quite gritty or slaty in texture, and as a rule bituminous. This carbonaceous matter requires slow burning to remove it from the clay without bloating or forming black-core. Iron pyrites is sometimes present and may cause a sulphur scum if barium carbonate is not added. Its low plasticity makes it difficult to use in the auger machine unless it is mixed with plastic clay. It can be dry-pressed. Ottawa Brick and Terra Cotta Company (formerly Merkley's Limited) have used this shale.[2]

Lorraine Shale.—This shale, often called Hudson River shale, is the bed rock of a considerable area near the lake shore of York, Peel, and Halton counties. The outcrops are 20 to 40 feet thick in this section and have a total known thickness of 770 feet in the township of Collingwood, Grey county. While it is widespread in occurrence, it is only worked in the Toronto area. It is found in Manitoulin is'and and in Carleton and Russell counties, as well as at the points already mentioned. It is probably the first shale to be used in Ontario for brick-making. It is lighter in colour than the Utica shale and is more plastic when properly prepared. It contains numerous hard sandy layers and a few thin limestone beds which must be separated when used. It may be used for dry-press and wire-cut stiff-mud brick. Plastic clay is sometimes added when hollow building-block or field tile are made. Floor or quarry tile are made at the Canadian Fire-clay Products plant and at the Ontario Brick and Tile plant at Mimico, York county. It burns to a good red at about 1,850° F., the colour being improved when the parts high in lime are rejected. The vitrification range is short, and vitrified products like paving block cannot be made. The following analyses and physical properties are given by Keele.[3]

CHEMICAL COMPOSITION OF LORRAINE SHALE

	Silica, SiO_2	Alumina, Al_2O_3	Iron, Fe_2O_3	Lime, CaO	Magnesia, MgO	Alkalies, K_2O-Na_2O	Loss on ignition
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
No. 1.....	57.86	20.00	6.83	2.92	3.25	not det	5.74
No. 2.....	57.60	16.30	8.00	3.47	3.97	3.40	not det.
No. 3.....	60.01	18.62	10.15	0.10	0.20	6.70	11.45
No. 4.....	59.21	18.42	5.37	3.32	3.30	1.60	9.16
No. 5.....	58.42	16.18	7.41	3.53	3.18	not det.	8.88
No. 6.....	56.46	18.19	7.43	2.56	2.93	4.17	8.52
No. 7.....	61.60	17.62	7.32	0.68	3.07	4.27	5.81

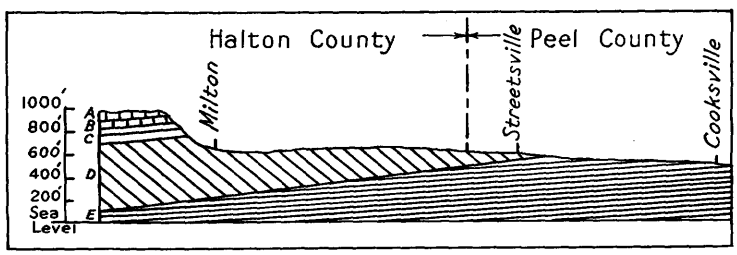
No. 1—Don Valley brickyard, Toronto.
No. 2—Ontario Government plant, Mimico.
No. 3—Upper weathered shale, Ontario Paving Brick Company, Islington (no longer operating).
No. 4—Ground shale from same plant.
No. 5—Meaford Brick Company.
No. 6—Port Credit Brick Company, Port Credit.
No. 7—Ottawa Brick and Terra Cotta Company, Gloucester township, Carleton county.

[1]J. Keele, op. cit., p. 14.
[2]Ibid.
[3]Ibid, p. 19.

PHYSICAL PROPERTIES OF LORRAINE SHALE, WET MOULDED

Lab. No.	Water of plasticity	Drying shrinkage	Cone 010		Cone 06		Cone 03	
			Fire shrinkage	Absorption	Fire shrinkage	Absorption	Fire shrinkage	Absorption
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1.....	.....	3	0	12	2	8	2	1
228.....	19	3	0	12	1	8	5	2
217.....	22	4	2	10	3	5	.....	.....
243b.....	25	6	0	17	5	7	8	0
243.....	25	7	0	12	4	10	10	0
220.....	24	5	4	6	6	2	8	0
369.....	24	6	1	13	2	11	3	11
381.....	14	3	0	11	1	9	2	7
233.....	15	3	0	11	1	8	3	2

No. 1—Ontario Government clay plant, Mimico.
No. 228—Shale, one mile west of Dunbarton station, Canadian National railway.
No. 217—Shale, partly weathered, at Craigleith, Collingwood township, Grey county.
No. 243b—Shale, partly weathered, at Thornbury, Collingwood township, Grey county.
No. 243—Clay on top of shale, same location.
No. 220—Shale, Meaford Brick Company, Meaford, Grey county.
No. 369—Shale, partly weathered, Gore bay, Manitoulin island.
No. 381—Shale, Gloucester township, Carleton county.
No. 233—Shale, Hawthorne, Gloucester township, Carleton county.



Section northeast-southwest through parts of Halton and Peel counties, showing succession of shale formations.[1] A—Lockport dolomite. B—Rochester and Clinton shale and dolomite. C—Cabot Head shale, sandstone, and dolomite. D—Queenston shale. E—Lorraine shale. The last two only are used commercially for the manufacture of clay products.

Queenston Shale.—Queenston shale, sometimes called Medina, is found overlying the Lorraine and outcrops along the base of the Niagara escarpment for a long distance between Lake Ontario and Lake Huron. From Hamilton the outcrops can be traced through Halton, Peel, and Dufferin counties, especially along the Credit and Nottawasaga rivers. It is seen as far as Eugenia, Artemesia township, in Grey county, and also near Little Current, Gore Bay, and other localities on Manitoulin island. Queenston shale is not known to occur in central Ontario. A small isolated area occurs in the township of Cumberland, Carleton county, and shale that is supposed to correspond to the Queenston outcrops below Coral portage on the Abitibi river in Northern Ontario.

Queenston shale is widely used in the heavy clay products industry. It is fairly homogeneous, being relatively free from hard, sandy limestone bands. The prevailing colour is reddish-brown, which may burn red or buff. In some places it contains greenish-grey bands of sandy texture, which always burn to a buff colour. As it burns both red and buff, depending

principally upon the lime content, careful selection is almost always necessary to obtain a satisfactory control of the colour of the finished product. It is easily mined and crushed and can be used in the auger machine for brick and hollow building-block or for dry-press brick. The shale drys without difficulty with a low drying shrinkage. It has a short firing range like the Lorraine shale, and vitrified products cannot be made. Keele gives the following analyses and physical properties.[1]

CHEMICAL ANALYSIS OF QUEENSTON SHALES

	Silica, Si_2	Alumina, Al_2O_3	Iron, Fe_2O_3	Lime, CaO	Magnesia, MgO	Potash, K_2O	Soda, Na_2O	Loss on ignition
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
No. 1....	55 90	18.46	6.60	3.82	2.65	3.55	0.53	8.74
No. 2....	56 90	17.40	6.64	3.84	2.65	3.51	.53	8.78
No. 3....	53 20	17 73	6.91	6 00	3.24	3.40	.46	9.58
No. 4....	47 98	13 10	4.42	12.53	3.25	3.39	.78	14.50
No. 5....	56 52	15.21	5.82	6.86	2.82	3.59	.56	8.79
No. 6....	62.28	17.22	8.82	1.56	2.64	.....	.....	5.24

No. 1—Beamsville. Lincoln county.
No. 2—Fruitland Brick Company, Wentworth county (no longer operating).
No. 3—Milton Brick Limited, Halton county, red-burning shale.
No. 4—Milton Brick Limited, buff-burning shale.
No. 5—Brampton Pressed Brick Company, Peel county.
No. 6—Russell Shale Brick, Limited, Russell county.

PHYSICAL PROPERTIES OF QUEENSTON SHALE, WET MOULDED

Lab. No.	Water of plasticity	Drying shrinkage	Cone 010		Cone 06		Cone 03		Colour
			Fire shrinkage	Absorption	Fire shrinkage	Absorption	Fire shrinkage	Absorption	
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	
201.....	17	4	1	11	.....	.....	4	1	Red.
325.....	17	4	0	10	0	8	0	6	Red.
326.....	18	4	S	15	S	.....	S	15	Buff.
275.....	20	5	0	10	1	8	4	0	Red.
267.....	18	4	0	15	0	12	0	6	Buff.
268.....	18	4	0	16	0	14	0	13	Buff.
269.....	17	3	S	18	S	17	S	15	Buff.

S—Slight increase in size on burning.

201—Canadian Pressed Brick Company, Bartonville.
325—Milton Brick Limited, Milton, red-burning shale.
326—Milton Brick Limited, buff-burning shale.
275—Streetsville Brick Company, Streetsville, Peel county.
267—Halton Brick Company, Terra Cotta, upper shale.
268—Halton Brick Company, middle shale.
269—Halton Brick Company, lower shale.

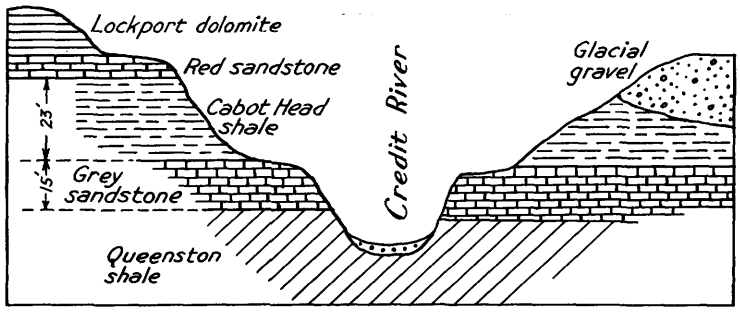
A section of the shales and sandstones between Cataract Junction and Credit Forks, Peel county, as given by Keele[2] is shown on page 24.

[1]J. Keele, op. cit., p. 22.
[2]Ibid, p. 23.

SILURIAN SHALES

Cabot Head Shale.[1]—This shale is not used in the clay industry but is an important formation lying above the Queenston shale. The type outcrop is at Cabot head, Bruce county. The shale is mostly greenish-grey, but at some locations there are beds of reddish shale of the same formation. Alternating thin beds of shale and limestone are sometimes found, but usually the shale is of considerable thickness. Most of the outcrops are in the Niagara escarpment and are so overlain by hard beds of Lockport dolomite that the formation would be difficult to work without mining. It is also found at Grimsby, Lincoln county, as well as in Wentworth, Halton, Peel, and Grey counties, and Manitoulin island. Keele's laboratory tests indicate that it has a high shrinkage, easily overfires, and is more fusible than the Queenston shale, but that the colour of the product would not be good, being neither red nor buff. The best sample was taken from Cataract, Peel county.

Salina Shale.[2]—This shale has been pierced by borings in the western part of the Interlake peninsula, but there are few outcrops. It may be



Section of shales and sandstones between Cataract Junction and Credit Forks, Peel county.

seen along the Niagara river and the Saugeen river in Grey county. It is pea-green to grey and sometimes red. Keele states that it is of little use to the clay-worker as it is very impure, burning to a chalky body which swells during firing.

DEVONIAN SHALES

Hamilton Shale.—The most extensive outcrops of this shale are along the Ausable river and its tributaries in Lambton and Middlesex counties. The best-known outcrop as used for clay-working is at Thedford, where W. S. Watson is making drain tile from this shale. It works nicely in the auger machine making a tile which drys and burns without trouble but shows considerable white surface scum. A reported analysis gave 0.63 to 0.59 SO_3. Both red- and buff-burning shale is found at this point. The normal burning temperature is cone 06.

Huron Shale.[3]—This shale is found in Lambton and Kent counties but is of little importance to the clay-worker. Keele's laboratory tests show that it has little or no plasticity, is highly carbonaceous, contains concretions of calcite, and bloats easily on firing.

[1]J. Keele, op. cit., p. 22.
[2]Ibid, p. 26.
[3]Ibid, p. 28.

CRETACEOUS CLAYS

These are refractory clays and are found only in Northern Ontario, on the James bay slope. While they have not been used commercially as yet because of lack of transportation, considerable prospecting and semi-commercial testing has been done by the Ontario Department of Mines and by private companies. The early explorers, Dr. Robert Bell[1] and E. B. Borron,[2] recognized these formations as unusual clays, but it was not until 1920 that Joseph Keele, of the Canadian Geological Survey, made the discovery that these refractory clays were of Cretaceous age and were likely to be of considerable economic importance. Interest has centred around the deposits on the Mattagami river, as they are only 7 miles from transportation, but clays of equal quality are found on the Missinaibi river to the west. Also clays of the same type but of lower refractoriness are found on the Abitibi river to the east.

These clays are now thought to have been laid down as lacustrine sediments in two structural basins formed in the underlying Paleozoic rocks. One of these basins reaches from Blacksmith rapids on the Abitibi river across to and includes outcrops at the junction of the Mattagami and Missinaibi rivers and probably embraces an area of 600 square miles. The second and larger basin to the southwest includes the outcrops on the Mattagami and Missanaibi rivers with a probable area of about 2,000 square miles. These two basins may be a part of a still larger basin. In 1929, W. S. Dyer, of the Ontario Department of Mines, investigated a seam of lignite coal at Blacksmith rapids. Drilling by the Government to date has shown an average thickness of about 30 feet over an area of more than five square miles. Steel for the Temiskaming and Ontario Railway extension to James bay reached this deposit in the spring of 1930.

The Cretaceous deposits are composed of clay and silica sand and are of two general types. The first is a mottled red, brown, and white clay associated with silica sand; and the second is a dark-grey to black carbonaceous clay. The outcrops of both of these types seldom exceed 15 feet in vertical section, and many of them can only be seen at low river level. They are overlain by 40 feet of the glacial till which covers most of this region.

The mottled clay type consists of a bedded series of fine-grained plastic fire clays marked by blotches of grey, brown, red, and buff colours. Both overlying and underlying the fire clays are beds of white quartz sand. A certain amount of sericite (mica) is mixed with the quartz, and considerable kaolin is found filling the spaces between the quartz grains. The kaolin content of the sand varies from 9 to 19 per cent.; some is of very good colour and quality, and some is discoloured. The actual extent of the kaolin-sand deposit is still uncertain. The silica sand after washing will contain from 0.062 to 0.191 per cent. ferric iron. It could be used for the poorer grades of glass and possibly for potter's flint if ground.

The mottled fire clays are impure or stained kaolin. The more refractory ones are of first quality, having a fusion temperature of cone 32 to 32½. Other samples will fuse as low as cone 27. This lower fusion temperature is partly due to the presence of sand, which forms a eutectic with the alumina content of the clay. Washing this clay would increase its purity and refractoriness. It is thought that the mottled clay deposits are extensive, as they occur on the Mattagami, Missinaibi, and Wabiskagami rivers.

The dark carbonaceous fire clays are believed to be widely distributed and to form a large part of the Cretaceous deposits in the structural basins referred to. At Great bend on the Mattagami river a prospecting shaft went through 80 feet or more of fire clay, which had a fusion temperature

[1]Geol. Surv. Can., Rept. of Progress, 1877-78, pt. C., p. 4.
[2]Part of the Basin of Moose River, Toronto, 1880; Report on the Basin of Moose River, Toronto, 1890.

between cones 29 and 32. An analysis of clay from this location gave the following:—

	Per cent.
Silica	51.35
Ferric iron	1.44
Alumina	31.08
Lime	.43
Magnesia	.06
Alkalies	trace
Carbon	1.88
Combined water	8.92
Volatile matter	4.68

Fragments of lignite are found in much of this clay.

On the Abitibi river the clay is associated with lignite, and drill holes going down 200 feet are in Cretaceous clays for at least half that distance. However, the refractoriness is not so high at this location, ranging from cone 29 to cone 10. The clay becomes more calcareous with depth and much of it has little commercial value.

These carbonaceous clays derive their colour from the carbon and lignite fragments, are fine-grained and plastic, and if used would generally have to be mixed with a non-plastic or grog to reduce the shrinkage. The better grades resemble New Jersey stoneware clays quite closely, as they have a long firing range and many samples burn to a light-coloured body, reasonably free from iron spots until cone 10 is reached. Semi-commercial tests indicate that the clay is satisfactory in making first quality fire brick if 40 per cent. or more of grog is added. Also the clay can be used in pottery and sanitary porcelain.

The physical properties of these clays are listed in the table below:—

CRETACEOUS CLAYS, MOOSE RIVER BASIN[1]

	Sample No.					
	94	96	52	73	74	75
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Water for plasticity	31.2	32.7	30	39.4	42.2	43.4
Drying linear shrinkage	5.9	6.6	5.2	7.8	7.8	8.5
Burning shrinkage:						
Cone 08	1.4	2.8	1.4	2.8	2.8	4.3
Cone 4	3.5	4.9	2.8	7.8	7.8	10
Cone 10	4.9	7.7	3.5	9.9	10.6	11.4
Cone 14	5.6	7.7	3.5	9.9	11.3	14.3
Porosity:						
Cone 08	33.6	34.8	36.2	38.4	39.3	41.7
Cone 4	28.7	29.5	33.4	18.5	21.2	24.5
Cone 10	27.6	19.2	32.4	13.3	16	15.7
Cone 14	20.9	14	31.6	6.4	5.1	7.5
Fusion cone, P.C.E.	31	32	32	30	32	32
Sieve test:	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
On 20 mesh	10	0	0	0	0.8	0
On 28 mesh	1.3	.2	trace	0	.2	0
On 35 mesh	.5	.2	trace	0	.3	0
On 48 mesh	.5	.2	trace	.4	.4	0
On 100 mesh	4.2	1.3	3.2	5.6	1.2	.6
On 200 mesh	2.8	1.1	11.4	2.4	1	.6
Through 200 mesh	80.7	97	85.4	91.6	96.1	98.8
Total	100	100	100	100	100	100

[1]R. J. Montgomery and R. J. Watson, Fire Clay, Kaolin, and Silica Sand Deposits of the Mattagami and Missinaibi Rivers, Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928.

Sample No. 94.—The sieve-test residues are mostly silica but show some mica on 200 mesh. The raw clay is almost white, rather sandy but of good plasticity. The burned clay is grey-white at low temperature, turning light-buff at cone 14. It is steel-hard at cone 10.

Sample No. 96.—The sieve-test residues are mostly silica with considerable partly decomposed feldspathic rock and some round shot-like grains of iron mineral, probably ankerite. The raw clay is light-grey, smooth, and of good plasticity. The burned body is light-buff, with iron spots showing at cones 10 and 14. It is steel-hard at cone 4.

Sample No. 52.—The sieve-test residues are mostly buff-coloured silica with some mica on the 100- and 200-mesh screens. The raw clay is mottled white, red, and buff, fine-grained, smooth, and of good plasticity. The clay burned pink at low temperatures, turning buff at cone 14. It was not steel-hard at cone 14.

Sample No. 73.—The sieve-test residues are mostly silica but with some undecomposed clay. The raw clay is light-grey, smooth, and of good plasticity. The burned clay is grey-white at low temperatures, turning to a dark-brown at cones 10 and 14 owing to iron spots. It is steel-hard at cone 4.

Sample No. 74.—The sieve-test residues are mostly undecomposed clay with some iron minerals. The raw clay is light-grey, smooth, and of good plasticity. The burned clay is grey-white at low temperature. Iron spots show at cone 10, which make the body quite dark at cone 14. It is steel-hard at cone 4.

Sample No. 75.—The sieve-test residues are mostly silica with some iron. The raw clay is grey, smooth, and of good plasticity. The burned clay is grey-white at low temperatures, turning to a buff at cones 10 and 14. The body is steel-hard at cone 4.

QUATERNARY CLAYS

This latest of geological periods is subdivided into Pleistocene and Recent. In Pleistocene time, great ice-sheets or glaciers advanced from the north, covering the entire province of Ontario for a considerable period. These ice sheets, in moving forward, scoured the surface of the country down to solid rock, picked up boulders and clay, and by grinding the rocks together made silt. The materials were transported long distances to be dropped when the ice melted. As the ice melted, large lakes were formed in depressions, owing to the glaciers blocking off the natural drainage outlets. Clay, silt, and sand were deposited in these lakes, and after the lakes had shrunk or disappeared the deposits remained to form the post-glacial clays now used extensively by clay plants. In addition to these lacustrine (fresh-water lake) deposits, there are marine (salt sea-water) deposits in eastern Ontario and on the James bay slope to the north. The sea invaded the St. Lawrence river valley and covered much of eastern Ontario. The same was true of the Moose River basin, and the sea covered much of the Cretaceous basins in Quaternary time.

A satisfactory classification of these glacial and post-glacial clays is difficult. Baker used local names appearing in Logan's summary of the geology of Canada in 1863 and added the term Red-top clay. The names used are Erie, Saugeen, and Leda. Keele[1] points out certain errors in trying

[1]J. Keele, op. cit., p. 43.

to apply these names to all the Quaternary clays and uses the classification proposed by A. P. Coleman.[1] This classification is as follows:—

CLASSIFICATION OF RECENT CLAY DEPOSITS

	Interlake peninsula	Eastern Ontario
Lacustrine	Nipissing clay, sand, and gravel Algonquin clay, sand, and gravel Iroquois clay, sand, and gravel Warren gravels	Marine: Saxicava sand and gravel. Champlain clay.
Glacial	Wisconsin moraines Wisconsin till	Wisconsin moraines. Wisconsin till.
Lacustrine	Clarke sands and clays.	
Glacial	Wisconsin till.	
Interglacial	Toronto formation: Scarborough beds. Don beds.	
Glacial	Illinoian till.	

In general, the Leda clays of Baker are the marine clays of eastern Ontario and are called Champlain clays. The Saugeen clays, named from the Saugeen river in Bruce county, are thinly-bedded, brown, calcareous clays, often containing a few boulders or pebbles. This local name was used by Baker to cover clays in northern and eastern Ontario that are not contemporaneous. The Erie clay underlies the Saugeen clay in the Interlake peninsula, and at points the difference in level is as much as 500 feet. Most calcareous clays which have a bluish colour when wet have been called Erie. Such clays have also been observed on the rivers flowing into James bay in Northern Ontario. Red-top is the name used by Baker for a red-burning surface clay that overlies a buff-burning clay.

These glacial and post-glacial clays are, therefore, either lacustrine or marine and will be discussed under locations rather than under formations.

Eastern Ontario

Marine or Champlain Clay.—This clay is the outstanding Quaternary deposit of this section. Late in Pleistocene time, a large section of eastern Ontario was depressed and covered by the sea, which entered through the St. Lawrence valley. The Champlain clays, which are the marine sediments of this period, are widespread and occur up to 500 feet above sea-level. The largest areas of Champlain clays occur in Russell and Prescott counties, but this clay is also found in Carleton, Glengarry, Stormont, Dundas, and Grenville counties along the St. Lawrence river, and in Leeds, Lanark, and Renfrew counties as far as Pembroke.

The Champlain clay areas are surrounded by unsorted glacial drift, boulder clay, gravel, and sand, which makes most of it unsatisfactory for brick-making.

A good exposure of the marine clay may be seen at Hogsback lock, Ottawa, where it is worked at the plants of T. E. O'Reilly and Ottawa Brick and Terra Cotta Company. The tables below of chemical and physical properties are taken from Keele's report.[2]

[1] A. P. Coleman, Ont. Bur. Mines, Vol. XVIII, pt. 1, 1909, p. 297.
[2] J. Keele, op. cit., pp. 65, 68.

ANALYSIS OF CHAMPLAIN CLAYS IN EASTERN ONTARIO

Sample No.	Silica, SiO_2	Alumina, Al_2O_3	Iron, Fe_2O_3	Lime, CaO	Magnesia, MgO	Potash, K_2O	Soda, Na_2O	Loss on ignition	Colour
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	
32.....	58.54	17.02	5.48	6.36	2.22	2.95	2.18	3.42	Red.
60.....	57.98	19.00	6.18	3.78	3.82	3.81	1.87	3.18	Red.
48.....	54.38	19.18	7.30	4.60	3.70	3.62	1.42	5.60	Red.
30.....	51.92	13.74	5.03	10.03	3.78	3.06	1.67	11.34	Buff.
31.....	51.30	9.80	3.70	13.63	3.82	2.27	1.64	13.88	Buff.
38.....	51.06	15.58	4.78	10.00	4.47	2.68	2.42	9.76	Buff.

No. 32—Ottawa, average of 14 feet depth, worked by Cain Brick Company.
No. 60—Arnprior, Renfrew county, upper clay at brick yard.
No 48—Renfrew, Renfrew county, upper clay, Thomas Henderson brickyard.
No. 30—Prescott, Grenville county, under clay at Wiser and Son brick plant.
No. 31—From same plant, showing variation in pit.
No. 38—Renfrew, Renfrew county, clay underlying clay No. 48.

PHYSICAL TESTS ON CHAMPLAIN CLAYS, EASTERN ONTARIO

Sample No.	Water of plasticity	Drying shrinkage	Cone 010		Cone 05		Cone 03	
			Fire shrinkage	Absorption	Fire shrinkage	Absorption	Fire shrinkage	Absorption
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
237.....	32	9	0	17	2	16	9	0
235.....	27	6	0	17	1	15	3	3
590a.....	30	10	1	16	2	15	.....	(*)
590.....	28	5	0	20	0	20	10	0
592a.....	30	10	0	17	0	16	7	0
592.....	28	8	0	22	0	21	1	14

(*) Softened and deformed.

No. 237—Ottawa, upper clay, Ottawa Brick and Terra Cotta Company.
No. 235—Ottawa, bottom clay, Ottawa Brick and Terra Cotta Company.
No. 590a—Arnprior, Renfrew county, upper clay at brickyard.
No. 590—Arnprior, lower clay.
No. 592a—Renfrew, Renfrew county, upper clay at old brickyard.
No. 592—Renfrew, bottom clay, burns buff.

The principal product is red soft-mud brick. Good buff-burning clay is hard to find in many sections of eastern Ontario, especially at Ottawa. The clay is highly plastic, and sand or shale is usually mixed with it to reduce losses during drying and burning.

Interlake Peninsula

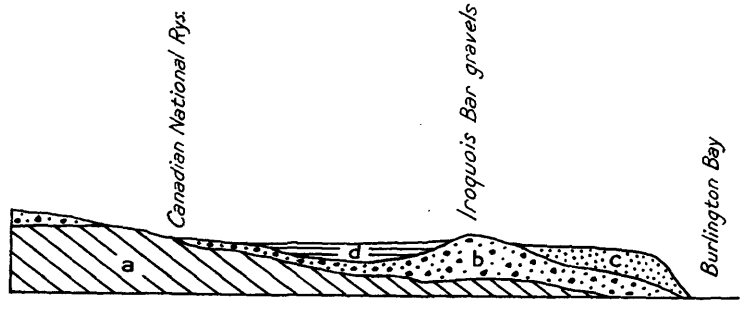
Iroquois Clay.[1]—Lake Iroquois was the name given to the glacial waters that occupied the basin of the present Lake Ontario. Clays laid down in this lake are worked at Hamilton, Toronto, Bowmanville, Whitby, and elsewhere. At Hamilton, some of the clays are about 80 feet above the present lake level. Iroquois deposits of this section have been used for soft-mud brick for years. By careful selection for plasticity and smooth-working qualities, the Foster Pottery Company manufacture from it a very fine flower-pot. The selected clay burns to a good red. Such clay

[1]J. Keele, op. cit., p. 46.

is now hard to find near by, as the local deposit, which has been used for years, is about exhausted. Near Waterdown, clay suitable for the manufacture of sewer pipe is found, which was laid down behind a low gravel bar in Iroquois time.

The clay seems to be derived from the weathering of the red Queenston shale which formed the shore line. This weathering and reworking has leached out a large part of the lime present, and the resulting clay will burn to a dense red body that will take a salt glaze. The deposit is unique in Ontario and furnishes all the clay used for the manufacture of sewer pipe.

The terrace of the Lake Iroquois shore near Toronto reaches a height of 200 feet where it ends in an abrupt escarpment noticeable between Bloor Street and St. Clair Avenue. While the bulk of the Iroquois deposits are sands and gravel, clays were formed in restricted areas that were formerly bays in the ancient lake or depressions behind gravel bars along the old



Section of shale, clays, and sand at Waterdown, Ont. a—Queenston shale. b—boulder clay. c—sands. d—stratified clay.

shore line. The brick plants on Dawes road and Weston road, and at Mount Dennis and West Toronto use this clay. Soft-mud brick are made, burning red and buff. The Iroquois clays in this section are being worked out, and the growing city is forcing the plants to move. Shale brick are replacing the soft-mud brick to a large extent for face purposes. Iroquois clay is not found above the 450-foot level.

Toronto Formation.[1]—This name is given to the Scarborough and Don beds near Toronto, which are of interglacial time. The upper interglacial clay is rather extensive but is mostly buried under a cover of stony clay, which cannot be removed economically. The clay is used in the Don Valley brickyard, as the overburden is light at this point. The upper part is a yellowish silty clay, from 9 to 10 feet thick, stoneless, and buff-burning, which is never used alone. Below is 30 feet of grey, stratified, plastic clay, which burns to an excellent hard, buff-coloured body. The third or lowest division of the series contains massive stony bands with scattered pebbles. This clay is also used at Richard Butwell's plant on the Lake Shore road near the Humber river and at the Price and Cumming plant in the same section.

The lower interglacial clay is said to be the oldest known deposit of brick clay in Ontario and is worked at Don Valley and Greenwood Avenue. The section on Greenwood Avenue shows 30 to 80 feet of stratified clay overlain by 10 to 20 feet of sand and boulders. The red colour of the soft-mud brick made from the Greenwood Avenue deposit is especially pleasing, and the brick are in demand for face purposes. At Don Valley it varies from 10 to 40 feet in thickness, being overlain by a layer of glacial drift and the upper interglacial clay. At Scarborough Heights the overburden in-

[1]J. Keele, op. cit., p. 142.

creases to over 200 feet in thickness, and no attempt is made to use it commercially.

Miscellaneous Glacial and Post-Glacial Clays.—In the Interlake peninsula there are large and extensive clay deposits, which are classed as glacial and post-glacial or boulder clay. These include the Erie, Red-top, and Saugeen clays as described by Baker. Well-defined deposits extend along Lake Erie through Norfolk, Elgin, Kent, and Essex counties, and along Lake Huron through Huron and Bruce counties. It is seldom that the clay is free from pebbles, which are often of limestone. The clay is usually associated with sand or gravel below or above and as a whole is highly calcareous. The greatest thickness of clay is about 150 feet on the shore of Lake Erie, between Port Dover and Port Talbot. The faces ordinarily worked for brick-making are not over 10 to 12 feet, owing to the difficulty of finding beds free from gravel and sand. In Essex and Kent counties only the top clay is used, and a depth of 12 to 18 inches is not uncommon. The lower clay burns buff to cream because of its high lime content, and it is only the top clay, often called Red-top, which has been leached free enough from lime to burn red.

In Lincoln, Welland, and Haldimand counties, clay free enough from sand and stone to make brick is hard to find. The deposits are not generally sorted into clay beds, and only one plant, Fred R. Paxton of St. Catharines, is operating on glacial clay in this section. The clays suitable for brick-making near London, in Middlesex county, and near Brantford, in Brant county, are of the general glacial type. Several of the deposits are described in detail by Keele.[1]

The rest of the Interlake peninsula contains small scattered areas of stoneless clays suitable for making brick and tile. Those in Perth county and in the southern part of Grey county are called high-level clays, some being as high as 1,200 feet above sea-level. The scarcity of clays in Dufferin, Wellington, Perth, and Waterloo counties, as well as in the southern part of Grey county is due to the small amount of sedimentation at this high level.

Farther east there are detached clay areas, probably laid down in small lakes, as at Peterborough and Lindsay. The deposits at Tweed and Madoc, Hastings county, and at Fell, Victoria county, are of the same type.

CHEMICAL ANALYSIS OF POST-GLACIAL CLAYS[2]

Sample No.	Silica, SiO_2	Alumina, Al_2O_3	Iron, Fe_2O_3	Lime, CaO	Magnesia, MgO	Potash, K_2O	Soda, Na_2O	Loss on ignition	Colour
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	
43....	59.48	17.48	7.38	2.60	3.32	2 96	1.74	3.82	Red.
57....	64.44	15.26	5.96	3.65	1.78	3.20	2.52	2.92	Red.
270....	47.50	13.66	4.44	15.58	.80	1.60	2.82	12.94	Buff.
2....	46.16	13.76	5.58	15.74	3.78	2.00	.70	17.48	Buff.
14....	39.92	12.69	4.67	16.56	3.72	2.43	.76	18.82	Buff.
1....	69.12	14.03	4.81	1.94	1.10	2.05	1.53	4.80	Red.
7....	63.56	16.91	6.24	1.91	2.42	3.15	.70	5.64	Red.

NOTE.—Buff is called cream in this report.

No. 43—Kingston, Frontenac county.
No. 57—Peterborough, surface clay above No. 270 at Curtis brickyard.
No. 270—Peterborough, lower clay.
No. 2—Stratford, Perth county, lower clay, Stratford Brick, Tile and Lumber Company.
No. 14—Alvinston, Lambton county (J. C. Waide) Alvinston Brick and Tile Company.
No. 1—Stratford, Perth county, clay overlying sample No. 2.
No. 7—Crediton, Huron county, upper clay.

[1] J. Keele, op. cit., pp. 93, 94.
[2] Ibid, pp. 79, 108.

PHYSICAL TESTS ON POST-GLACIAL CLAYS[1]

Sample No.	Water of plasticity	Drying shrinkage	Cone 010		Cone 06		Cone 03		Colour
			Fire shrinkage	Absorption	Fire shrinkage	Absorption	Fire shrinkage	Absorption	
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	
648.....	36	8	0	18	0	16	8	3	Red.
769.....	28	10	0	15	1	13	7	0	Red.
270.....	20	4	S.S.	19	0	18	1	10	Buff.
251.....	20	5	S.S.	28	S.S.	25	S.S.	25	Buff.
262.....	25	7	0	21	1	21	3	15	Buff.
252.....	25	7	0	15	3	13	6	0	Red.
250.....	21	5	0	15	0	13	0	11	Red.
255.....	21	6	0	15	0	14	3	6	Red.

NOTE.—Buff is called cream in this report.
S.S. denotes slight swelling in firing.

No. 648—Madoc, Hastings county, clay from brickyard.
No. 769—Penetanguishene, Simcoe county, clay from brickyard.
No. 270—Peterborough, under clay from Curtis brickyard.
No. 251—Crediton, Huron county, calcareous clay underlying sample No. 250.
No. 262—Port Rowan, Norfolk county, calcareous drain-tile clay.
No. 252—Essex Centre, Essex county, plant of Aaron Hill.
No. 250—Crediton, Huron county, upper clay.
No. 255—Toronto, interglacial clay, Greenwood Avenue.

Northern Ontario

Ojibway Clay.—One of the large lakes formed during the retreat of the ice sheet in Northern Ontario is called Ojibway and included an area from the Mattagami river to east of Lake Abitibi, probably 100 miles wide from east to west and 150 miles long. The surface level of the region was about 300 feet lower than the present level, allowing James bay to extend about 100 miles inland. Some stoneless clays are found in this old lake bed, but they are not used commercially. The drying properties of the clays are not good as they are liable to crack when placed in a dryer. Their use is limited to common building brick and drain tile.

Algonquin Clay.—Another of the large post-glacial lakes included Lakes Superior, Michigan, Huron, Nipigon, Nipissing, and Simcoe. This large body of water was called Lake Algonquin, and many of the sediments laid down in it give clays suitable for the manufacture of clay wares. Some of these clays are found up to 150 feet above the present lake levels. Deposits are found at Beaverton in Ontario county, at Meaford in Grey county, in Muskoka, and at Spanish River, Huntsville, Bracebridge, Parry Sound, Sault Ste. Marie, Fort William, etc.

Other lakes, smaller in size, are responsible for patches of clays at different locations. These are all of about the same age and quality. They are suitable for common brick and drain tile but cannot be used for vitrified bodies. The chemical composition and the physical properties are about the same as those of the surface clays to the south.

Western Ontario

Clay of any kind is exceedingly scarce over a large part of this region. Shales suitable for the use of the clay worker are found on Thunder bay, and stoneless glacial-lake clay is found near Wabigoon lake and river, Rainy lake, Lake of the Woods near Kenora, Fort William, and Port Arthur.

[1]J. Keele, op. cit., pp. 80, 110.

THE MANUFACTURE OF CLAY PRODUCTS

Raw Material

From the standpoint of the manufacture of clay products, the clays of Ontario may be divided into three classes:—

1. Refractory and stoneware clays of Northern Ontario, which are not yet accessible for use.
2. Shale, which is used for the manufacture of brick, hollow building-block, floor tile, and drain tile.
3. Surface clay, which is used for the manufacture of brick, hollow building-block, flower-pots, drain tile, sewer pipe, conduits, etc.

Refractory and Stoneware Clays

The refractory clays of the Moose River basin should be of value when they are more accessible, and that time should come soon. These clays vary from No. 1 fire clay to lower refractory stoneware clays and are capable of being used in a variety of products that are either not made at all in Ontario or only produced in a rather small way. Imported fire brick range from $60 to $80 per thousand, and fire clay from $5 to $15 per ton, depending upon quality. Stoneware clay runs about the same in price. Importations into Canada for 1928 bearing upon the use of these clays were as follows:—

Fire clay	$266,320
Other clays (largely stoneware)	93,663
Fire brick and shapes	1,334,542
Earthenware and chinaware	5,418,017

The possibility of substantial growth in the industry is apparent. Experimental fire brick made from Ontario fire clay equals the Ohio-Woodland brand of commercial No. 1 fire brick in its ability to carry loads at 1,300° C. The illustration on page 34 shows the appearance and porosity of two fire clays and one stoneware clay burned to several temperatures. The colour of the fire clay is good up to cone 10.

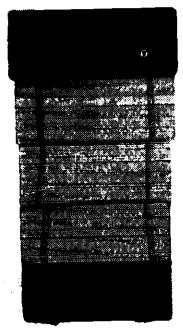
Shale

Shale brick are dominating the face brick industry at present in practically all parts of the province. The general use of brick veneer, 4½ inches thick, instead of all brick, 9 to 13 inches thick, in wall construction, as was common in the past, permits higher prices for the face brick and a greater allowance for transportation. At the same time better quality and greater variety of colour and texture are demanded. The 1928 prices for Canada, according to the Dominion Bureau of Statistics, are as follows:—

Type of Brick		Price per 1,000
Soft-mud process	Face	$19.90
	Common	14.30
Stiff-mud process	Face	22.20
	Common	15.10
Dry-press process	Face	20.40
	Common	13.90

Freedom from physical defects, and texture and colour are of utmost importance, if the brick are to be sold for face use and not for common. It often costs as much to manufacture the common brick as the face brick, the latter being merely a selection for colour, texture, and condition. Although care in manufacture is as important as the choice of raw material, most manufacturers consider that it is easier to meet the trade requirements by using shale. Lorraine and Queenston shales are used, both of which allow the production of brick by the dry-press and the stiff-mud process.

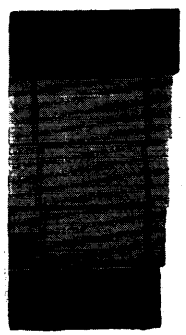
Nº 64-1



	% Porosity
Raw	
Cone 08 (1733°F.)	43·2
4 (2129°F.)	31·0
10 (2300°F.)	20·3
14 (2534°F.)	9·1

P.C.E.-Cone 33
(3173°F.)

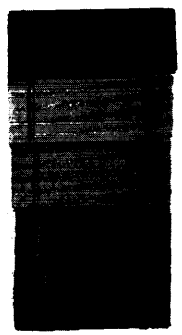
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	% Porosity
Raw	
Cone 08	38·1
4	31·4
10	24·9
14	15·5

P.C.E.-Cone 32½
(3130°F.)

Nº 64-3



	% Porosity
Raw	
Cone 08	34·4
4	23·8
10	9·3
14	11·4

P.C.E.-Cone 23
(2876°F.)

Test pieces (reduced to one-quarter actual size) of fire clay from the Mattagami river, showing porosity and shrinkage at progressively higher temperatures. The half tones illustrate the fact that the clay burns to ivory shades at intermediate temperatures.

A thorough knowledge of a pit is necessary to obtain the colours desired, and the final colour depends largely upon the setting of the brick in the kiln and the handling of the fires during the burning process.

Queenston shale is almost free from limestone and sandstone layers and gives little trouble, but the overburden must be removed in some places, as with the Lorraine shale. Colour variations and variation of plasticity and shrinkage cause considerable trouble. The buff-burning layers are often too thin to sort out easily, but when they are left in they will spoil the good red colour so much desired in the brick. Considerable judgment and compromise is necessary in working the pits to the best advantage.

Another advantage of shale is the size of the deposit. A well-located plant will have enough raw material on a 40-acre lot to last for a generation.



Queenston shale pit, Halton Brick Company, Terra Cotta, Peel county.

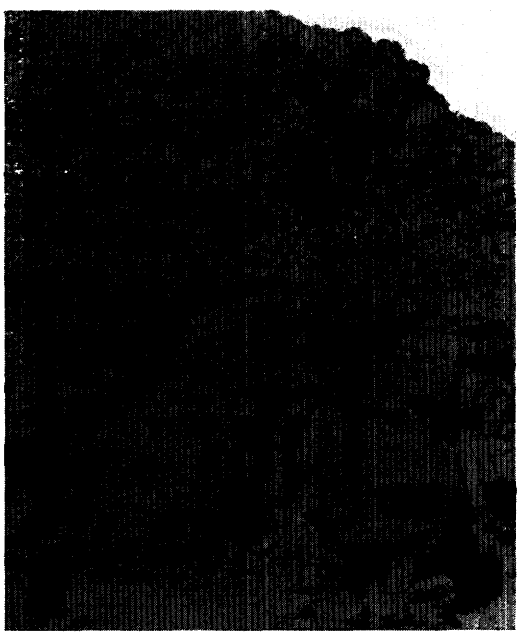
The face may run from 20 feet to 100 feet. The photograph on page 37 shows a 100-foot face of Queenston shale with a steam shovel removing the overburden. Lorraine and Queenston shales are being used to 100 feet in depth, with the bottom not in sight, as compared to 18 to 24 inches deep for many surface clay pits in the Interlake peninsula. The shales are known to be several hundred feet thick. As the lower levels are harder and do not work so easily, they are often avoided, the shale near the surface giving sufficient material. Drainage also becomes more difficult if the pit is deep.

Lorraine shale is rather short when used by itself in the auger machine, and it is often customary to add clay or weathered surface shale. There are numerous layers of sandstone and limestone running through the shale, which must be sorted out. This condition is worse in some pits than in others. The sandstone is hard on the grinding machinery, and the limestone will affect the colour of the finished brick, giving light-buff specks or a general lighter red, depending upon how fine it is ground. Of course, if it is not ground fine, the limestone will crack the brick and give white spots. Lorraine shale contains more of this sort of material than the Queenston shale. The upper photograph on page 38 shows a 70-foot face of Lorraine shale with a pile of rejected material in the foreground.

Freedom from physical defects is more easily obtained with shale, although satisfactory stiff-mud brick may be obtained by using clay. Shale usually shrinks less than clay during both drying and burning, and has less tendency to warp. Its plasticity can be controlled by the amount of grinding and the size of screening, as well as by blending with surface or top shale which has been weathered or with other clays.

The photograph below shows the difference in structure from top to bottom of the face. The upper part is soft and weathered.

The texture of shale brick is more easily controlled than that of clay brick. With care a rug surface may be given to clay brick, but the peculiar



Queenston shale pit at the Toronto Brick Company's plant, Milton.

character of the shale body, which is partly plastic and partly non-plastic, allows rug, bark, and other effects which are difficult if not impossible to obtain on clay.

Colour control is necessary, and shale lends itself to a wide variety of shades and tints from red to buff and cream, from brown to black, and with green tints. The colour chart inserted between pages 36 and 37 give an idea of the shades obtained.

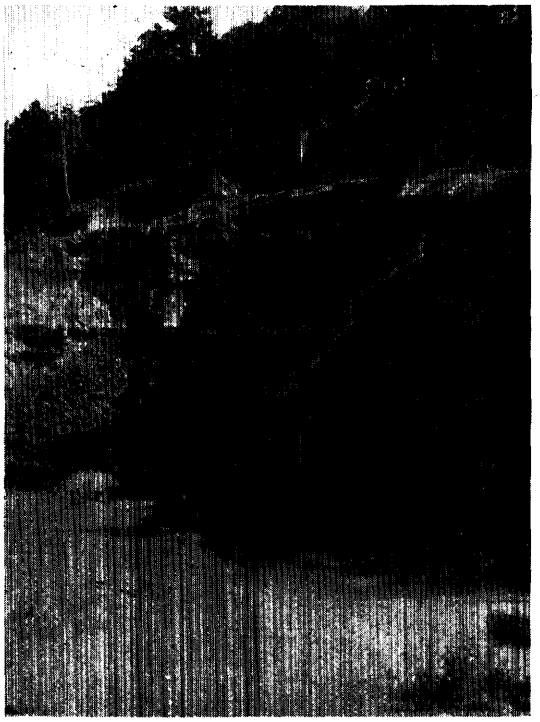
Lorraine shale burns red normally, and Queenston shale burns both red and buff with intermediate colours. A proper blending of Queenston shale will give all the colours now in demand. Lorraine shale requires blending with other shale or clay. Each shale bank, however, has its drawbacks. All Queenston shale deposits will not give a good bright-red and a good buff. Much of it gives intermediate colours suitable only for common brick or a limited colour range of face brick. The various colours are usually in layers, and a shale pit is often worked in a series of benches to allow careful selection.

The photograph on page 36 shows three levels being worked at Terra Cotta, Peel county.

Lorraine shale also contains considerable organic matter. If this is not oxidized slowly during the burning, black-core, swelling, and poor colour will result. The variation in colour of the burned brick from using shale from different parts of the pit is less pronounced with Lorraine shale.

The use of shale necessitates grinding and screening, which is not needed in the manufacture of clay brick, so the increased sale price is offset to some extent by increased manufacturing costs. Both of these shales are used in the manufacturing of hollow building-block with or without the addition of clay to control the plasticity and the behaviour in the auger machine die.

Hamilton shale is used at only one place, at Thedford, Lambton county. Its use has been so limited that its properties are not well known, except



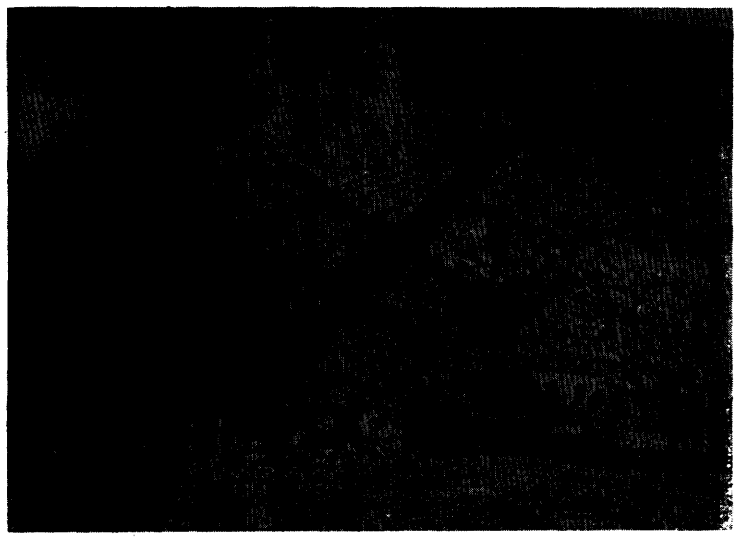
Queenston shale pit at the plant of the Caledon Shale Brick, Limited, Credit Forks.

that it is plastic, drys easily, and shows surface scum from soluble sulphur compounds in the shale. Correction of this by the use of barium compounds has not been tried. The lower photograph on page 38 shows a view of this deposit.

Clay

Shale, which is used by many of the larger plants in the manufacture of brick, is not available in many sections, and its use is confined almost entirely to the Toronto and Hamilton areas. Clay is used in all parts of the province. Soft-mud face brick, to the value of $349,847, were made in 1928, and the common brick, soft-mud and stiff-mud, valued at $3,511,288, were largely made of clay. In many sections it is believed that the demand for clay brick is falling off; but while substitutes are making some inroads into the industry, it is still a large one. Many of the plants making brick from clay try to produce them for face brick purposes by greater care in

manufacture and selection. In a few cases there has been considerable success, and the Greenwood Avenue plants in Toronto are selling most of



Lorraine shale pit, Don Valley plant of the Toronto Brick Company.

their product for this purpose. The soft-mud brick made in these plants are highly thought of by the architect for their deep rich red colour and sanded surfaces, and have been used in such buildings as the Granite Club, St. Clair Avenue, Toronto.

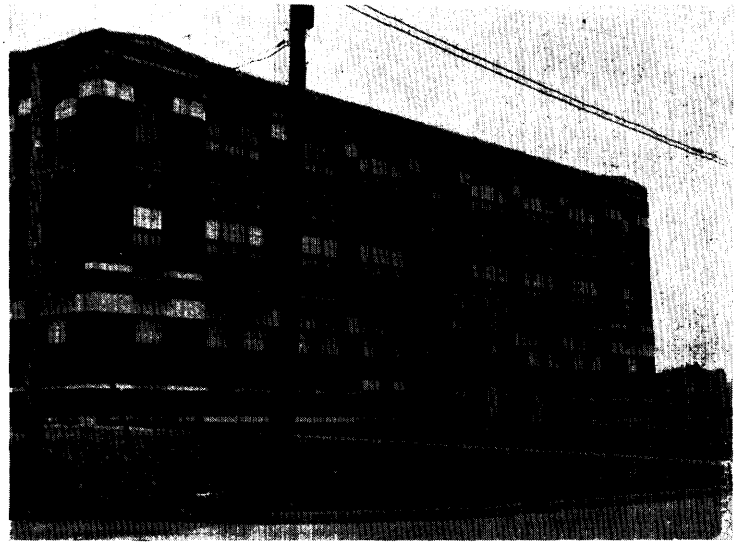


Hamilton shale pit, W. S. Watson plant, Thedford, Lambton county.

Fred R. Paxton, of St. Catharines, also makes clay brick for face purposes. Soft-mud brick are hard burned in down-draft kilns to the point

where they start to warp out of shape without bloating. When properly laid with uneven joints and slightly uneven course lines, an appearance of age is obtained in a new building. An architect of St. Catharines has built several houses of Old English design which are unusual in appearance and has just finished a new building with these brick for the Y.M.C.A. and Y.W.C.A.

Rug texture and a series of colours can be obtained by using red and buff or cream-burning clays and blends of these clays. The burning may be clear or flashed. Curtis Brothers, of Peterborough, have been very successful in making this type, and many fine structures including churches, schools, and other public buildings in this city are the result. James Elliott, Jr., at Sault Ste. Marie, also makes rug brick from clay, with flashed and clear colours. A new school building, as shown in the photograph below, is constructed of his brick, and this job kept his plant busy for the greater part of a season.



Clay rug brick, Technical School, Sault Ste. Marie.

In the Interlake peninsula some clay rug brick are made. Those made by Herbert Ha latt and Sons, Comber, Essex county, are a good example.

Many of the manufacturers using clay do not seem to appreciate the fact that if they are to compete with shale in the face-brick field they must have a variety of colour and texture as well as hard-burned brick. Often the clay is not suitable, and in many sections buff clays are not in demand and the red-burning clays give a poor red colour. Flashing red-burning clays will often give more desirable colours than a poor red, burned clear. Advantage of this fact is seldom taken. If a manufacturer decides not to compete with face brick, then his costs must be reduced to make a profit when the product is sold as common brick. Many manufacture on a face-brick basis and sell most of their product on a common-brick basis. An attempt to solve this problem is being made in the new plant of Crang-Booth, Limited, of Weston, York county. A new up-to-date plant, which will use a minimum of labour, has been constructed. The brick will be dried by waste heat and burned in a continuous railroad tunnel-kiln of the Booth design. The plant has a capacity of 60,000 or more brick per day. In the Chicago and other areas, large scove kilns are used for burning common

brick, with overhead crane service to reduce the labour required. The small plant with a small overhead, but with meagre equipment and inadequate dryers and kilns, has not solved this problem for the Ontario brickmaker, and this trial of the larger plant with modern equipment will be watched with considerable interest.

The plant using clay instead of shale usually has a more variable raw material. In some sections of eastern Ontario, where the marine or Champlain clay is found, a face of 15 to 20 feet, or more, is not uncommon, and a satisfactory clay supply for years is in sight. The photograph below shows such a deposit.

Clay deposits are not always homogeneous from top to bottom, but the variations of sandy material, pebbles, etc., are usually fairly well defined and the pit can be worked accordingly. The interglacial clays of



Marine clay pit at the T. E. O'Reilly plant, Ottawa, Carleton county.

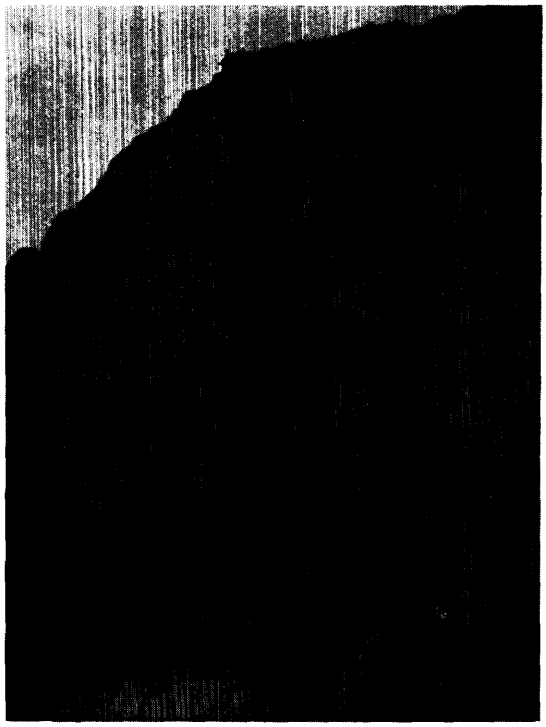
the Toronto formation give unusually fine faces to work, but their distribution is not wide. The photograph opposite shows the interglacial clay at the Don Valley plant.

Beds of freshwater glacial clays vary considerably in thickness and in quality. Some of the deposits are 6 to 8 feet deep, or possibly more, but often 2 to 3 feet is the limit that can be used, as the clay changes in character and composition. It may be sandy; it may contain "chisel," concretions, or limestone pebbles; or it may be below the natural drainage level. Hand-digging is often required to sort the material.

When only 18 inches to 2 feet of clay is used, a plant of fair capacity will work over a considerable area and the transportation to the plant as well as the cost of the land becomes a problem. At one plant the clay pit is on a hillside which is worked only one spading deep, which is as deep as the red-burning clay goes; and much ground is covered in a season. The worked-over land is of little value, except where it can be used for building lots. Owing to its level or failure to replace the top soil in a smooth layer, the writer found very few cases where such land was returned for farming. In some cases it is used for pasture of a rather poor quality. If the clay is 18 inches deep, one acre will make between a million and a million and a half brick. A plant making over five million brick a year would cover

considerable ground in the course of 25 years, which is a reasonable life for a plant. This is one reason why there is a hesitation to build modern plants in certain locations. It is difficult to find 100 acres of land with a uniform quality of clay covering it.

When using clay, grinding and screening is not done. Ordinarily it is already fine and plastic and only requires the addition of water. When the clay contains pebbles, screening would be of value, but the clay is too wet as it comes from the ground, and it would be necessary to dry the clay, then grind and screen. Such an operation would be very expensive and difficult. Stone or hard particles of any kind are, therefore, very objection-



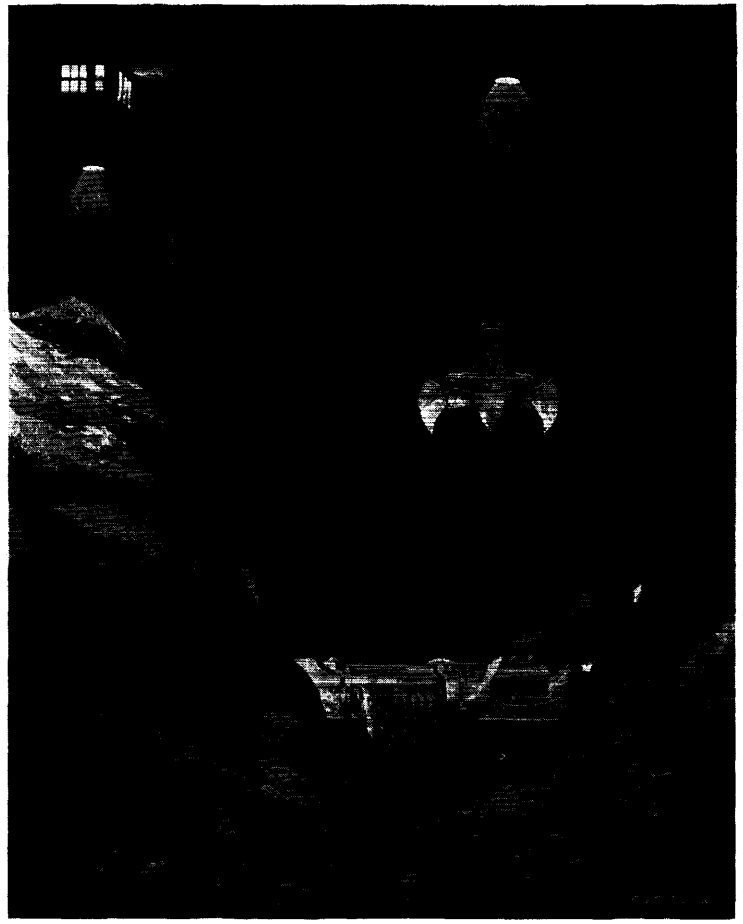
Top interglacial clay, Don Valley Brick Works.

able. The larger ones clog in the die and break the cutting wires. On drying and burning pebbles often cause defective ware, especially if the pebbles are limestone. Such lime pebbles burn to quick lime in the kiln, and when exposed to moisture will take up water to form the hydrate of lime, which expands and cracks the piece. A great many of the clays contain some pebbles, and the trouble is one of degree in different sections.

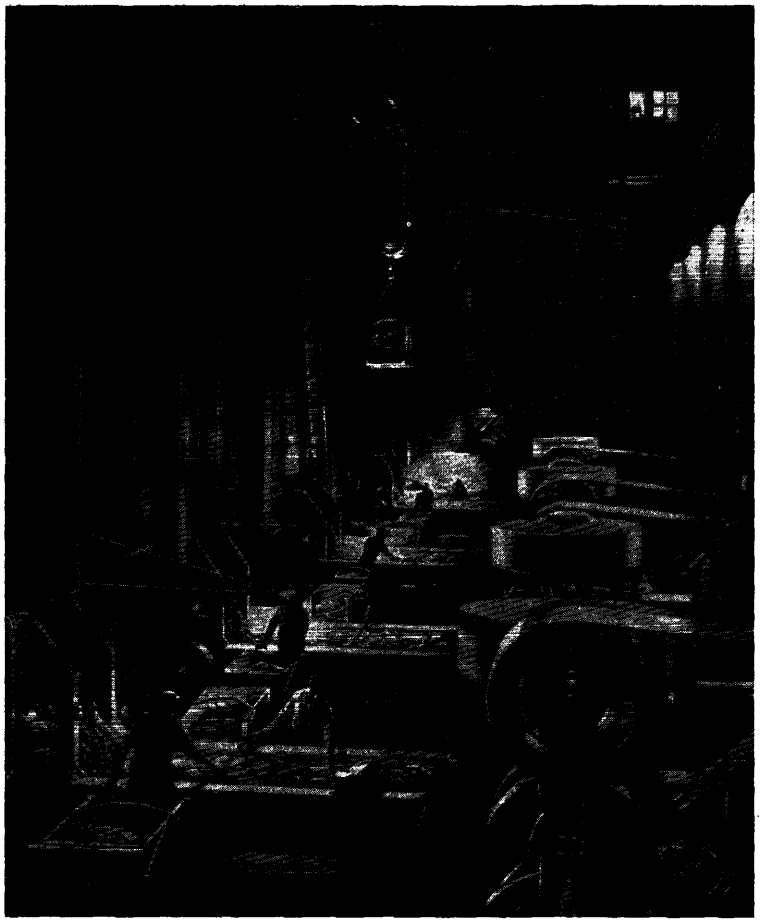
Some clays are too plastic and sticky, especially when very wet in the spring of the year, and additions of sand are made. Suitable sand is sometimes found on the same property but often must be hauled from a distance. In the soft-mud process sanding of the moulds is important, and the sand should burn to the same colour as the brick. A red brick should have a red-burning sand, and a buff or cream brick should have a light-burning sand. The photograph on page 45 shows a clay pit of medium depth, being three spadings or about 30 inches. In the background is seen the straw that is placed over the clay in the fall to aid in retaining the ground moisture during the summer months.



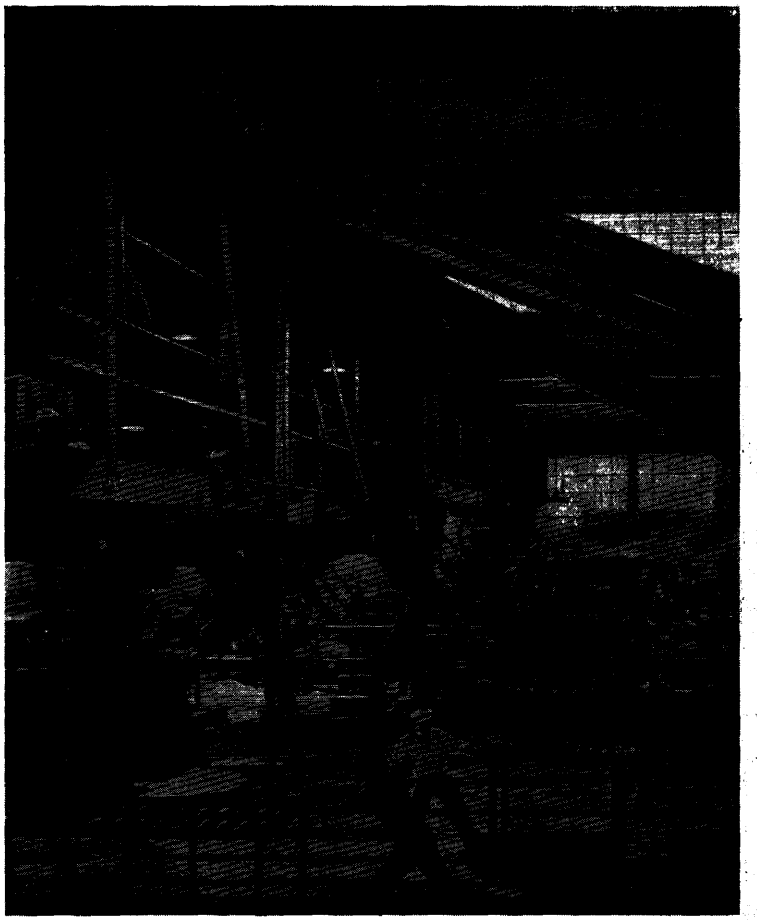
Loading shale into cars with a steam shovel, Cooksville Company, Limited, Cooksville.



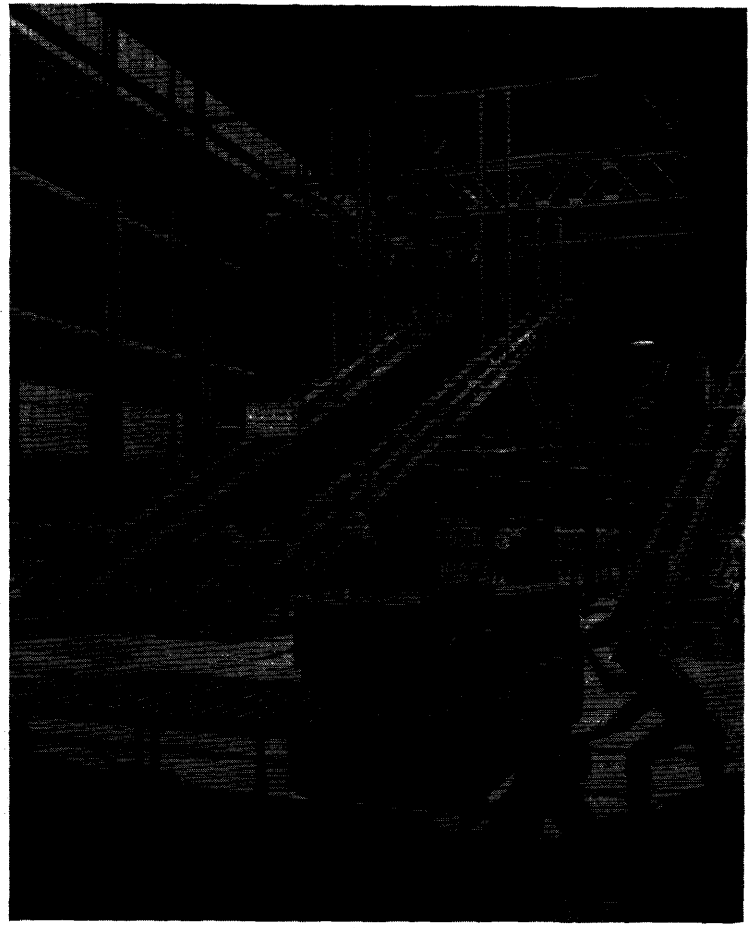
Shale being dumped from car to storage shed, Cooksville plant, Cooksville. The overhead crane keeps the dumping pit clear of shale and removes it to the storage piles in the foreground or delivers it to the feeders supplying the dry pans.



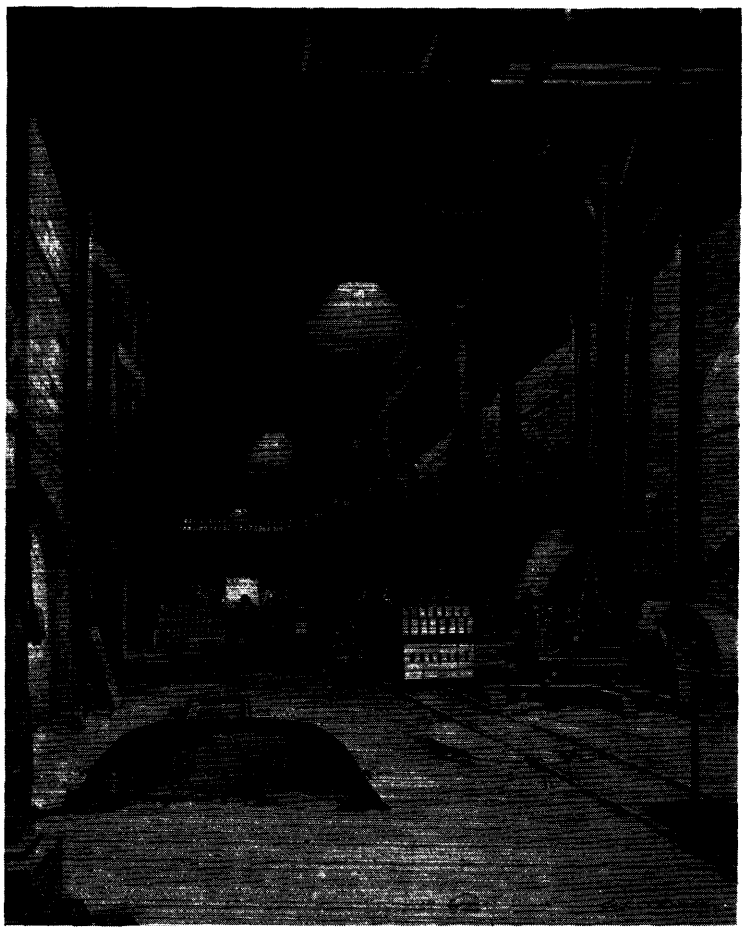
Shale being fed by belt to the dry pans, Cooksville Company, Cooksville. Limestone impurities are being removed by hand-picking as the material travels along the belt. The shale storage bin is at the left. An overhead crane removes the rejected material.



Forming brick by the stiff-mud process, Cooksville Company, Cooksville. The screens and the storage bins for the ground material are above. The open-top pug mills are seen on the second floor; the auger machine with automatic cut-offs are on the first floor.



Brick being loaded on to the dryer cars from the off-bearing belt, Cooksville Company, Cooksville. Conveyers return the imperfect brick to the pug mill.



Continuous-chamber kiln, fired with producer gas, to which the brick go after drying, Cooksville Company, Cooksville.

blasting. At the Don Valley brick yard,[1] an Ingersoll-Rand air jack-hammer, weighing 40 pounds and requiring 85 pounds air pressure, is used. This outfit drills 25 holes, 8 feet deep, per day. Ten holes will give enough shale for 75,000 brick a day. The holes are 9 feet apart in rows 6 feet back from the face. Seven pounds of Polar ammonia dynamite, 40 per cent. strength, is used for each hole. One man does all the work. As the plant is within the city of Toronto, small charges are necessary. Deeper holes and larger charges could be used in some locations. The drills are as follows: 2-foot, 2½-inch bit; 4-foot, 2¼-inch bit; 6-foot, 2⅛-inch bit; 8-foot, 2-inch bit.

The Brick and Clay Record[2] states that the secret of fast drilling in shale is to dress the drills to the shape of a blunt chisel about a quarter of an inch wide, instead of drawing to a sharp edge. The blows reduce the size of the cuttings so that they can be easily washed out as fast as the drilling progresses. The following notes are taken from the same reference. Hand-



Clay pit, plant of Fred Howlett and Sons, Brigden, Lambton county.

drilling is usually more expensive than power-drilling in shale. Well drills cannot be used to advantage unless the entire face, 70 to 90 feet high, is to be blasted at one time. They are not portable enough. A steam drill is difficult to maintain in winter and the air drill gives some trouble from condensing water in the air line. The electric drill is free from these troubles, and while not used in the Ontario plants it is popular in some localities. There are four types of explosives available, powder, straight dynamite, ammonia dynamite, and gelatin dynamite. The dynamite strengths vary from 15 to 60 per cent., the most popular being 40 per cent. ammonia dynamite. The photograph on page 36 shows Queenston shale being worked. The drilling is done by hand, and the shale is worked in three benches to allow selection for colour.

Shale is usually loaded by hand or power shovel to cars which haul it to the plant. The shale planer, to be described later, can be used under favourable conditions, but is not used in Ontario at the present time.

Clay

Drilling and blasting in the clay pit is often done to loosen up the clay where there is a considerable face. Hand-drilling using a wood auger with

[1]Ann. Rept. Can. Nat. Clay Products Assoc., 1927, p. 21.
[2]Vol. 70, June 21, 1927, p. 1002.

Processes of Manufacturing

In the process of manufacturing clay ware the following divisions will be discussed separately: (1) Clay winning or gathering—the obtaining of the raw material; (2) Transporting the clay to the plant; (3) Aging, weathering, and developing plasticity of the clay; (4) Forming the clay into ware, including grinding, screening, pugging, forming, etc.; (5) Drying clay ware; (6) Burning of the ware to give a product for the market.

The illustrations on the three preceding pages depict these operations as carried on in one of the Ontario plants (Cooksville Company, Cooksville).

CLAY GATHERING OR WINNING

The cost of clay winning has been studied by J. F. McMahon,[1] of the Ceramics and Road Materials Division of the Mines Branch, Department of Mines, Ottawa, and every clay plant should have a copy of this pre-



Surface clay pit, showing method of hand-digging, Dover Brick and Tile Company, Dover Centre, Kent county.

liminary report. A final report is to follow. The costs for 20 plants ranges from 19 to 68 cents per ton. It is difficult to analyse the cause for this variation as the conditions are different. The wage per day is, of course, important, and one gets the impression that mechanical digging, where this is possible, will allow the payment of higher wages without increasing the cost. A tractor and scraper gave the low figure of 19 cents, while hand-digging gave the high figure of 68 cents. Power shovels gave an average of about 40 cents. The distance, grade of the haul, character of the clay, dampness, and amount of sorting required, all influence the total cost. Sorting seems to be justified in the manufacture of face brick, but common brick plants should not have this extra expense.

Shale

Drilling and blasting is usually necessary to loosen up the shale bank enough to allow loading by hand or by power shovel. Even the more powerful shovels have difficulty in handling material in winter without

[1] J. F. McMahon, "Preliminary Report on Clay Gathering," Investigations in Ceramics and Road Materials, 1927, Mines Branch, No. 697, Ottawa, 1929.

a 2-inch bit is used at the Don Valley plant, and 7 to 8 pounds of dynamite are placed in a hole 16 feet deep. With faces of 2 to 4 feet, blasting is seldom necessary unless the clay is worked in freezing weather.

Hand-loading is done either with the clay fairly dry, containing only the natural ground water, or wet with water added purposely. At the plant of Thos. Godfrey and Company, Carleton Place, Lanark county, the pit is equipped with a hose to wet the clay before it is loaded on the car. The photograph opposite is a view of a deeper pit kept damp by water in the bottom. It is 11 spadings deep, or about 10 feet.

The natural moisture in the ground is often held by placing a layer of straw 4 to 6 inches thick over the surface of the clay. The straw is placed



Clay pit, Price and Smith plant, Greenwood Avenue, Toronto.

in the fall, covering the clay to be used the following summer. The straw may be saved and used again with enough added to replace the natural loss from decay. The photograph above shows a pit which is dry or contains only the natural ground water.

At the Price and Smith plant the sandy material is blended with the clay below by the shovellers. A man on the bench above throws down enough sand to give the correct blend for soft-mud brick.

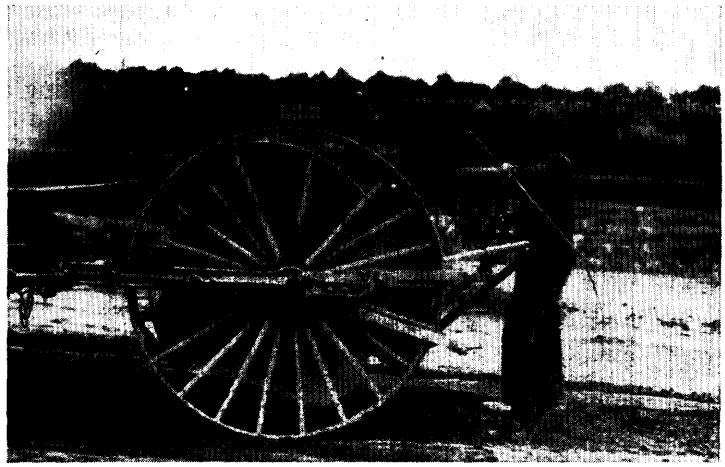
Mechanical Digging.—One of the simple ways of winning clay is the use of the clay gatherer, which is shown in the upper photograph on page 48.

The clay surface is broken up by use of a toothed drag like a harrow, and as the gatherer passes along revolving scrapers carry the clay up into the box carried on the main axle. This takes an even layer of dry clay, a few inches deep, and tends to equalize the inequalities of a deposit. The ordinary plow and scraper gives good results, and McMahon's cost figures,[1]

[1]J. F. McMahon, op. cit., p. 17.

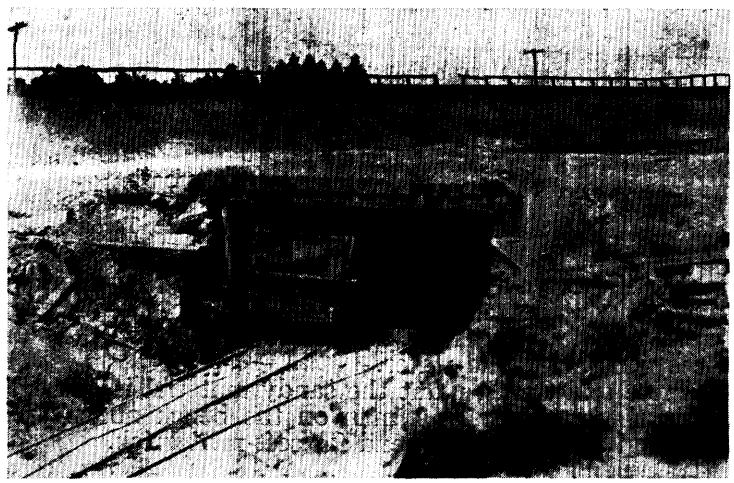
for such an outfit using a tractor for power, are very low. A car-loading bridge, as shown in the photograph below, is often used in connection with the scraper when the distance from the plant is great.

Another form of scraper, the drag line, is shown in a photograph on page 49 and is used to win sewer-pipe clay. The clay is only 12 to 18



Clay gatherer, W. H. Cooper plant, Hamilton, Wentworth county.

inches deep, and a large area must be covered. A cable pulls the scraper up the incline to allow dumping directly into cars, which are placed on the track below. A tail cable running through a pulley attached to a heavy stake, about 1,000 feet distant, pulls the scraper back to position for another



Car-loading bridge, A. Snelgrove plant, Beaverton, Ontario county.

load. Both pulling and tail cables are operated from a motor and drum in the shed at the back. The digging speed is about 600 feet per minute. A three-quarter yard size of scraper will give a capacity of 25 or more cubic yards per hour for a 600-foot haul. The operation cost is low with soft dry clay. Plowing in advance may be necessary in some cases.

The Buckeye clay digger is an adaptation of the ditching machine to clay gathering. The photograph below shows one of these machines.

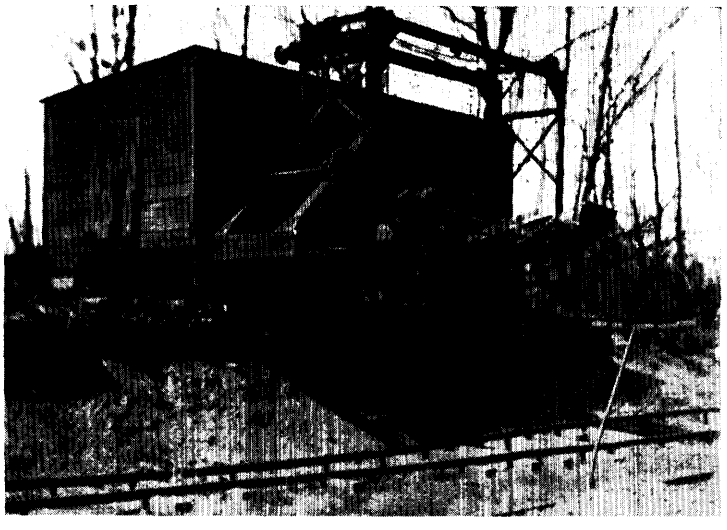
The machine travels on a track on top of the bank and loads to cars on a track below. As this picture was taken in the early spring, before the



Drag line, National Sewer Pipe Company, Waterdown.

clay pit was operated, the bank shows some caving. The machine actually gives a very clean pit and face, and an even grading and mixing from top to bottom is obtained.

A unique machine, similar in type, is used at the plant of Amos C. Martin, Wallenstein, Wellington county. It was made by Mr. Martin



Buckeye clay digger, National Fireproofing Company, Aldershot.

from various tractor parts in his own machine shop and gives efficient service.

The power shovel is used for clay as well as for shale. The photograph on page 50 shows a Bay City electric shovel handling a 3-foot face of clay.

The clay is kept wet by the addition of water as needed, and one man does all the digging, while a man and a horse haul to the plant.

The capacity of the shovel selected depends largely upon the hardness of the material to be handled, as the capacity of even the smaller ones usually exceeds the amount required for plant operation. The power may be supplied by steam, oil, or gasoline engine, or electric motor. Steam is the most expensive to operate. Where electric power is available and cheap this is probably the best, except where considerable movement of the shovel is necessary. In such a case the gasoline or oil engine is cheaper. A full circle swing and crawler tread, able to move under its own power,



Bay City shovel, Denison Tile Company, Fletcher.

is desirable in most pits. A three-quarter yard size is generally selected, although the half-yard size usually gives the needed capacity. The larger size is more rugged and has more cutting power at the lip of the bucket. A manufacturer gives the following capacities for an 8-hour day:—

Size in cubic yards	Capacity in tons per day
One-half	250 to 300
Five-eighths	300 to 375
Three-quarters	325 to 400
One	500 to 600

It is estimated that most shovels do not operate more than 20 to 25 per cent. of the time in normal operation in a clay pit.

The shale planer is a relatively new machine of high efficiency when the proper conditions obtain. It works best on a shale bank, uniform in structure and hard enough not to cave in. Soft spots, large stones, or heavy hard layers cause trouble. The planer is used in pits with a face from 20 to 80 feet. As the machine moves along a track under mechanical

control, it takes a thin layer off, giving a very uniform blending from top to bottom. It is built like a bucket conveyer extending from the bottom to the top of the face. The buckets have a cutting edge, which engages the face and cuts about one inch deep.

TRANSPORTATION OF CLAY TO THE PLANT

In a few cases the machine that gathers the clay takes it to the plant, as does the gatherer and wheel scraper. In most cases, however, some means of transportation is necessary. The simplest method is the dump cart and horse. This means is not used in the larger plants and is considered to be expensive. Also in the pit or at the machine, there is usually an incline which is too steep for the horse. In a few cases the automobile truck is used to advantage. Where the distance is considerable or where



Overhead loading-track, National Sewer Pipe Company, Aldershot.

selection of clay demands several loading points, the truck has a certain advantage. In the photograph above, an overhead loading-trestle, approached by an incline, allows sewer-pipe clay to be loaded to trucks for an 8-mile haul to Hamilton.

The clay is loaded into cars by a Buckeye clay digger, and the cars are pushed up the incline of the trestle by a gasoline locomotive.

The dump car, either side or end dump, on a narrow-gauge track is widely used. The cars are of one to two yards capacity. The track gauge is 24-, 30-, or 36-inch, with rails weighing 12 to 30 pounds per yard. The 16-pound rails are said to be the lightest that will be satisfactory and are easier to keep in repair than the 12-pound rail. Thirty-pound rails are often recommended, especially when a locomotive is used. Roller bearings are well worth while. Professor Nold, of Ohio State University, gives the following draw bar pull per ton of load and car for various conditions:—

	Lbs. per ton
Good level track and roller bearings	15–20
Good level track and smooth bearings	30
Rough, poor track and smooth bearings	40–45

For locomotive hauling, the grade on a straight track should not be over 12 per cent. Locomotive speed is usually from 2 to 12 miles per hour.

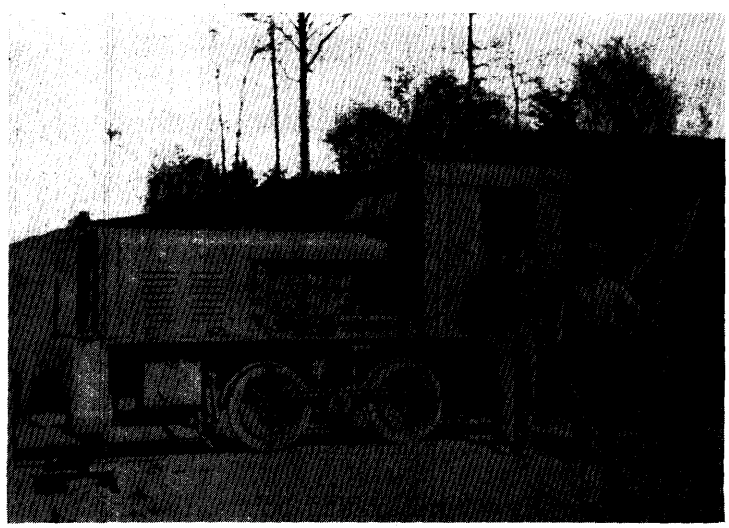
Curves should be kept to a minimum, especially on a grade, and the outer track should be raised to allow for the centrifugal force of the cars going around the curve. With car speeds of 6 miles per hour, the elevation of the outside rail should be as follows:—

Radius	Elevation of outside rail
50-foot	1½ inches
80-foot	1 "
150-foot	½ "

To prevent the track from buckling in hot weather, expansion allowances for temperature changes should be left at each joint in open-pit work, as follows:—

Temperature when rail is laid	Space between rail ends
25° F., or less	¼ inch
50° to 74° F.	⅛ "
95° F., or above	0 "

A Vulcan gasoline locomotive of the latest type is shown in the photograph below. It is 60 horse-power and will pull 7 cars of 4-yards capacity



Vulcan 60 h.p. locomotive, National Sewer Pipe Company, Aldershot.

each, equalling a load of 35 tons. It makes a haul of 1½ miles with a maximum grade of 4½ per cent. loaded and 6 per cent. empty. It has given very good service.

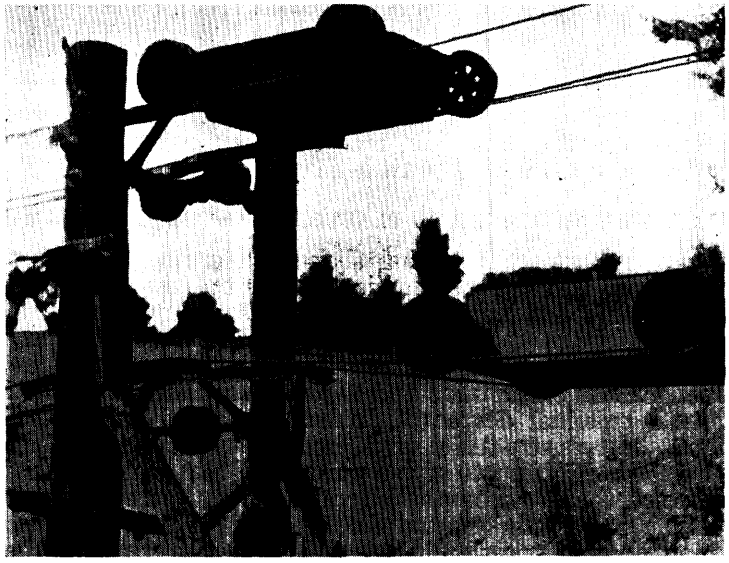
Aerial tramways can sometimes be used to advantage where uneven ground or an obstacle, like a river or railway, must be crossed. The Crang-Booth plant at Weston is installing one to reduce the amount of labour required. The photograph on the opposite page gives a view of this tramway.

Small cars with 4 wheels travel to the plant on the two upper cables and return upside down on the two lower cables. The cars or buckets are fastened to another endless cable, which goes around a large pulley wheel at either end of the cableway. The cars are spaced on the endless cable to give the required capacity.

Wire Rope.—In using wire rope for tramways, inclines, or drag lines, the tensile strength, flexibility, and resistance to abrasion are of utmost importance. The life of a wire rope of given quality depends principally upon the diameter of the drums or sheaves over which it runs and the speed

of travel. Wire rope is made from iron, crucible cast steel, extra strong crucible cast steel, plow steel, and special or improved plow steel. It grades in quality and price in the order named.

Pumps.—Pumps are often necessary to pump the pit dry in the spring, or after heavy rains. In a few cases they are required all season. At one plant a small portable electric pump was used to keep the flues dry after heavy rains. A sump was placed in each flue near the base of the stack. The centrifugal pump using electric power in a compact unit is most popular where electric power is available. Gasoline engines are sometimes used on



Aerial tramway system, Crang-Booth plant, Weston, York county.

such pumps. A type which will take dirty water with some clay and sand is necessary to avoid trouble or damage to the pump. Special trash pumps can be purchased which will handle considerable solid matter without clogging.[1]

Inclines.—The usual drum hoist with friction clutch and direct-connected motor through gears is generally used. Grades up to 9 per cent. may be pulled by a horse and dump cart, if the grade is not longer than about 25 feet. A locomotive will work with fair efficiency up to a 12 per cent. grade. Above this a wire rope is necessary. In most plants the angle of the incline will not be over 40 to 50 per cent. The following table gives the relation between angle in degrees and per cent. grade (feet rise

[1]Smart-Turner Machine Company, Limited, Hamilton, advertisement in "Manufacturing in Canada," March, 1928.

per 100 feet horizontal distance) and the stress in the cable per ton load of car and clay.[1]

Per cent. grade	Angle of incline	Pounds stress per ton load
5	2° 52′	140
10	5° 43′	240
15	8° 32′	336
20	11° 10′	432
25	14° 3′	527
30	16° 42′	613
40	21° 49′	782
50	26° 34′	933
60	30° 58′	1,067
70	35°	1,185

The diameter of the rope should be determined for each case. Diameters of seven-sixteenths to half an inch are common, but larger ones may be necessary on a steep incline with a heavy load.

AGING, WEATHERING, AND PLASTICITY OF CLAY AND SHALE

When clay is formed into final shape by forcing through the die of an auger machine, it must be plastic enough to flow smoothly and give good square corners and smooth surfaces. Dry clay, wet in a pug mill and passed on through the auger machine in 5 to 10 minutes, does not develop as much plasticity as can be obtained. The water does not have time to penetrate the clay grains and allow the separation of the individual particles into a colloidal degree of fineness which gives greater plasticity and strength, better structure, and improved product. The plasticity developed must be sufficient to give a product of reasonable quality, and the method by which this is accomplished varies with the raw material and the product. Shale is usually ground fine enough to break down the hard structure, and enough top-weathered shale is added to give the required plasticity or a clay is blended with it. In the larger plants the face of the shale pit will not weather fast enough to improve plasticity materially, and the top layers exposed to weathering for years must be depended upon. Natural ground water makes little difference in the plasticity of the shale deposit. Wet grinding a shale in a wet pan or ball mill will improve its plasticity.

In clay pits the natural ground water is often conserved, and the clay reaches the plant with almost enough water for forming the ware. Often water is added in the pit in dry weather. In some cases the clay to be used the following year is plowed or shovelled over by hand during the fall and early winter. This would seem to be an unnecessary expense if proper mechanical equipment is used. Clay is sometimes dug and piled near the forming machine in the fall so as to provide good plastic clay to start with in the spring. When the clay pit is very wet or full of water in the spring, this is almost necessary if the plant is to run. In the manufacture of flower-pots, the Foster Pottery Company, Hamilton, runs the clay through an auger machine or pug mill and stores the blanks of wet plastic clay in a damp cellar to age for 6 weeks to 3 months before using. This greatly improves the working properties of the clay.

CLAY-FORMING

This subject should properly include "Factory Design, Equipment, and Manufacture of Clay Wares," which is the title of a book by T. W.

[1]Kent Hand Book.

Garve.[1] Factory design is beyond the scope of this survey and will only be mentioned in an incidental way. The usual equipment and the more important technical points will be referred to, drawing from this book by Garve, general literature on the subject, and field notes.

In Ontario heavy clay products are formed by the following three methods:—

Method	No. of plants
Soft-mud	48
Dry-press	14
Stiff-mud	112

Several plants use two methods, and one plant uses all three. Hand slop-moulding is a thing of the past, except in the refractory industry and in making a few special clay shapes. The distribution according to county is given in the list below. Many of the stiff-mud plants make drain tile and hollow building-block as well as brick, or may make drain tile as the principal product and only a few brick. The product changes from time to time depending upon demand, and a classification for any one year would not hold over any period of time.

Distribution of Clay Plants according to Methods of Manufacturing, 1929

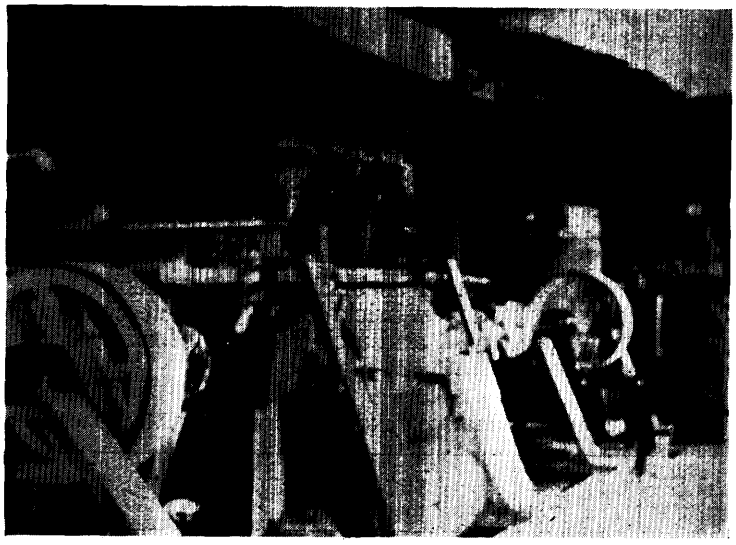
District or county	Soft-mud	Dry-press	Stiff-mud	District or county	Soft-mud	Dry-press	Stiff-mud
Brant	1	0	1	Norfolk	0	0	1
Bruce	0	0	3	Northumberland	1	0	0
Carleton	2	0	1	Ontario	1	0	2
Durham	1	0	0	Oxford	1	0	3
Elgin	0	0	6	Peel	0	6	6
Essex	0	0	11	Perth	0	0	3
Grey	2	0	2	Peterborough	1	0	1
Halton	0	3	2	Prescott	1	0	0
Hastings	2	0	0	Renfrew	5	0	3
Huron	0	0	5	Simcoe	1	0	1
Kenora	0	0	1	Thunder Bay	1	0	1
Kent	1	0	15	Timiskaming	1	0	0
Lambton	0	0	9	Victoria	2	0	1
Lanark	1	0	0	Waterloo	0	0	4
Lennox and Addington	1	0	1	Wellington	0	0	2
Lincoln	1	1	1	Wentworth	3	2	6
Middlesex	3	0	9	York	13	2	9
Muskoka	1	0	2				
Nipissing	1	0	0	Total	48	14	112

Soft-Mud Method

Clay suitable for this type of brick must be sandy. A clay that is too plastic will stick to the moulds and be difficult to handle. The clay is of almost "slop" consistency, containing about 20 per cent. water. The moulded brick will hold its shape under its own weight but cannot be piled up on dryer cars like dry-press or stiff-mud brick. The method is ideal for many of the glacial and post-glacial clays, as they are often sandy or so associated with sand below or above that material for a suitable mix is at hand. Both red and cream (often called white) brick are made, and it is important that the sand in the red brick burns red and the sand in the cream brick burns to a light colour or cream. The process is simple. The clay is brought from the pit in cars or in dump carts. It already contains a certain amount of water, either natural or added in the pit. Three combinations of

[1] T. A. Randall and Company, 1929.

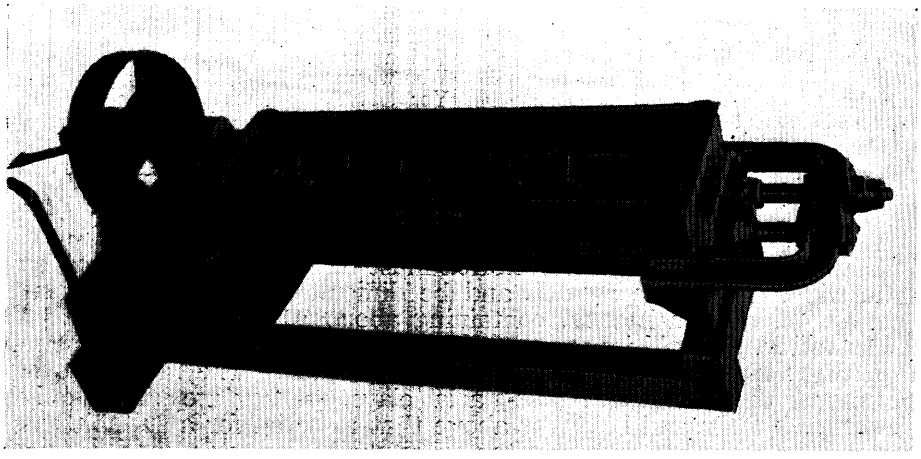
machinery are common, more water being added in each case: 1. The clay goes direct to the soft-mud machine. 2. The clay is first dumped into a disintegrator or open-top pug mill for tempering before it reaches the soft-



A set of two pairs of rolls to remove large pebbles and crush small ones, Aaron Hill plant, Essex, Essex county.

mud machine. 3. A pair of rolls is introduced to break up or reject stones or pebbles before the clay goes to the other machines.

Rolls.—A pair of horizontal rolls revolving towards each other is considered to be one of the best crushers for clays and reasonably hard shales. The capacity is large; the cost, power, and upkeep are reasonable. Rolls



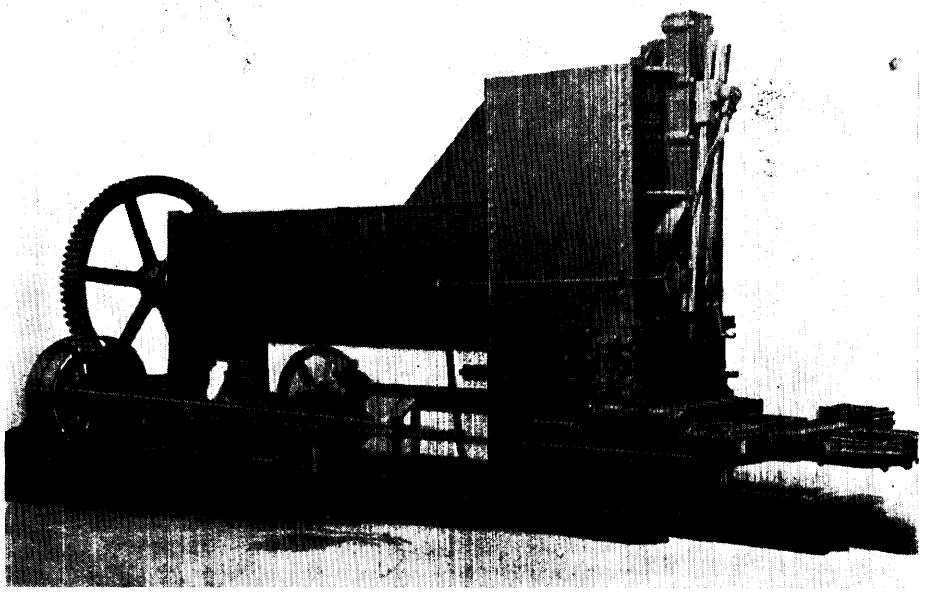
Disintegrator or open-top pug mill.

of small diameter revolving rapidly and set close together are often used to remove pebbles from clay. The angle of nip gives little chance to hold a round pebble and it will ride on the roll without going through. A suitable

The Arnold Creager machine is shown in the illustration below. This is not used to any extent in Ontario. The pugging section is horizontal instead of vertical.

A five- or six-brick mould is used in these machines. It is of wood with iron protected edges. Before introducing it into the machine, the mould is soaked in water and sanded to prevent the clay from sticking to it. The sand gives a pleasing finish to the brick.

The soft-mud machine will make from 10,000 to 20,000 brick a day when the moulds are removed and emptied by hand. Automatic attachments and improved design allow this to be done by machinery, and the capacity is greatly increased. The manufacturers of these automatic machines state that productions up to 100,000 brick per day have been obtained.[1] In Ontario, where soft-mud brick are manufactured primarily



Arnold Creager soft-mud machine.

to be used for face brick, the automatic machine has not given as good quality as desired.

Ten to twenty horse-power is required to operate these machines, although in a few cases a team furnishes the power. The upper photograph on page 59 shows a plant that still uses a team for this purpose. The machine has just enough roof to protect the men from sun and rain.

Another simple outfit using electric power is shown in the next illustration. The horse and cart on the right bring in the clay. A water barrel on the platform in front of the horse furnishes the additional water for working the clay in the soft-mud machine, which is powered with a 25 h.p. electric motor. The production is 17,000 brick per day. The rack wagon carries the brick on pallets to open-air dry racks.

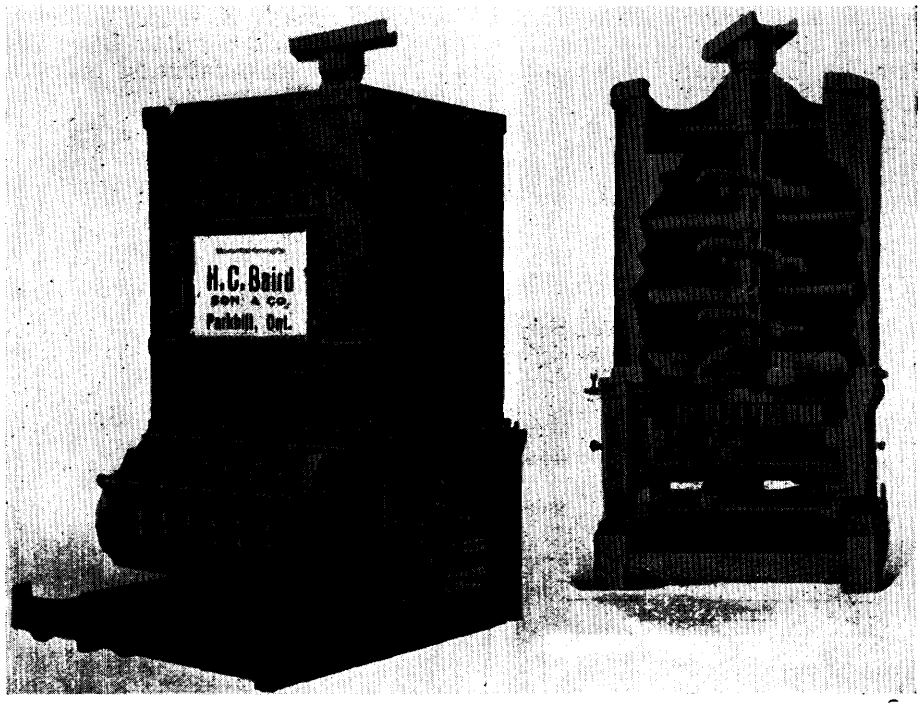
Dry-Press Method

There are only 14 plants making dry-press brick. These are located in Halton, Lincoln, York, Peel, and Wentworth counties. The raw material

[1]Ceramic Products Cyclopedia, 1929.

appliance may be used to pull the pebble off to one side. The upper photograph on page 56 shows such a set of rolls.

The upper set is of small diameter to remove the stones, while the lower set will crush the stones which pass the first set. Above the upper set is a device for removing the stones from the roll. A vertical piece of flat steel extends down between the rolls and is bolted into position on a horizontal supporting rod, which travels back and forth from end to end of the rolls. The movement pushes the pebbles off the end at each stroke.



Iron Quaker soft-mud machine, H. C. Baird, Son, and Company.

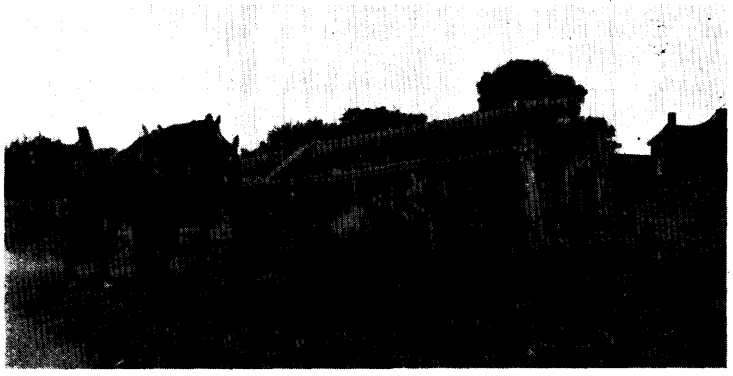
The Disintegrator or Open-Top Pug Mill.—When clay is dry or lumpy as it comes from the pit, the small amount of working given in the soft-mud machine is not sufficient to give a proper consistency for moulding. The clay, water, and sand (when added) will not be uniformly mixed. The open-top pug mill, an illustration of which is shown on page 56, corrects this condition. The revolving knives on a single or double shaft carry the clay along slowly to the end while mixing it with water and discharge it into the soft-mud machine. The machine is also widely used in the stiff-mud process of manufacturing.

The Soft-Mud Machine.—Four types of soft-mud machine are used in Ontario: 1. Martin A, manufactured by H. C. Baird, Son, and Company, Parkhill, Ont. 2. Iron Quaker, manufactured by the same firm. 3. Arnold Creager, manufactured by the Arnold Creager Company. 4. Hercules, manufactured by C. W. Raymond Company.

In the last one named, there is a pug mill combined with the brick-making machine. The first three are about the same in design. The illustration above, taken from the Baird catalogue, shows a front view, with a section to show the working parts, of the Iron Quaker machine.

is shale, either Queenston or Lorraine. Clay has not been found to be satisfactory for the purpose because of its plasticity or stickiness in handling.

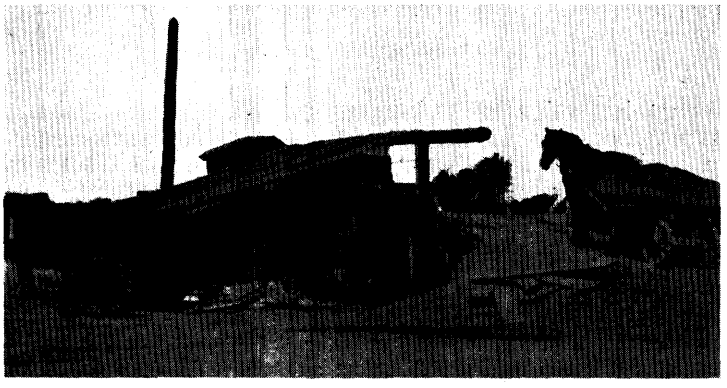
The shale is brought in from the pit and is delivered directly to a dry pan, where it is ground to the proper fineness. The ground material passes over a screen, the fines going to a storage bin over the dry press and the tailings returning to the grinder. The correct amount of water, about



Horse-powered soft-mud machine, Bay of Quinte Brick Works, Belleville.

10 per cent., is added at the dry pan. Often the natural moisture of the shale is nearly enough and very little is added.

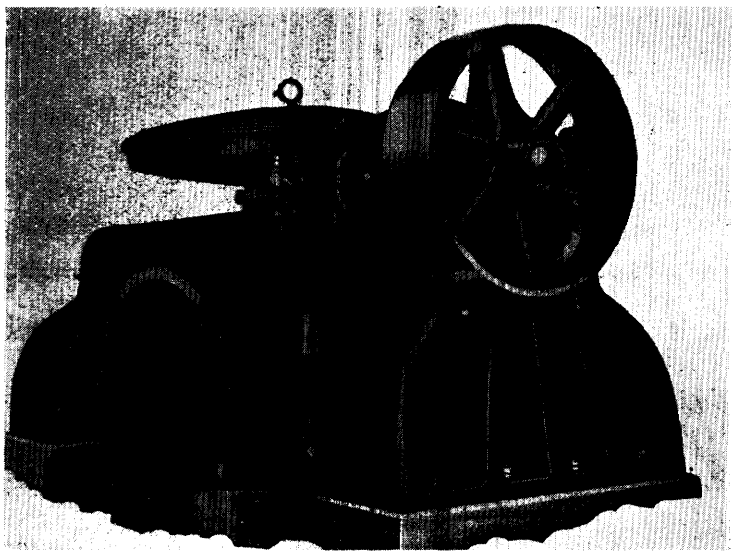
The Grinder or Dry Pan.—A modern dry pan is shown in the illustration on page 60. It is quite different in action from the old type of dry pan, is more efficient, and has a larger capacity. The older types have screen-plate openings sized so that 80 per cent. of the ground material will go



Simple soft-mud plant, Chapman Brick Company, Dawes Road, Toronto.

through the screen and 20 per cent. will return as tailings. The mullers or revolving crushing-wheels are rather narrow of face. The capacity of the machine is small. The other extreme would be to make the slots in the floor plates very large, so that only about 20 per cent. would go through the screen and 80 per cent. would be returned as tailings. The mullers would be heavy and wide-faced. This would, in turn, require a large screen capacity and is objectionable. The middle course is considered to be best.

Large, wide-faced mullers are used, the screen plates have openings of medium size, and the outfit is so balanced that about 50 per cent. goes through the screen and 50 per cent. is returned. A pan of these proportions would easily have four to five times the capacity of the old type and a much smaller power requirement per ton of screened material. The wider muller gives a contact crushing area of twice that of the narrow muller, and greater muller weight increases the crushing action. A single unit of large capacity reduces the number of conveyers, bins, etc., necessary for a given capacity. It reduces the labour of feeding and the number of motors, saves floor space, and reduces the total power. In construction the modern grinder is much improved. The mullers are 60 inches in diameter with an 18-inch face and



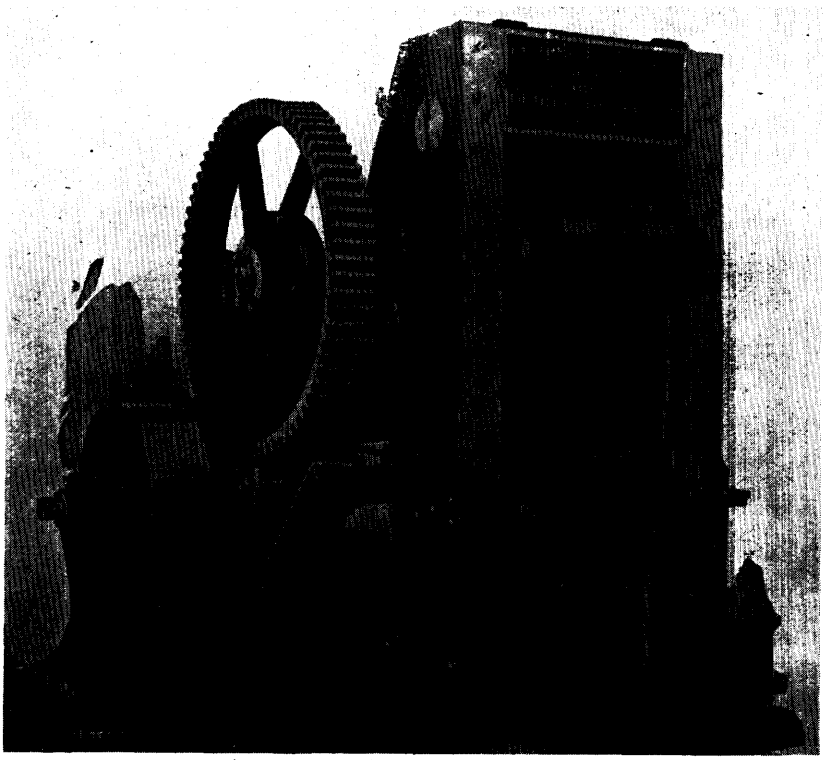
A modern dry pan.

have a total crushing weight of 30,000 pounds. The power required on tested installations of 9-foot pans is from 56 to 67 h.p. Correct pan speed is obtained through the use of two sets of gears instead of the one set that is customary in the old machines, making it possible to enclose all gears in dust- and oil-tight housings. These improvements mean that many of the old pans are obsolete, even if they still grind shale and allow production.[1]

Screens.—Screens may be of three types: stationary, rotating, and vibrating. The method of feeding is usually by bucket elevator. The stationary ones are made of piano wire, perforated metal plate, or wire mesh. Such screens are placed at an incline of 35 to 45 degrees, and the material is allowed to run over it by gravity. The length is from 6 to 14 feet and the width about 3 feet. This type is largely used in the Ontario plants and is the simplest form, requiring little attention when properly placed. However, considerable material fine enough to go through is carried along with the tailings, and the efficiency is not what might be desired. Mechanical movement of the screen reduces this rehandling of ground material. The revolving screen has screen plates or wire mesh on the outside of a revolving cylinder, 4 to 10 feet long, which revolves at a speed of 12 r.p.m. It is not used in Ontario.

[1]Dry Grinding of Refractories, Clearfield Machine Company, Clearfield, Pa.

The vibrating screen is the more modern type. It is set at a low angle on an inclination of 10 to 20 degrees, and the mechanical vibration of the screen wire causes the tailings to travel to the far end and drop over the edge. It is seldom over 6 feet square, and the vibration is caused by eccentrics, cranks, hammers, or electric magnets. It is claimed by manufacturers of vibrating screens that increased capacities and grinding economies will result in substantial savings over the stationary type. Damp material is more easily handled on the vibrating screen. The following



Dry press for brick-making.

table gives the relation between the percentage of moisture and the fineness of screen that can be used with the average clay.

DATA FOR VIBRATING SCREENS

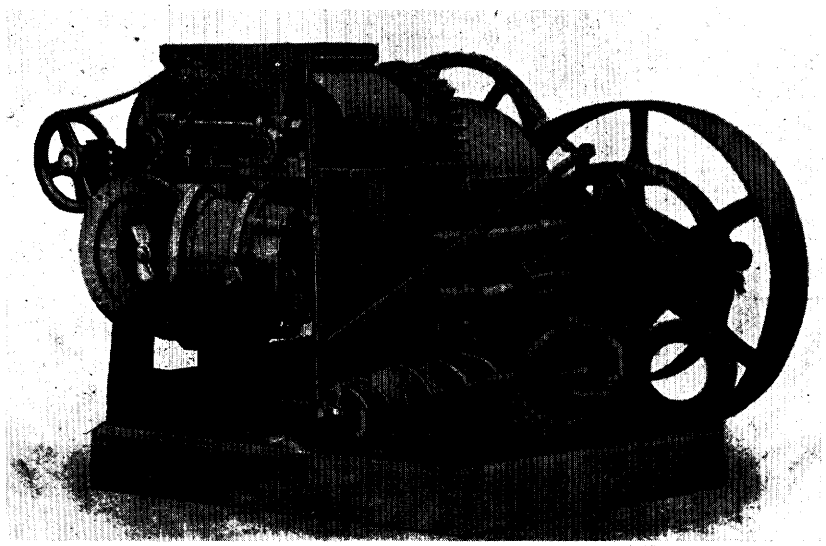
Moisture, per cent.	Fineness of screen which can be used
16	8-mesh
12	10-mesh
6	20-mesh
2	35-mesh

Several of the more modern Ontario plants use the vibrating screen to good advantage.

Dry Press.—After the material is screened to about 10 mesh and properly tempered with water, it is delivered to the dry press, a photograph of which is shown above.

There are several makes, but all are operated on the same principle. Six moulds are automatically filled with enough shale to form a brick, then

pressure is applied by means of a toggle-joint and plunger from above. Two or three pressures are applied successively to expel air and obtain good structure. Both the mould and the die are heated with steam to prevent adhesion of the clay to the moulds. The pressure developed is said to be 60 to 80 tons per brick, or about 6,000 pounds per square inch. Recent work at the experimental plant at Roseville, Ohio,[1] indicates that the actual pressures are less than this, ranging from 530 to 3,250 pounds per square inch, with an average of about 1,500 pounds per square inch. The capacity of a 6-mould press is 30,000 per 10-hour day, or 20,000 for a 4-mould press. The resulting brick are dense and hard enough to be taken to the kiln at once for setting instead of going through a dryer. The first part of the burning is slow, as much moisture (about 10 per cent.) must



No. 1 Kells B auger machine, H. C. Baird, Son, and Company, Limited, Parkhill.

be expelled. This method is considered to be cheaper than drying before setting. Barium carbonate is sometimes added to prevent surface scum on burning. Such additions will be discussed later.

Stiff-Mud or Plastic Method

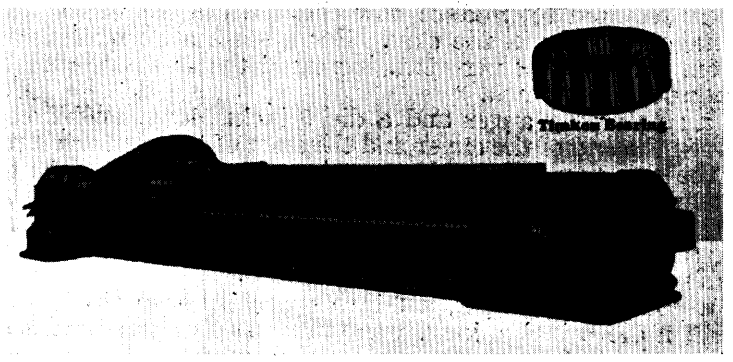
In this method of manufacture the clay is forced through the orifice or die of an auger machine. The clay, therefore, must be of fair plasticity but not too sticky or too sandy. Both clay and shale are used, as well as blends of clay and shale. The products are brick, drain tile, and hollow building-block. Sewer pipe is also a stiff-mud product, but is not made in an auger machine. The brick may be end or side cut, with smooth or rugged surfaces.

The normal process in the case of clay is to deliver the clay directly to the auger machine when the natural clay moisture is almost enough for proper working or to use an open-top pug mill to further temper the clay before it reaches the auger machine. With dry or lumpy clay, the open-top pug mill is almost necessary, and with most clays it is to be desired. When shale is used it must be ground and screened before reaching the open-top pug mill. Shale requires more pugging or working than clay, as it is not

[1]Engineering Experiment Station News, Ohio State University, Nov., 1929, p. 2.

so plastic, and it is not uncommon to have two pug mills in series before the clay reaches the auger machine. Rolls are also used to good advantage.

Auger Machines.—The auger machine most widely used is known as the Kells type, patented in 1885 and renewed in 1890. It is manufactured by H. C. Baird, Son, and Company, Limited, of Parkhill, Ont. In 1907, a rolls crusher was added as an integral part of the machine. Since then some improvement in design has been made, including bearings and quality of material. The illustration on page 62 shows the present machine, and while it has not been modernized to stand heavy service it has given good service in many of the plants of moderate production. Plants requiring large production, say over 30,000 brick per day, especially side-cut brick or drain tile of 14-inch diameter, often find it advisable to buy a machine of larger capacity, stronger construction, and more modern design. The Baird Company makes two sizes. The photograph is of the larger size,



A modern auger machine, Crang-Booth, Limited, Weston.

known as No. 1 Kells B. The maximum capacity is given as 18,000 3-inch tile or 36,000 brick per 9-hour day. The smaller machine, No. 2 Kells, has a rated capacity of about two-thirds of the larger. Open-top pug mills are almost always used with the auger machine and are especially recommended in the Baird catalogues.

One of the large modern machines being installed by Crang-Booth, Limited, of Weston, York county, is shown in the photograph above. It is of simple construction with 2 shafts and 2 gears, with Timken bearings of extra length and replaceable liners, and it has a capacity of 100,000 brick per day, requiring a 75 h.p. electric motor. The best of material and design make this an efficient machine for a plant of this size. A range in size and horse-power allow a proper selection to meet the needs of plants of various sizes.

The design of auger machines and dies has been based upon practice and not upon definite data. A machine will not work equally well on all clays. Differences in plasticity and general characteristics make some clays very difficult or impossible to run through the auger machine without high loss or low production. The first American patent was in 1863 (U.S. patent No. 40221, 1863), and the "cut and try" method is largely responsible for the present machine. The United States Bureau of Standards is making a study of the subject, and the first report is given in their Journal of Research,[1] from which the following notes are taken. Manufacturers interested should obtain the original report for complete data.

[1]Vol. 6, December, 1928.

Differential flow of the clay is always present in the auger machine as the clay tends to travel faster at the centre of the column than at the sides, where it is in contact with the die. Friction is the main cause of this differential clay travel, and the relations of length, diameter, and resistance of the die to the size, speed, and position of the auger are of utmost importance. Laminations caused by the auger itself are also present. As the knives and screw pass through the clay, air is often enclosed and the clay is so smoothed or surfaced that it will not heal after the auger has passed on. This gives lines of weakness, which will sometimes show as air-filled open spaces and cracks in the finished ware.

The original machine used for testing employed a plain thrust-bearing for the end of the auger shaft. This was replaced by a tapered roller thrust-bearing, and with this change the power loss through the machine was 13.5 h.p. When using a 45 h.p. motor, only 31.5 h.p. was effective in rotating the auger. The thrust on the back thrust-bearing was calculated as 27,250 pounds. A plain thrust-bearing is entirely unsuited to the task. The pressure required to produce flow through the die varies widely with the percentage of water in the clay. For a shale a decrease in the water content from 23.3 to 22.8 per cent. increased the flow pressure from 54.6 to 72 pounds per square inch.

With a single-wing auger and a die 6 inches long, an increase in the space between the end of the auger and the start of the die from 4 to 6 inches decreased the clay flow in pounds per minute in the ratio of 80 to 68, but cracking, tearing, and flaking are reduced. An increase to 8 inches gave still better quality but reduced the production ratio from 68 to 61. A further increase in die length above 8 inches gave no further improvement in the quality of the clay bar extruded.

With a double-wing auger, a 6-inch space between the auger tip and the die, with a die 6 inches long, was found to give the best results with the clays tested. This was gauged by the production per horse-power, without producing a defective column.

With a triple-wing auger, an 8-inch space from auger tip to die and a 6-inch die are best for production with good quality. The water content should be as low as possible to get production. The relative power efficiency of the single, double, and triple wing auger is in the following ratios:

Single-wing auger	100
Double-wing auger	60.57
Triple-wing auger	60.53

An 8-inch spacer between the auger tip and die should be long enough in most cases where the triple-wing auger is used, but with some clays it may be necessary to make them longer. The longer this space and the longer the die, the more power required. A 3-degree taper on a die seems to be about correct. Proper lubrication tests were started but not completed. Oil, water, steam, and air were used, and the indications were that air is the best and easiest to control. The power reduction is in the neighbourhood of 8 to 10 per cent.

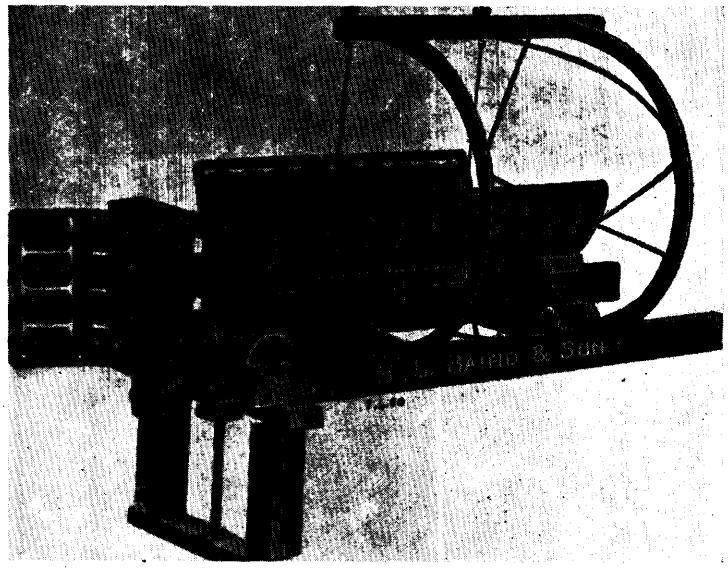
With hollow-ware dies, the most efficient length, giving good ware with reasonable power, is not over 3 inches with the core not over $1\frac{1}{2}$ inches.[1] The taper on the core and the die should be about 3 degrees. The taper affects the power consumption, and a shorter die will give transverse cracks and torn corners. Laminations and lines of weakness, which often do not show as cracks until drying or burning, are due to several causes.[2] The die must be properly balanced to allow an equal travel of the clay in all

[1]Technical News Bull. No. 151, U.S. Gov. Printing Office, November, 1929.

[2]Greaves Walker, Jour. Amer. Cer. Soc., Vol. 10, p. 309; H. F. Dingledine, Ann. Rept. Can. Nat. Clay Products Assoc., 1927, p. 28.

sections; baffles may be placed to obtain this balance. Wearing of the die parts may easily cause an unbalanced flow; a thirty-secondth of an inch may be sufficient to unbalance a die. Weathering of the clay, fine grinding, addition of grog, lime, tannic acid or soluble salts, all have an influence.[1]

Cut-Offs.—As the column of clay is extruded from the auger machine it is cut off by passing a wire under tension vertically through the column. For small outputs of brick a hand-operated cut-off can be used, but an automatic one is required for larger production. For drain tile and hollow building-block automatic cut-offs may be used, but the hand-operated one is considered to do better work as it gives a truer cut and less loss from



Hand cut-off for tile, H. C. Baird, Son, and Company, Parkhill.

broken corners, etc. The photograph above shows the hand cut-off for tile. The cut-offs for brick and hollow tile are similar in construction.

The modern automatic cutter or cut-off, capable of cutting from 25,000 to 100,000 brick a day, is shown in a photograph on page 43. Fourteen brick are cut at once. The cutter may be driven by a separate motor, and a magnetic clutch is used on one type to control the rotation of the cutting wires.

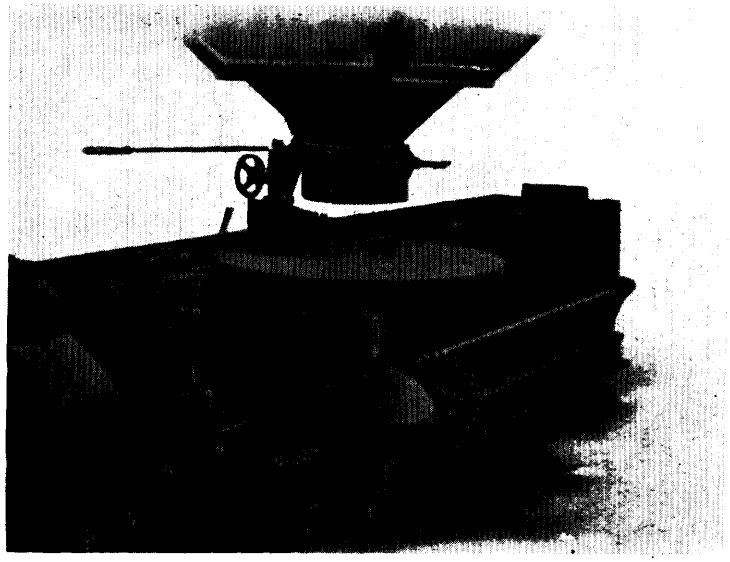
In the stiff-mud process the ware is carried to the dryer on wheelbarrows, horse wagons, or cars. Cars are the most common for brick and hollow building-block and are necessary when the car tunnel-dryer is used. Wheelbarrows are usual in the drain-tile plant when natural or open-air drying methods are employed. The stiff-mud brick may be piled 3 or 4 high without loss of shape, so the two-deck car is used. The 10-shelf car is used for soft-mud brick.

Clay Feeders.—The best results are obtained when there is a constant rate of feeding clay to the auger machine, and this is difficult to accom-

[1]Howells Fréchette and J. G. Phillips, "An Investigation on the Treatment of Certain Western Clays to Overcome Drying Defects," Investigation in Ceramics and Road Materials, 1927, Mines Branch, No. 697, Ottawa, 1929, p. 4.

plish with hand feeding. When wet clay is used, automatic feeding devices are not satisfactory because of mechanical difficulties, but when the material is dry, as with ground shale, mechanical feeding is desirable. The photograph below shows a feeder of the disc type.

A horizontal revolving disc is fed from a hopper above, the mouth of which is shown in the picture. Centrifugal action of the clay on the disc and a properly placed scraper feeds the clay at a uniform rate to the pug mill. These are made to feed one material, or definite proportions of two or more clays at the same time. The vertical shaft with horizontal knives revolves with the disc and may extend up into the hopper to prevent bridging of the clay above. Screw conveyer feeds are also made to handle ground material, and plate feeders based on another principle will handle lump



Disc type of clay feeder.

material. In the plate feeder a horizontal plate moves back and forth under a hopper, pushing a certain amount of material off the end at each movement. The labour of one or more men can often be saved by the installation of such machines.

THE MANUFACTURE OF SEWER PIPE

The manufacture of sewer pipe requires a clay that will give a vitrified body with low drying and burning shrinkage and that will take a salt glaze. Fire clay of low refractoriness is often used, and the mixing of two or more clays including shale is common practice. The proper composition was made the subject of an extensive research carried on by H. G. Schurecht[1] at the Mellon Institute of Pittsburgh for the Eastern Clay Products Association. Limits of composition were established, including iron, lime, and silica, in connection with colour and quality of glaze. The main points brought out were:—

1. The colour of the glaze darkens with an increase in iron oxide content. One per cent. iron oxide gives a light-tan; 8.2 per cent., a black.
2. An increase in silica improves the gloss of the glaze.

[1]Jour. Amer. Cer. Soc., Vol. 6, pp. 615, 716; Vol. 7, pp. 411, 539.

3. A clay with a high iron content should be glazed at a low temperature, as it will give a dull glaze at a high temperature.

4. A clay with a low iron content should be glazed at a high temperature.

5. A higher temperature darkens the glaze.

6. One per cent. calcium oxide will prevent a bright glaze at low temperature. The glaze will be a matt or of a dull texture.

7. A clay with a fairly high lime content will glaze only at a high temperature, and then only if the iron content is not above 3.5 per cent. The higher the lime content the greater the difficulty in obtaining a satisfactory glaze.

8. Lime causes a greenish-yellow colour in the glaze.

Clay suitable for the manufacture of sewer pipe is difficult to find in Ontario, and the clay now used occurs east of Hamilton as a surface clay underlain with Queenston shale in some places and by an inferior stratified clay in others. Sewer-pipe clay ranges from 1 to 4 feet in depth in different sections and is considered to be derived from the weathering and leaching of the Queenston shale near by, resulting in a material very low in lime and with good plasticity. This clay is used by the National Sewer Pipe Company, Limited, at their four plants in Hamilton, Aldershot, and Toronto. The low lime content allows a fair salt glaze. An analysis of this clay by H.P. Kimbell and W. G. Wilson[1] at the University of Toronto gave the following properties:—

	Per cent.
Silica	64.54
Alumina	16.54
Iron oxide	6.14
Calcium oxide	.44
Magnesium oxide	1.29
Sulphur trioxide	.23
Total alkalies	5.32
Loss on ignition	5.40

The clay is red in colour, smooth, and plastic, requiring 26.6 per cent water for plasticity. The drying shrinkage is 11.9 per cent.. and the clay has a fusion point (P.C.E.) of cone 4 (about 2,210° F.). The sieve test gave 90 per cent. through 200 mesh, the residue on this mesh being rather equally distributed in size from 10 mesh to 200 mesh and being composed of quartz sand and angular rock fragments, some of which were limestone. Data on the burned clay is as follows:—

	Linear burning shrinkage	Porosity	Hardness
	per cent.	per cent.	
Cone 015 (1,480° F.)	0	28.8	Soft.
Cone 08 (1,742° F.)	1.4	25	Hard.
Cone 05 (1,904° F.)	4.2	19.6	Steel-hard.
Cone 02 (2,057° F.)	7.1	11.6	Steel-hard.
Cone 1 (2,120° F.)	8.6	1.5	Steel-hard.

In practice the glazing of this clay is done as follows: When the highest temperature of the burn has been reached, which is about cone 01, or 2,030° F., common salt (sodium chloride) is thrown on the glowing fires, about two shovelfuls to each fire box, the round of the fire boxes being made as quickly as possible. The draft is then shut off, which gives strongly reducing conditions and prevents loss of salt up the stack. This condition is held for about half an hour, or until the black and yellow smoke issuing from the stack has changed to white salt fumes. The damper is then lifted, and when the fires have gained temperature again the process is

[1]H. P. Kimbell, thesis, 1926; W. G. Wilson, thesis, 1929.

repeated. Two or three saltings are sufficient, as determined by drawing trials from the kiln. Wood of small diameter, which will burn rapidly, has been used to increase the fire-box temperature for a short period during the salting.

The salt combines with the clay and iron at the surface of the ware, giving a sodium silicate. A published analysis of a salt glaze[1] gives the following, all the material but the sodium oxide being furnished by the clay:—

	Per cent.
Silica	55.47
Alumina	21.34
Iron oxide	2.64
Calcium oxide	3.50
Magnesium oxide	.04
Sodium oxide	17.21
Potassium oxide	.08

The glaze on the Aldershot clay is only fair, as far as appearance goes, but the structure of the well-burned pipe and the protecting glaze meet the commercial requirements in a very satisfactory way. The glaze texture is more of a matt than a gloss. If the lime content of the clay is a little higher than average, the gloss or texture will not be so good and greenish-yellow discolorations will appear. Care in selection of the clay in the pit is necessary. The thesis studies by Kimbell and Wilson at the University of Toronto, already referred to, brought out the fact that, as this clay must be glazed at a low temperature for fear of overfiring the body, the high lime content (up to 1 per cent.) and the rather low silica content tend to produce a matt glaze texture. An increase in silica by the addition of potter's flint increased the gloss of the glaze, but increased the temperature required to obtain a vitrified body. Blending with fire clay and increasing the temperature of the burn also improved the glaze in these laboratory trials.

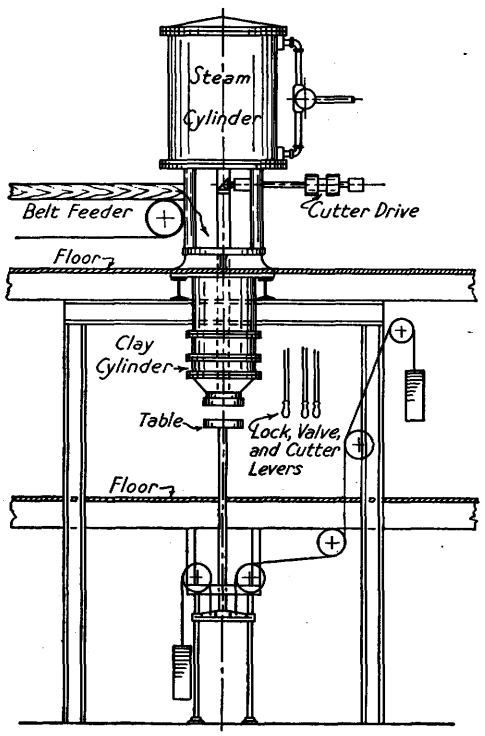
Some experimental work done at one of the clay plants in the Windsor area indicates that some of the surface clays in this section are low enough in lime to take a salt glaze when properly handled, and it is possible that a new supply of sewer-pipe clay has been located.

In the process of manufacture the clay is ground in a dry pan, screened (in some of the plants), then tempered with water to a plastic mass in a wet pan.[2] The wet pan is of the same type of machine as the dry pan, except that the bottom is solid. The clay and water are ground and kneaded together in periodic charges and removed with a long shovel without stopping the machine. A treatment of 3 to 5 minutes is sufficient. The plastic clay is conveyed to a sewer-pipe press, such as is shown in the photograph on the opposite page.

The press consists of two cylinders, one above the other, and is operated by steam introduced into the upper cylinder above a piston at a pressure of about 120 pounds per square inch. The clay is introduced to the lower cylinder below a piston, and at the bottom of this cylinder is a die through which the clay is extruded. It might be called a periodic plunger press; the movement of the plunger is controlled by the steam cylinder and piston above. The plunger gives a pressure of about 800 pounds per square inch in the clay cylinder, which forces the clay through the die. The shoulder on the pipe is formed by a special die clamped into position during the start of the forming of each pipe. The normal sewer-pipe plant has two presses, one for large and one for small pipe. After forming, the pipe are removed by barrows to the drying floor of the building, where they are smoothed and finished when the clay becomes sufficiently hard to allow handling.

[1] L. E. Barringer, Jour. Amer. Cer. Soc., Vol. 14, p. 211.
[2] C. A. Miller, Jour. Amer. Cer. Soc., Vol. 8, p. 452.

As sewer-pipe clay is ground in a dry pan, it must be dry enough to go through the screening process. The obtaining of dry clay for a continuous production during twelve months of the year presents a difficult problem, as the surface clay cannot be protected from the rain and ground moisture. In wet months the clay in the pit is too wet to use without drying. Summer digging and storage for winter use seems to be the only solution. A dryer of the rotating cylinder type was tried at one plant with little success because of clogging. The plastic clay is very sticky when wet, and it adhered to the side walls of the dryer so much that only a very small production could be obtained. Such drying cylinders are 40



Plan of sewer-pipe press.

feet long, with a diameter of 6 to 8 feet. Some have single shells with the products of combustion coming into contact with the clay, while others are double-shelled and separate the products of combustion from the clay. The ventilation of both types is important in order that condensation of moisture in the cooler parts may be prevented.

DRYING CLAY WARE

Introduction

Until a calculation is made, it is difficult to appreciate the amount of water that must be evaporated from plastic clay, the amount of heat required to change the water into vapour, and the amount of air required to carry away the vapour. A plastic brick coming from the auger machine will contain about 16 per cent. water. The total weight of the brick is about 7 pounds. A day's production of 50,000 brick will carry 56,000 pounds of water. To evaporate this, heat is needed to change the water

into vapour, and air to carry it away. About 5 tons of coal and 30,000,000 cubic feet of air at dryer temperature will be required.[1]

There are three stages of drying:[2] (1) shrinkage water; (2) pore water; (3) hygroscopic water. All plastic clays shrink during the drying period, but all the water is not lost when the shrinkage has taken place. If a clay contains 16 per cent. water as it comes from the auger machine, during the shrinkage period it will lose about 8 per cent. This is called the shrinkage water. When the shrinkage is complete the clay particles are in solid contact and will no longer slide one past the other when pressure is applied. The clay will crack under pressure and not deform. The body is, however, not solid, but is full of pores, and these pores are still full of water. With additional drying this water, which is called the pore water, is lost. The porosity of an air-dried brick may easily be shown by pouring on the surface a few drops of water, which will immediately sink into the porous structure. Air-dried clay still contains some moisture, about 1.5 per cent., more or less, depending upon the moisture of the air. The clay must be heated to the boiling point of water, 212° F., or above, to drive out this water, which is called hygroscopic, meaning that the amount of moisture the clay will hold will depend on how dry the weather is. On a wet day it will absorb some water and on a dry day it will lose some, but the total will always be around 1 to 1.5 per cent. The commercial drying process usually removes the shrinkage and pore water, but seldom removes the hygroscopic water. This must be done during the water-smoking period in the kiln.

As the water evaporates the clay will no longer distort under pressure but will crack. It increases in strength as the shrinkage water is being expelled. The strength increases very little as the pore water evaporates. When the hygroscopic water is driven off, the maximum strength of bone-dry clay is reached, that is, the colloidal clay is exercising its greatest bonding effect.

In drying, water leaves the clay as vapour and is carried away by the air. When wet clay from the forming machine is placed in position to dry, there is moisture on the surface and the drying action is the same as if a pan of water were placed beside the brick. When this surface moisture is gone, water comes from the interior of the brick to the surface, and this in turn is evaporated. The rate of evaporation is retarded, because the water comes to the surface slowly at room or out-of-door temperatures. The pore spaces between the clay grains make a continuous passage way for the water to follow from the centre of the piece to the surface. These passage ways are called capillary tubes, by which is meant a passage way of very small diameter, so small that the surface tension of the water tends to pull it along these capillary tubes and aids in bringing the water to the surface. The water flow is also aided by the dry air surrounding the piece, which is capable of taking up moisture. The dry air causes a slight internal "pressure" which forces the water to the surface.

If the evaporation at the surface progresses at the same rate as the water comes naturally to the surface through the capillary tubes, satisfactory and rapid drying is obtained. If the evaporation from the surface is faster, as in ordinary open-air or room drying, the continuous flow of water to the surface is broken, the advantage of the capillary action is lost, and the drying proceeds very slowly. The surface is dry, but the centre is wet, and the slight "pressure" developed at ordinary temperature is not enough to cause rapid drying.

The new types of dryers, with the temperature and the dryness of the air under control, can dry ware in 8 to 10 hours, which would require five to ten times that long in the ordinary dryer. At the same time warping

[1]Clay Worker, August, 1929, p. 123.
[2]Hewitt Wilson, op. cit., pp. 120-141.

and cracking losses can be largely avoided. In hollow building-tile, electrical conduits, etc., this is very important. The National Sewer Pipe Company, of Toronto, is putting in the first dryer of this type to be used in Ontario at their plant at Aldershot. Other plants use the principles involved to a limited extent, but this is the first dryer to have automatic control.

Controlled drying[1] involves the following points: (1) heat; (2) air to remove the water as evaporated; (3) control of the humidity of the air; (4) control of the evaporation "pressure" of the water in the clay, called "vapour pressure."

Heat.—When water evaporates or changes from a liquid to a vapour, it absorbs heat. This heat does not increase the temperature but performs the work of changing the state of the material. Water may evaporate at any temperature up to 212° F. At this temperature it flashes into steam, and water cannot be heated above this temperature under normal conditions. Heat, then, is used to raise the temperature of the water (and the clay and air at the same time) to the temperature of evaporation and to change its state from a liquid to a vapour. The heat required for this change of state is considerable, being 967 B.t.u. per pound of water.

Air Circulation.—Air circulation or movement mechanically carries away the vapour, and the air must come in contact with the clay surface to be dried. An air velocity of less than 300 feet per minute will not carry away the vapour as fast as it is formed. The rate of evaporation will increase with increased velocity. The rate of evaporation when air strikes directly against a surface is double that for a surface with a parallel air flow. Air movement and circulation in a dryer is, therefore, very important.

Humidity of the Air.—Every plant man knows that the rate of drying will depend upon whether the day is dry or wet. Very dry air may crack the ware, while wet air will do no drying. Air is said to be saturated when it is carrying all the water possible. The amount it can carry increases with the temperature, hence we heat a dryer. The carrying capacity of air when saturated at several temperatures is given below.

	Water per 100 cubic feet of air, pounds
50° F.	0.060
70° F.	.117
90° F.	.218
110° F.	.384
150° F.	1.051
175° F.	1.826
200° F.	3.024

The carrying capacity of air increases rapidly with increasing temperature, and at 150° F. it will carry almost 10 times as much as at 70° F. If the air carries only one-half as much water as it can carry for a given temperature, its "relative humidity" is said to be 50 per cent., and this is a measure of the "evaporation pressure" or the severity of the drying operation. In open-air drying the relative humidity will vary from 40 to 100 per cent. A humidity of 40 per cent. accompanied by a wind exceeding 300 feet per minute may easily cause cracked ware if the clay is tender. A humidity of 100 per cent. means no drying; the saturation point or dew point is reached, and it will rain.

Evaporation Pressure.—In a simple discussion of this, without going into a technical consideration of equilibrium conditions and partial pressure, it can be said that water tends to evaporate at all temperatures, and this

[1]Drying and Processing of Materials by Means of Conditioned Air, published by the Carrier Engineering Corp., Newark, N.J.; Ellis Lovejoy, Drying Clay Wares, T. A. Randall and Co., Indianapolis, Ind.

tendency exerts a "pressure" which can be measured. The amount of this "pressure" depends upon the humidity of the air and its temperature. If the air surrounding the clay is saturated with moisture, there is no "evaporation pressure," unless the temperature is above 212° F., when steam would be formed. When the surrounding air is not saturated, the evaporation pressure increases with temperature up to 212° F. and reaches a maximum equal to that of the atmosphere, which is 14 pounds per square inch or equivalent to the weight of a column of mercury 29 inches high. The table below gives values for this pressure, called vapour tension, expressed in inches of mercury. These values are for dry air and will be reduced in proportion to the percentage of humidity of the surrounding air. Humidity of 100 per cent., or saturation, reduces the value to 0.

	Vapour tension in inches of mercury (evaporation pressure)
50° F.	0.361
70° F.	.733
90° F.	1.410
110° F.	2.578
150° F.	7.545
175° F.	13.650
200° F.	23.460
212° F.	29.000

The evaporation pressure increases rapidly with increased temperature, and at 150° F. it is about 10 times that at 70° F. This pressure tends to force the water out to the surface through the capillary tubes. It is evident that by heating the clay from 70° F. to 150° F. the flow, or the pressure to cause a flow of the water to the surface of the piece, is increased about 10 times.

In the commercial application of these ideas the percentage of relative humidity of the air that must be used is determined. In the more modern dryers referred to, the air is conditioned to the desired percentage of humidity and the ware is heated to develop the desired evaporation pressure. Atmospheric humidity varies with changing weather conditions, and its importance in relation to commercial drying is brought out in a study by Westman and Mills.[1] The figures are for New York city and show that, if 22,000 cubic feet of air per minute will dry 50,000 brick per day in average weather, normal moisture variation in the air would require a volume of 20,000 cubic feet on a dry day and 32,000 cubic feet on a wet day to do the same amount of drying.

It has already been stated that when water evaporates it takes up heat. This property is utilized to measure the percentage of humidity of air. If the bulb of a thermometer is covered by a piece of thin wet cloth, the evaporation of the water will cool the thermometer, just as a person covered with perspiration will become chilled when exposed to a draft. The amount of cooling below the temperature of the surrounding air will depend upon the dryness of the air. The reading on the thermometer is called the wet-bulb temperature. By reading two thermometers, one dry and the other wet, the percentage of humidity may be obtained by referring to a table or chart published by the manufacturer of the instrument. Such instruments are called hygrometers and may be obtained with recording charts if desired. For example, the table below gives the percentage of humidity for several wet-bulb readings with a constant dry-bulb temperature.

[1] Westman and Mills, Jour. Amer. Cer. Soc., Vol. 12, 1929, p. 167.

Dry-bulb temperature	Wet-bulb temperature	Difference	Humidity
			per cent.
80° F.	75° F.	5°	80
80° F.	70° F.	10°	63
80° F.	65° F.	15°	45
80° F.	60° F.	20°	30
80° F.	55° F.	25°	17

In open-air drying the manufacturer takes what comes with only a small amount of control by closing shutters or dropping curtains to protect the ware when required. From 2 days to 2 weeks are required to dry. In the car-tunnel dryer there is usually little control. Not enough heat is the usual condition, and wet brick go to the kiln entirely too often. The normal drying time is 36 hours or more. With commercial drying under control, there are three possible drying treatments:—

1. The ware is subjected to a high temperature and low humidity throughout the drying period.
2. The humidity remains low during the entire period, but the temperature is slowly increased.
3. The temperature is slowly increased but the humidity is kept comparatively high in the first part of the period and low toward the end of the period.

Only fast-drying clays will stand treatment No. 1 without cracking or warping badly. Fast-drying from the surface starts at once, and the capillary flow to the surface will probably be broken, as it takes considerable time for the internal temperature to rise and increase the evaporation pressure enough to supply water for the rapid surface evaporation. "Case hardening" of the surface before the interior shrinkage is complete is apt to crack the ware. Irregular drying, and drying strains will result.

Treatment No. 2 is not so severe and is the method often used in hot-room periodic dryers, starting with a cold room and increasing the temperature. Treatment No. 3 is more modern and technically correct. It allows very rapid drying of large pieces when under proper control. The manufacturers of such dryers make a careful study of the clay and conditions before recommending a dryer design. The clay is dried in a laboratory unit and a proper relation between temperature and humidity is established. The following factors are determined:[1]—

1. The best rate of internal temperature rise of the clay.
2. The minimum or critical internal temperature from which drying can proceed at a rapid rate.
3. The maximum rate of drying after the critical internal temperature has been reached.
4. The cracking and slumping zone (where the humidity is too high) for various temperatures.

Rapid and controlled drying means rapid turnover, constant flow of ware through the plant regardless of weather conditions, smaller drying space, no setting of wet ware in the kilns, and a reduction of dryer losses.

Open-Air Dryers

Many of the smaller plants in Ontario operate only in summer, starting as soon as the frost disappears in the spring and ending with the first frost in the fall. The drying is usually the factor which controls the length of the season and the season's production. A wet season means two weeks or more of drying and a hold-up of production when the dry racks are full.

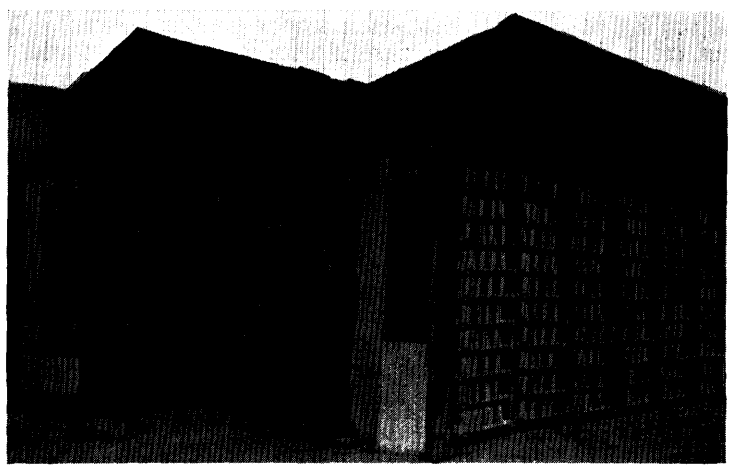
[1]Hewitt Wilson, op. cit., p. 135.

When the season is only 18 to 24 weeks out of 52, depending upon location, wet weather may seriously curtail the business and profits of the year. The illustration below shows one of the simplest forms of dry yards for brick, called the hack system.



Hack yard with pivot roof.

A roof pivoted at the centre post may be leaned to one side or the other to protect the hack of brick from rain, sun, or wind. The brick are hacked on edge in a solid wall, one row added each day, until 8 or 10 rows are



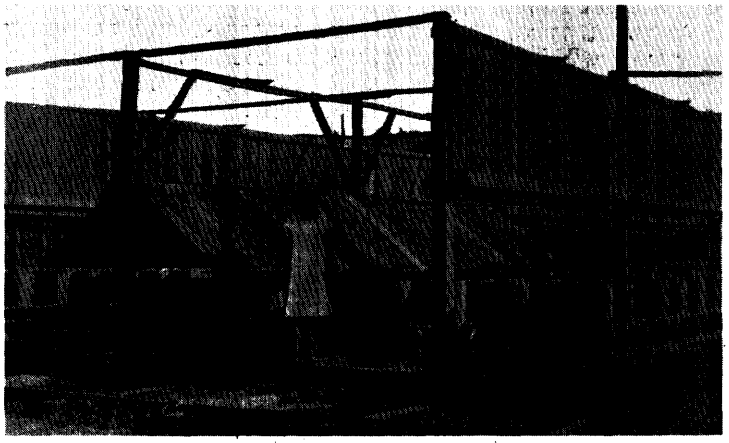
Pivot dry racks, Chapman Brick Company, Dawes Road, Toronto.

placed. A long narrow floor of wood or cement under the first row prevents absorption of moisture from the ground. The soft-mud brick will dry sufficiently in one day to take the load of another brick the next day, and so on till the total of 10 courses is reached. As the wall is solid, drying

is slow and the normal drying period of two weeks may be extended greatly in wet weather.

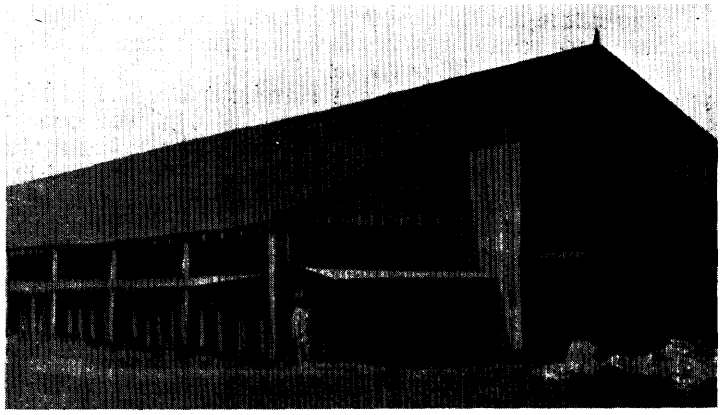
Probably the most widely used system for open-air brick-drying is the type shown in the lower illustration on the opposite page.

Here the brick are placed on pallets, laid flat as they come from the soft-mud machine, and then are turned on edge after a day or two of drying.



Open-air tile dryer with cars, W. J. Jervis, Dorchester Station.

The roof is pivoted at the centre so it can be inclined to protect the brick or catch the wind as desired. The racks or rows are usually 10 feet between post centres. The pallets are set on cross-cleats on the uprights 10 shelves high. From two to four pallets are put on each cleat. The normal drying time is about a week, but this varies with the weather and time of year.



Drain-tile dry shed, Neil F. Campbell and Sons, West Lorne.

The same type of rack may be adapted to drying drain tile by building 3 shelves instead of 10.

The shed roof may be permanent and not of the pivot type. The tile are set three high on shelves or on cars loaded at the auger machine and run into position under the shed roof for drying. A transfer track takes the cars to the dryer and then to the kiln.

The illustration on page 75 shows an ingenious system devised by W. J. Jervis, which gives very rapid drying of drain tile in good weather and full protection when necessary. The tile are set on light-weight home-made cars one deep and pushed into place for drying. The transfer track in the foreground takes the ware to the two kilns for burning. Mr. Jervis gets a very rapid turnover, as the tile are fully exposed to the sun and air, and he thinks he is justified in not setting more than one tile high.

When posts set in the ground are used to support dryer roofs of the stationary or pivot type, they must be watched and straightened every year or so or they will lean. Such posts do not go below the frost line, and each winter freezing and thawing will leave the post out of alignment. Repairs are necessary every two or three years.

Better dryers are often constructed for drain tile, and the photograph on page 75 shows an example of the shed type, which was constructed this year. It has a concrete floor, large doors, and pivot side-walls which allow freedom of ventilation in good weather and protection in bad weather, even protection from the early fall or late spring frosts.

There seems to be little agreement as to what kind of an open-air drain-tile dryer is best. Capital invested as compared to turnover, etc., of the various types has apparently never been studied. As the sales price varies considerably in different sections, it would seem that there is a lack of knowledge on the subject of drying costs.

Artificial-Heat Dryers

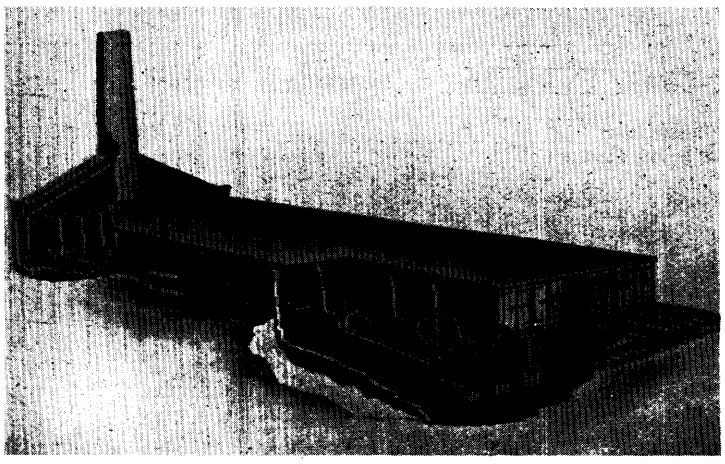
Plants operating all year require a dryer with artificial heat and the car-tunnel type is most popular. These may be of two types, direct-fire and waste-heat.

Direct-Fire Car-Tunnel Dryers.—In the direct-fire dryer, fuel is burned in flues running beneath the dryer tracks, and the heat reaches the ware by radiation. It is the simplest type to use and can be installed in a plant as an independent unit. It must be remembered that in a properly organized plant enough waste heat from cooling kilns is available for drying by the use of a proper flue and fan system. The fuel used in the dryer, therefore, is considered to be an unnecessary expense when the heat from the kilns is not used for some useful purpose.

A new dryer recently built by the Hamilton Pressed Brick Company, of Hamilton, is a good example of this type. It is well constructed and gives satisfaction. A shed roof over the dryer gives a warm storage room and protects the dryer from the weather. This dryer is 109 feet long, and each tunnel is 43 inches wide and 57½ inches high above the track level. The cars, of the double-deck type, carry about 500 brick each. There is a space of about 12 inches between the track and the top of the flue. The stack is about 50 feet high and is 10 feet by 20 inches in size at the top. The flues are of brick, 24 inches wide and 28 inches high, with cast-iron tops to increase radiation. The iron castings have a rise of 8 inches at the centre, the flue walls are 4½ inches thick, and the fire-box doors are 15 inches wide by 19 inches to the top of the arch. The grates are 23 inches wide and 42 inches long.[1] The walls are of brick with a cement slab roof and a wooden shed roof over all. Coke is used as fuel. The superintendent states that each tunnel will take about 3,000 wire-cut shale brick per 24 hours. This number of brick per tunnel per day seems to be near the maximum for any plant with tunnels 100 to 110 feet long. General data based upon yearly production indicate that the figure varies from 1,500 to 2,500 brick per day, when calculated over a long period.

[1]For further notes on construction, *see* Greaves Walker, Dryer Construction, Ann. Rept., Can. Nat. Clay Products Assoc., 1927, p. 24.

The accompanying photograph of the Raymond dryer gives a very good idea of this type, except that the flue tops are of brick instead of cast iron. There has been very little attempt to improve this design or to supplement the natural air circulation by the use of fans. Undoubtedly the capacity could be increased considerably. In this type the flue gases do not come in contact with the ware, so sulphur in the coal will not cause dryer scum unless the flues leak. Expansion of the brickwork during heating and cooling are apt to cause cracks in the side walls or in the joints of the cast-iron top, allowing leakage and causing scum. Because of this, high-grade coal with less than 1 per cent. sulphur or coke is the fuel chosen. Sulphur in the combustion gases will combine with the moisture from the



Raymond dryer.

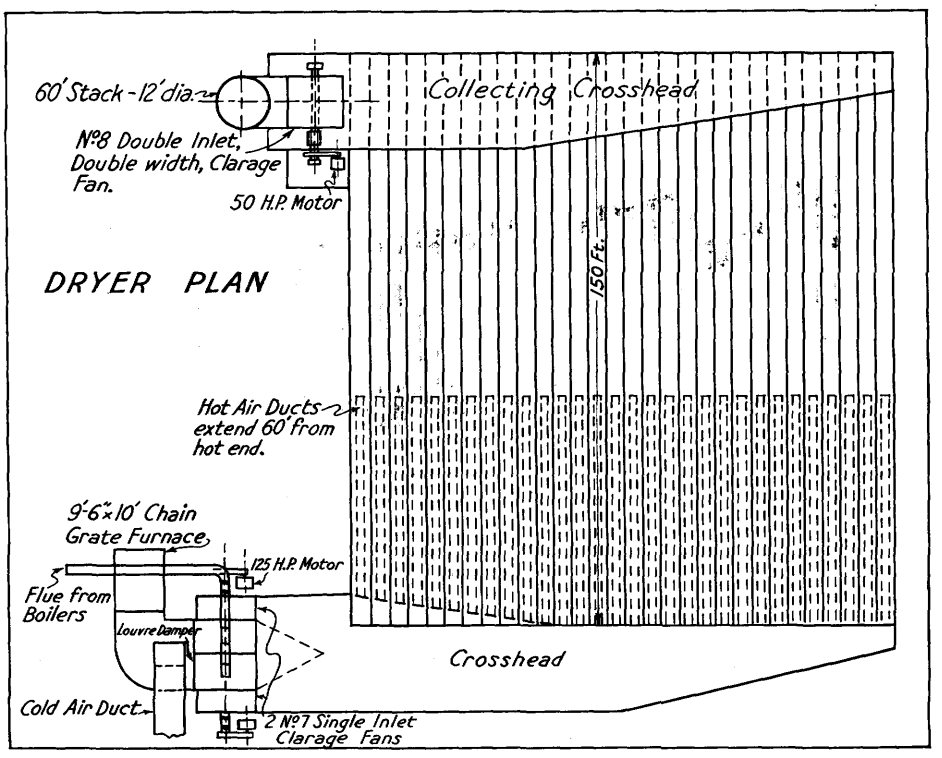
brick, forming sulphuric acid, which condenses on the brick, reacts with the lime in the clay to form calcium sulphate, and leaves a residue of white scum on evaporation. The sulphuric acid also attacks the iron frames of the dryer cars and makes their life very short.

Direct-fire dryers, in which the flue gases go directly into the dryer chamber or in which hot combustion gases from the kiln go to the dryer instead of to the stack, are used to a certain extent. This is considered to be poor practice where face brick free from scum are desired, and the conditions which would justify its use would be exceptional. For common brick and drain tile, where scum is of no importance, it can be done but the iron parts of the cars will still be damaged. Good ventilation, using fan control to prevent condensation, would greatly reduce the scum formed from this cause.

Waste-Heat Car-Tunnel Dryers.—In this type hot air, usually from cooling kilns, is introduced by a fan. The hot air goes through the chamber containing the ware and is taken out with the evaporated moisture at the cooler end of the tunnel by stack or fan. While the cooling kilns are the primary source of heat, it may come from steam coils, from recovered heat from combustion gases, or from a direct or indirect fire box operated for the purpose. The hot air, as from cooling kilns, should be free from scum and acid-producing sulphur. When auxiliary heat is obtained from a direct-fire box, so that the combustion gases go into the dryer, coke of wood fuel will give much less sulphur than coal. In several plants auxiliary heat is obtained from the radiation of two or more house furnaces set near the

fan in a single housing. In a plant making common brick in the Chicago area,[1] heat is supplied from a fire box equipped with a chain grate and stoker. The gases are diluted before they reach the fan. Rather complete data for this dryer were obtained by Professor R. K. Hursh, of the University of Illinois.[2] The dryer consists of 30 single-track tunnels, 150 feet long, each holding 18 cars of 1,048 brick each. The plan is shown in the accompanying sketch.

Hot air is delivered to the large cross-head duct, 6 feet 6 inches deep, with a width of 31 feet at the nearest tunnel and 8 feet at the farthest end. A hot-air duct, 18 inches wide and 4 feet deep, extends under each tunnel for a distance of 60 feet from the hot end. The 60-foot slot, 18 inches



Plan of waste-heat dryer, Bohnsack Brick Company, Chicago.

wide, in the tunnel floor is not covered. Air is exhausted from the cooler end through roof ports, 10 by 24 inches, in each tunnel through a fan to a 60-foot stack, 12 inches in diameter. The average drying time is 45 hours. Ten cars or 10,480 brick are pulled from each 150-foot tunnel per day. This might be compared to the maximum of 3,000 brick per day per 109-foot tunnel in Ontario practice. We have no data to indicate that waste heat is efficiently used or that tunnel dryers are efficiently operated in Ontario. At this Chicago plant the air temperature at the fan is 250° to 340° F. The highest dryer temperature, which is along the top, is 170° to 200° F. The air entering the exhaust fan is at 110° to 130° F. The average relative humidity of the exit air was 25 per cent. The brick contained 13 to 19 per cent. water on entering the dryer and required 288 cubic feet of air at 70° F.

[1]The Clay Worker, August, 1929, p. 117 (Bohnsack Brick Company).
[2]Ibid.

to evaporate a pound of water. The volume of air per minute per 1,000 brick dried per 24 hours, calculated to cubic feet at 70° F., is 740 cubic feet. Coal burned per pound of water evaporated is 0.36 pounds. Coal burned per 1,000 brick dried is 202 pounds. Power used for fans per 1,000 brick is 8.73 h.p. hours. An analysis of this dryer showed that conditions were far from being ideal, and the conclusions reached will be of value in comparing the Ontario plants. The air flow in the cross-head flue was not at all uniform, giving a poor distribution of air volume among the various tunnels. The accompanying sketch shows this, with arrows denoting the apparent path of the air before and after baffles were placed in the air stream. This uneven distribution was aggravated by too strong a pull by the exhaust fan, giving a negative pressure in the cross-head at the opening into the tunnel nearest the fan. It is better practice to force the air from the cross-head under a slight pressure than to depend upon the exhaust. Three deflectors, placed as indicated, tended to break up the air currents and force a reasonable amount of air into the first tunnel. The air leaving

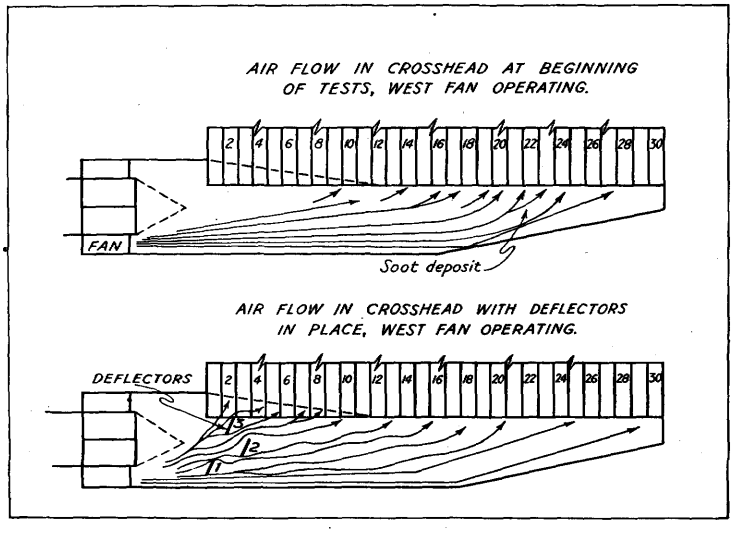


Diagram showing air flow in cross-head flue with and without deflectors.

the dryer had a very low water content (25 per cent. relative humidity), showing that the circulation within the dryer is not good. Some means of recirculation would increase the efficiency of the dryer, and less hot air would be required. The normal car setting makes proper circulation impossible, the brick in the centre not being reached as promptly as they should be. The open floor duct is 60 feet long, and the air did not rise through the cars until it reached the end of the duct. Very little drying was accomplished in the first 50 feet. The temperature peak was not at the car exit, but 50 feet inside. Covering the duct and leaving openings improved the distribution of hot air and extended the high temperature zone. For this particular dryer a temperature of at least 200° F., 9 car-lengths from the hot end, gave the best results, and this is considered to be the "control" station for the dryer.

This discussion gives an idea of the conditions which obtain in the ordinary dryer. Operation has not reached a high degree of efficiency. Some of the important points are brought out and methods for correction are suggested. The impression must not be given that waste-heat dryers are not on the whole satisfactory, but improvement can be made. Several

systems include a co-ordination of drying and burning, using waste heat to the best advantage. A modified form is in use at the John Price plant, Toronto Brick Company, Toronto. Very satisfactory results are reported.

Other Types of Tunnel Dryers.—In the waste-heat tunnel dryer the usual direction of air travel is horizontal from end to end. It is recognized that such air travel does not penetrate the brick setting on the car as desired. The direct fire, with radiation flue below, takes advantage of the tendency of hot air to rise and develop some vertical movement as well as horizontal. Steam pipes take the place of the radiation flues in one type, and the manufacturers of such dryers claim a saving over other methods, as they are more independent of the weather and burning schedules and are free from scum.

Another type, which utilizes the idea of vertical movement of air instead of horizontal, takes advantage of the fact that as evaporation takes place the air becomes cooler, moisture-laden, and heavier. The hot air is forced into the dryer tunnel through the ceiling at various points throughout the entire length of the tunnel; and when the cooler damp air settles to the bottom, it is drawn off by a fan. A 10-hour drying period is claimed even for rather tender clays, and the drying capacity for a 100-foot tunnel is about 8,000 brick per day.

Sewer-Pipe Dryer.—Sewer pipe as now handled in Ontario are not dried in car-tunnel dryers but on dry floors. The type is rather like some of the buildings used for drain tile, except that they are well-built structures of brick and timber, and heated with steam for all-year production. The buildings are usually of four storeys, with slat floors to allow free circulation of warm air. Steam pipes are placed under each floor. In one case a considerable portion of the ground level is a hot floor with metal flooring over heated flues. The open-slat floor construction allows very little drying control for various sections of the building, and large pipe often crack owing to too rapid drying. Considerable success has attended experiments made with temperature and humidity control when drying large pipe.

Fans.—In controlled-dryer operation, fans are almost imperative, as satisfactory circulation can hardly be obtained by natural draft. The theoretical amount of air required for drying a certain number of brick may be calculated. Examples of such calculations[1] are rather involved and are not included here.

There are two types of fans, the plate and the squirrel-cage. Of the two, the squirrel-cage type is the more efficient.[2] In the average waste-heat dryer, large losses and leakages make it necessary to specify a fan of larger capacity than the calculated requirement. It is better to have plenty of fan capacity, and the fan manufacturer can usually be depended upon to recommend the proper size. A roller-bearing fan reduces friction, and a fan of special design to reduce friction has been installed by the Crang-Booth plant at Weston, York county. The shaft extends through the fan, giving a balanced load on roller bearings, an installation that requires almost no attention and uses a minimum of power. Speeding up to enlarge capacity increases the power at a very rapid rate. A new fan of larger capacity is often cheaper. Figures for a given plate fan are as follows:—

15 h.p.	33,000	cu. ft.	per	minute, at	322 r.p.m.
20 h.p.	37,000	"	"	"	350 r.p.m.
100 h.p.	60,000	"	"	"	600 r.p.m.

[1]R. H. Minton, Trans. Amer. Cer. Soc., Vol. 6, p. 269; Ellis Lovejoy, op. cit.; Westman and Mills, op. cit., p. 162; Clay Products Cyclopedia, 1928, p. 46; R. K. Hursh, Brick and Clay Record, Dec. 3, 1929, p. 753.

[2]Ann. Rept., Can. Nat. Clay Products Assoc., p. 25.

Capacities of fans as given in the fan catalogues are usually for 70° F., while the dryer operates at much higher temperatures. Air expands with increased temperatures, and a correction must be made. The increased temperature does not reduce the capacity of the fan in cubic feet but reduces the pressure for a certain speed. The air does not weigh as much per cubic foot, and the pressure reduction is inversely proportional to the absolute temperature.[1] As an example, a certain fan gives a static pressure of 2 inches of water, working at 70° F. At 275° F., the static pressure would be:—

$$\frac{275+459}{70+459}=\frac{2}{x}$$

x = 1.44 inches static pressure at 275° F.
459° refers to the difference between absolute 0 and 0° F.

The fan must overcome the resistance or friction of the flue system to the dryer and the dryer itself. Fan catalogues give tables or charts for flue friction, which varies with the diameter of the flue and the velocity of the air. The friction of a right-angle bend with square corners in a flue of 2-foot diameter is equal to about 150 feet of straight flue. If the radius of the 90-degree elbow is 2 feet, or equals the diameter of the flue, the friction will equal that of about 20 feet of straight flue. The fan catalogues give complete data on this for all diameters. Fan pressures should be sufficient to give positive circulation and distribution of the air to all the tunnels and outlets as well as to maintain satisfactory velocity. It has already been noted that a velocity of at least 300 feet per minute in the dryer tunnel is necessary for satisfactory drying. Ventilating velocities in factory buildings through outlets or registers are 600 to 1,200 feet per minute, and indirect calculations indicate that the velocities in dryer flues are somewhat under 1,000 feet per minute. Lindsay and Wadleigh[2] give 600 feet per minute as a safe maximum.

Dryer Scum.—Scum due to improper dryer operation will be discussed under the general head of scum in a later part of this report.

BURNING HEAVY CLAY PRODUCTS

This subject is so large that it would be useless to try to cover it in detail. Only enough is given to bring out the more important points and to give references which will aid the manufacturer in selecting reading material on the subject. The effect of heat on clays has already been referred to, so the factory aspect of the subject will be given major consideration here. The brick and drain tile clays, whether shale, glacial clay, or marine clay, all mature at about the same temperature, so the problem is quite similar in all the plants, varying only in detail. L. P. Collin,[3] of the Department of Mines, Ottawa, tested 43 clays, practically all from Ontario, and found that the best burning temperature was between cone 08 and cone 02 plus, or from 1,738° to 2,030° F. The colour varied from red to buff. The composition and cost of the coals used varied as follows:—

ANALYSIS AND COST OF COAL

Sulphur	0.7-4.5 per cent.
Ash	4.3-16.7 per cent.
B.t.u. per lb.	12,100-14,000
Cost per ton at the plant	$5.79-$10.75
Cost per 100,000 B.t.u.	$0.022-$0.035

The temperatures in commercial kilns varied from 1,800° to 1,950° F.

[1] Sheldons, Limited, fan manufacturers, Galt, Ont.
[2] Jour. Amer. Cer. Soc., Vol. 8, p. 682.
[3] Investigations in Ceramics and Road Materials, 1924, Mines Branch, Ottawa, p. 16.

The burning labour-costs per ton of ware were:—

Setting	$0.13-$0.42
Firing	.15- .40
Unloading	.12- .54
Fuel	.40- 1.90
Total	$1.00-$2.42

The coal required per ton of wire-cut brick was 94 to 331 pounds. The burning time for wire-cut brick was 120 to 216 hours.

The significance of these figures is brought out in the original paper by Mr. Collin. The differences depend partly upon the differences in the clay as well as the process necessary to give a certain product, and partly upon the lack of proper balance in operation, including equipment and a knowledge of what can be done. The manufacturer of common brick may now know how low his burning cost should be. It certainly should be less than for face brick.

The Ontario clays are difficult to burn. There is a very narrow margin between the best quality obtainable and a ruined, overfired product. Long years of experience has developed many burners capable of producing satisfactory brick, including the control of colour by flashing, which is a most difficult operation. Modern efficient burning methods to reduce cost must often take second place to quality, and established methods giving a desired product should be changed only after full consideration.

The colour of the finished brick or drain tile depends largely on the content of lime and iron. If the percentage of lime equals that of the iron, the clay will burn red. If the percentage of lime is twice that of the iron, it will burn buff or cream. Intermediate compositions will give intermediate colours. Reduction of iron from the ferric to the ferrous form will give darker colours. This is done by flashing. Flashed colours are brown to black in red-burning clay, and greenish tints are obtained with buff or cream-burning clay.

In burning, certain things must be accomplished. Heat is generated by the combustion of fuel; the hot gases or products of combustion are carried into the kiln and diluted by a variable amount of air, which then passes around the ware. Some of the heat is taken up by the ware, some is used to heat the kiln, some is lost by radiation, and the rest is carried out of the kiln by way of the flue system. The clay ware first loses the mechanical moisture introduced to allow forming of the clay into the desired shape, all of which has not been removed by the drying process. The combined or chemical water found in all clay is driven off at from 750° to 1,100° F. The organic matter is lost progressively during this same temperature interval, but may require a somewhat higher temperature to expel it all. Vitrification progresses, and a well-burned brick is obtained at 1,750° to 2,030° F. The colour is controlled by fire manipulation. In such burning, the important points are: (1) fuel, (2) type and dimensions of kiln, (3) combustion of fuel (flue gas analysis), (4) draft and kiln pressures, (5) flashing, (6) scum.

Fuel

In Ontario the fuels used are wood, coke, and coal.

Wood.—Wood was used for many years as the chief fuel for burning brick and drain tile. An abundant supply within a short distance of the plant made it unnecessary to use coal. The wood was cheaper and gave a cleaner fire than coal, as it is free from sulphur, which causes scum. Cord wood, 4 feet long, was used, and the fire box was built to accommodate it. At the present time the use of wood for the entire burn is passing. It is hard to get and is becoming more expensive. This is especially true of

hard wood. The mixed soft woods do not burn so well. Wood is still used widely for water smoking, steaming, or starting the burn. While driving off the water, a fuel like coal, which contains sulphur, easily causes scum. The change from wood to coal for the larger part of the burn has been difficult at plants which have had no experience in burning coal. The method for burning coal is, therefore, given in some detail under the heading, "Combustion of Fuel and Flue Gas Analysis."[1] In the past it was customary for the gang that operated the plant in the summer to cut wood in the bush during the winter and haul it to the plant for use the following season. The gang could thus be employed the year round. Wood has also been used as a fuel for dryers because of its freedom from sulphur.

Coke.—Coke is relatively a new fuel. As it has been heated during the process of manufacture, the volatile matter has been driven off, and the sulphur has been largely expelled. Where it is easily obtainable, it has replaced wood for water-smoking to some extent. The W. H. Cooper plant, Hamilton, uses coke for water-smoking stock or soft-mud brick, stating that it is cheaper than wood and also cleaner and easier to handle. As the volatile matter, which gives a long flame, has already been driven off, the normal flame is short and it has been considered impossible to fire a large 30-foot kiln to the finish with this fuel.

Hamilton Potteries, Limited, burn coke altogether in their pottery kilns without experiencing any trouble from poor heat distribution, and it would seem that with proper control the necessary long flame could be obtained. Producer gas can be made, using coke as the fuel. Coke is used in dryers, as it is almost sulphur free.

Coal.—The coals used in the Ontario plants include lump gas coal, run of mine, and slack. The cost varies with the quality and haulage, including freight and cartage to the plant. Collin found that there was a wide variation in the quality of coal used. Lump gas coal is considered to be the best as it gives a long flame. Other general requirements are: (1) The ash content need not be above 5 per cent. (2) The ash should be refractory so as not to clinker on the grate bars. (3) The sulphur content should be 1 per cent., or below. (4) The heating or B.t.u. value should be fairly high.

Manufacturers often take the word of the salesman for quality and composition instead of having first-hand knowledge. One or two of the larger plants check these points themselves or through a testing laboratory and are able to buy to better advantage as well as to reduce operation losses by rejecting coal which will not meet their needs. Lump gas coal can be burned on any of the grates common in plants. Because of the lumps it is open enough to allow draft through the fuel bed. Mine-run coal is much finer, with few lumps, and is more difficult to burn with natural draft. Slack is used only where a forced draft is available.

Types and Dimensions of Kilns

Kilns vary widely in type and efficiency. Those used in Ontario may be grouped as follows: (1) Scove up-draft kiln. (2) Rectangular or round down-draft kiln. (3) Continuous-chamber kiln. (4) Car-tunnel kiln. (5) Potter's up-draft kiln.

SCOVE KILN

This is the simplest form of kiln. The dry brick are built up in a pile on the ground, leaving openings or fire holes through from side to side in which the fuel is burned on the ground. Wood is used as fuel,

[1]Page 100.

and the heat and smoke works up through the brick setting, which is open enough to allow some circulation. The outer wall is built up of brick bats or any unsalable brick around the yard. These are mudded up on the outside. The roof is laid with a tight floor except for a brick left out here and there to act as a stack and let out the products of combustion. The heat distribution is controlled by varying the position of the outlets in the



Small scove kiln, Thos. Godfrey and Company, Carleton Place.

top as required. After burning, the entire kiln is torn down as the good brick are sorted out and sold. The photograph above shows such a kiln with a capacity of 85,000 brick. For the manufacture of common brick such kilns give fair results, but the heat distribution is not good and not more than 60 per cent. are well burned in most kilns. This 60 per cent.



Shed over scove kiln, Brampton Pressed Brick Company, Brampton.

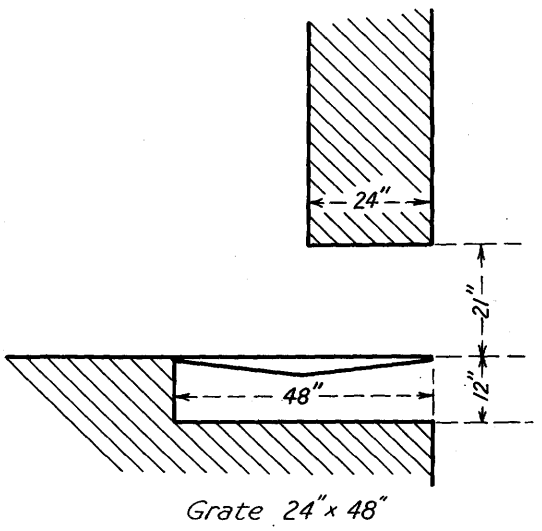
may be sold for face brick, but much of the other 40 per cent. can only be used for common because of soft burning.

In the Chicago area common brick are burned in this type of kiln, but the walls are permanent, there is a roof overhead, and the brick are set in the kiln and removed in large units by an overhead crane. Such handling results in very low costs. The manufacturers of face brick usually make

use of the down-draft kiln. In Ontario the permanent wall and roofed scove kiln is to be found, but the ordinary hand methods are used for setting and drawing.

At the plant of the Terra Cotta Brick Company, Terra Cotta, Peel county, a temporary roof is placed in position over the scove kiln. This gives protection from rain while setting green brick and is removed when the fire is started. The wall into which the fire boxes are built is permanent. There are grate bars in the fire boxes, and coal may be burned. An opening or door is in each end wall and is used for setting and drawing.

At the plant of Edwin G. Steele, Vankleek Hill, Prescott county, there is a very good type of shed roof over the scove kiln. The shed is 105 feet long by 32 feet wide, and the side roof extends about 6 feet beyond the edge of the kiln. The roof proper is supported by side posts which extend 12 feet above the top of the kiln, and the ridge is about 25 feet above the kiln top. A 6-foot strip at the ridge is of corrugated iron instead of wood to prevent fire, and an opening 18 inches wide the full length of the ridge



Plan of fire box, 14 inches wide, in a permanent wall scove kiln, Frid Brothers, Hamilton.

lets out the smoke and hot gases. The roof also gives protection in bad weather and easy shipping in the winter.

The photograph on page 84 shows a kiln shed of a slightly different type. The entrance is wide enough to allow a truck to back in for loading. The main shed roof is entirely of wood, and the fire boxes are on a slightly lower level, so that the grate bars will be at the floor level. The lean-to shed at the sides protects the fireman in bad weather. Dry-pressed shale brick are burned in this kiln.

The normal scove kiln will hold 20,000 brick to a fire hole or arch. The brick are set with three to five brick (brick legs as they are called) end to end between each fire hole. The fire hole is 14 inches wide and arched over at the top of the 13th course set on edge. The total height of the setting is 40 to 44 courses on edge and the width is about 40 brick set end to end. A kiln with 12 to 20 arches holding from 240,000 to 400,000 brick is normal. The permanent walls may have a cement foundation, and the grates may be well set with doors. The wall varies in thickness, but a satisfactory dimension is 24 inches at the fire box to 12 inches at the top.

Buckstays are used on the better kilns to hold the walls in position. The plan on page 85 shows a fire box in a new kiln. At the bottom of the setting, the first two courses are of burned brick covered with a strip of tar paper to prevent the ground moisture from penetrating the green or unburned brick. A centre solid wall, 17 courses high, prevents the wind from blowing through from side to side. The rest of the brick are set open to allow ventilation.

DOWN-DRAFT KILNS

This type of kiln was probably first used in Ontario for burning drain tile and sewer pipe. Such shapes cannot be burned satisfactorily in a scove kiln; a kiln chamber roofed or arched over is necessary. Better temperature distribution is obtained by this construction, and the loss from soft-burned ware will be under 10 per cent. instead of 25 to 40 per cent., as is common in the up-draft scove kiln. The combustion gases pass from the fire box into the kiln chamber, then down through the floor to a flue system that

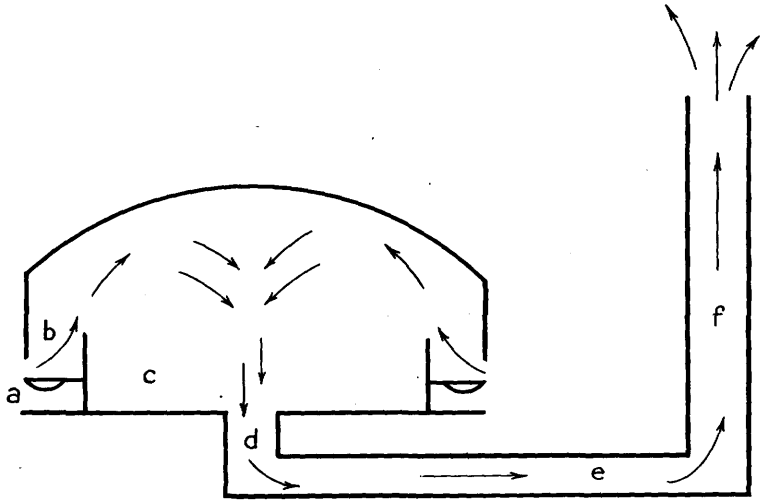


Diagram of the round down-draft kiln.

leads to the stack. Such kilns may be rectangular or round. The sketch above illustrates the principle.

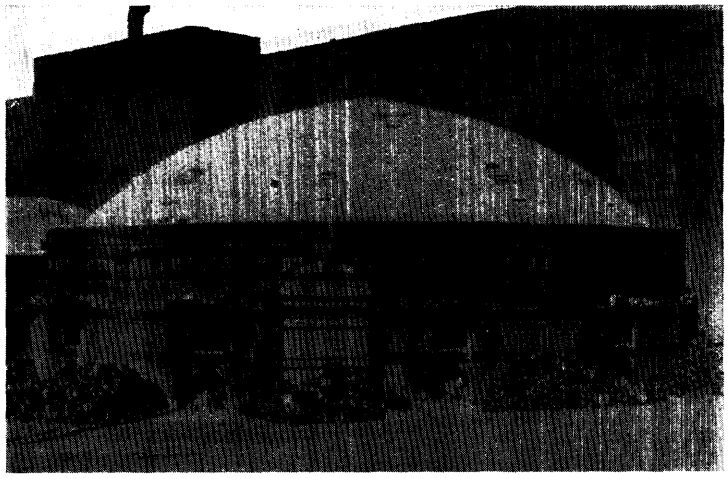
Round Down-Draft Kilns

The round kilns vary from 16 to 40 feet inside diameter, with 24 to 32 feet being the usual range. While the capacity of a kiln depends somewhat upon how the setting is done, the normal capacity in terms of brick is as follows:—

INSIDE DIAMETER feet	BRICK CAPACITY
24	70,000
30	85,000
32	100,000
36	130,000
38	150,000

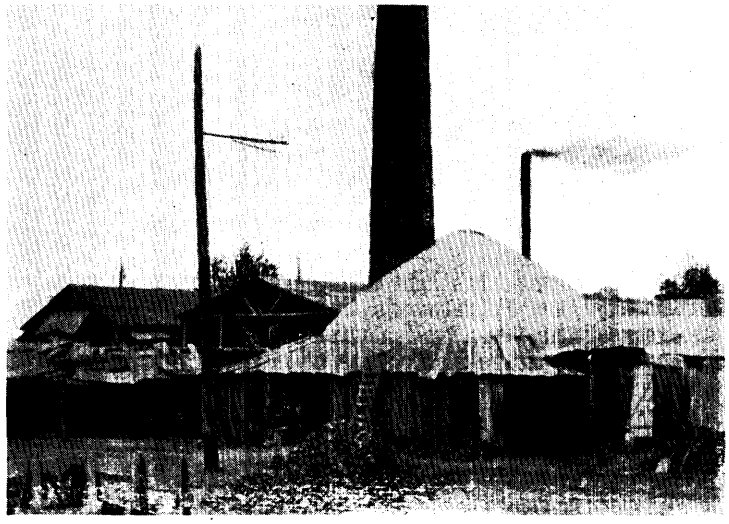
The upper photograph on page 87 shows a kiln of very good design, with a 37-foot inside diameter. The roof curve is good for long life, and there are bands and vertical iron plates above the fire boxes. Eight bands in all are used, one of which at the ground line cannot be seen. They are 6 inches wide by half an inch thick.

The H. C. Baird, Son, and Company's catalogue states that three bands are commonly used for a kiln, but very few kiln builders will agree that this is sufficient. The walls of this kiln are 24 inches thick above the fire box and 36 inches at the fire box. The crown is built of 9-inch fire brick.



Round down-draft kiln, National Sewer Pipe Company, Hamilton.

Wall thickness varies considerably at different plants. Frederick Kerr, of Crediton, Huron county, states that their experience of 50 years indicates that 12-inch walls will last 15 years or more and will last longer than a 24-inch wall. The thin wall cools quickly and gives a fast turnover.

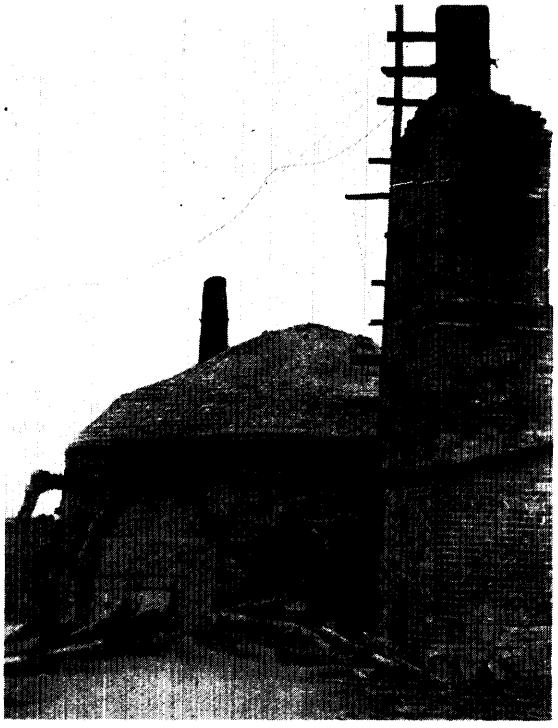


Kiln crown with poor curve.

At one plant, not in operation, an 8-inch wall was observed. The banding was insufficient and, after standing a year, the wall bulged, wrecking the kiln. Mr. Kerr also states that the protection of the kiln from the weather by a roof is as important as the construction to give long life.

Banding is important. At the plant of Herbert Hallatt and Sons, each kiln is built inside a sheet-iron shell of 3/16-inch steel. A 14-inch kiln wall is used. The additional cost is considered well worth while for the long life and freedom from air leaks that is given.

The lower photograph on page 87, which should be compared with the one above, shows a crown of unusual shape, very high and coming to a point. This design is not considered to be good practice, and a long life would not be expected. The kiln setting at the centre would have to be high to utilize the space, and a greater temperature difference than normal would be expected from top to bottom.



Poorly banded kiln with a crown of poor curve.

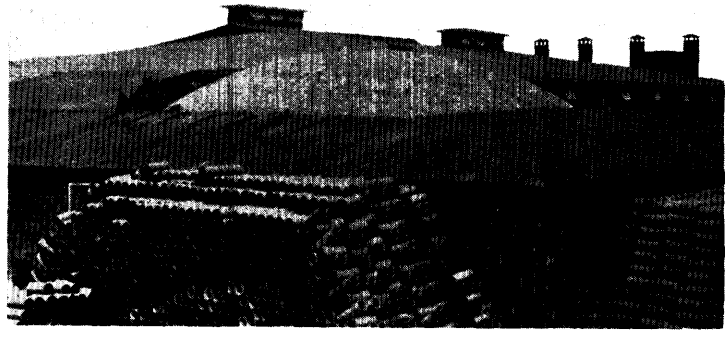
The shed roof around this kiln illustrates a practice quite common in the Interlake peninsula. High winds in this section make burning difficult at certain seasons of the year, and a windbreak is of value.

Improper roof curvature is a cause of crown failure, and this is illustrated in the photograph above. The crown has bulged and will soon fail.

There are only three bands on this kiln. Wood is the fuel and extended fire boxes are built to allow grate length for the cord wood. Such extended fire boxes are not banded, and the pile of brick, held in place only by mortar, is a constant source of trouble. This kiln also has two makeshift stacks partly of brick and partly of old metal stack. At the time it was visited, this kiln was being burned. Some plants operate with very poor equipment and are greatly handicapped. Insufficient banding and weathering is causing rapid failure of the kiln. The plant is not operated in the winter, and freezing and thawing have broken up many of the brick in the side walls and crown. Probably the brick were not hard-burned before using,

but even with properly selected brick the protection of the crown from weather should be considered seriously. A roof or grouting is to be recommended.

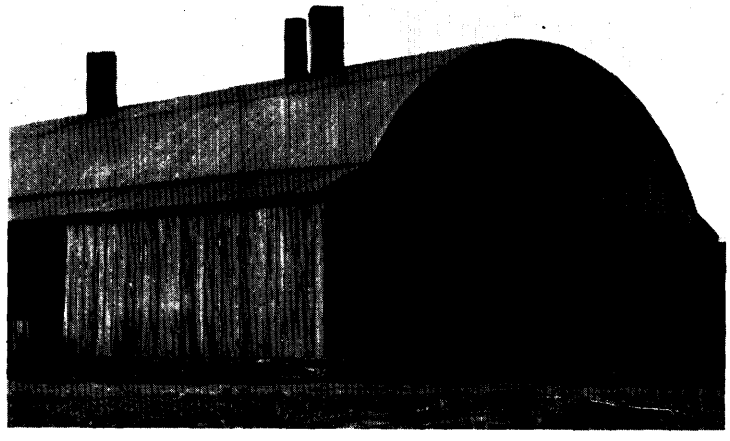
The photograph below shows a kiln crown of good curve covered with a grouting of cement for protection. There is also a brick wall and corrugated iron roof surrounding the kiln to keep out the wind and weather.



Kiln shed with grouted kiln crown, Albert W. Hill, Stevenson, Kent county.

The plant is operated all year, largely independent of weather conditions, and is one of the best-built plants in Ontario.

Another type of kiln protection is a roof over the entire kiln. Several plants have this, but the one shown in the photograph below is unique. The building is a copy of the ordinary hockey rink with no inside supports. The owner says the construction is easy and the cost reasonable. The



Kiln shed with stacks extending through the roof. Amos C. Martin, Wallenstein, Wellington county.

corrugated iron roof makes it fireproof, and painting will make it last indefinitely.

Many round down-draft kilns have a very simple flue system. Instead of the floor flues running to a centre well, from which a stack flue at a lower level goes to an outside stack, the floor flues go to the wall, where 4 to 6 stacks carry off the gases. This multiple-stack construction is cheaper,

as it is not necessary to dig a deep low-level flue to the outside stack. The small stacks at the kiln can be built without experienced help. Several important points, however, come up in their construction. The photograph below shows the stacks built on the kiln wall.

The kiln expands and contracts with the heat of each burn, causing the stacks to lean and necessitating their frequent repair or rebuilding to prevent falling. The stack walls are only 4½ inches thick, and as the outside is 16 by 24 inches (8 by 16 inches inside), the base is not very substantial. The built-out fire boxes are also seen in this picture. Another method is to build the stacks outside of the kiln but in contact with the kiln wall at the base, if not all the way up, as shown in the illustration on page 91.

The kiln expands and will gradually push over the stack. It can be seen that those in the picture are not vertical. It would seem that to be



Multiple-stack kiln with stack built in the wall, Red Star Brick and Tile Yard, Stratford.

satisfactory the stack should be built on a foundation separate from the kiln proper with an expansion joint between, so that any kiln movement will not be transferred to the stack.

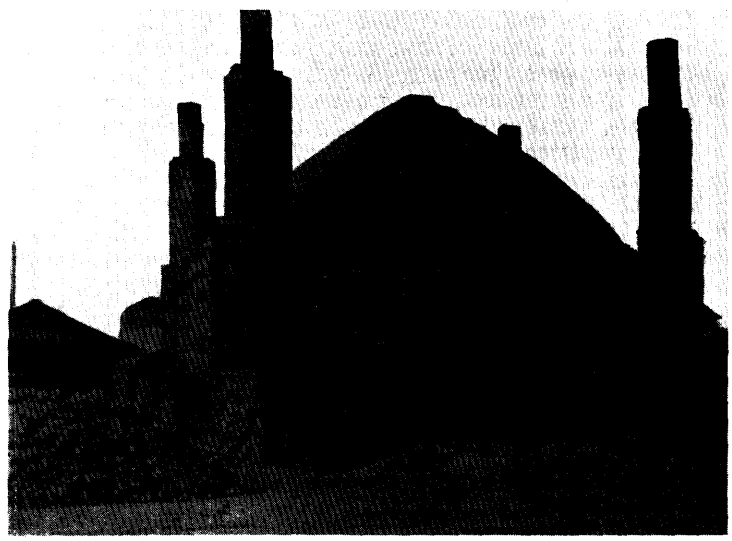
In most kilns there is one flue to each stack, but sometimes multiple flues are used. At the plant of the Port Rowan Brick and Tile Company, Norfolk county, there are kilns having three flues to the one stack, and there are two stacks to the kiln. Three dampers are placed in the base of the stack, and the centre flue draws from the centre of the kiln, the other two drawing from the sides. A cement slab over the fire box, protected from the heat by brick, gives a fair bond to the fire-box structure in the absence of tie rods.

Often when a kiln is being started, the draft is insufficient to give the volume of hot air desired to dry the ware and start the burn. In a few plants a fan replaces the stack, which gives a controlled draft at all times. In other plants two or more kilns are taken care of by one stack, and the burns are so arranged that the stack is always warm. At the plant of the

Jamieson Lime Company, Renfrew, Renfrew county, a small portable fan is in use, driven by a gas engine to give additional draft when it is most needed. The blower is a 21-inch one manufactured by the Canadian Blower and Forge Company, Kitchener. It is connected at the base of the stack at an angle, so that the incoming air will act as an injector and give momentum to the gas flow.

Dimensions of the round down-draft kilns vary considerably. The inside dimension above the bag wall varies from 22 to 40 feet. The smaller sizes, from 22 to 28 feet, are often used by manufacturers of drain tile where a faster turnover is desired. An 18-foot kiln is used by the Foster Pottery Company, Hamilton, for burning flower-pots. Of the larger sizes, 32 feet is considered by many to be more or less standard, giving reasonable burning speed, fuel economy, and a large percentage of No. 1 ware.

For burning Ontario clays, cone 02 or 2,000° F., is about the maximum temperature reached, and it is customary to construct the floor, flues, stack,



Kiln with 4 stacks in contact with kiln wall at the base, D. A. Hitch, Ridgetown. There are only 3 bands and the curve on the crown is poor.

side walls, and part or all of the crown with local brick, usually made from the clay or shale at the plant. Buff or cream-burning clay, well burned but not too hard, is considered better than red-burning clay by many manufacturers.

The fire box and the bag walls, especially the bottom of the bag walls, are usually of fire brick of good quality, often No. 1 grade. The inside walls directly over the fire box are sometimes of fire brick, as are the first 12 to 14 courses of the crown, where the direct flame hits it. In a few kilns, such as those made for burning sewer pipe and hollow tile, it is the practice to line the entire kiln with fire brick and also to build the crown entirely of this material. It is never necessary to use fire brick for the floor or the lower flues. The crown is usually 9 inches thick, but it is good practice to protect the crown by laying common brick flat $2\frac{1}{2}$ inches thick over the 9-inch crown brick, and grout in with a cement wash, which is renewed as required. Special waterproofing materials are on the market, and these have been used to advantage.

Wall thickness above the fire box has already been discussed. A thickness of 27 inches is as much as is justified, and this is called good practice

in many places. Thinner walls, from 12 to 16 inches, are common in Ontario, especially with kilns under 25 feet inside diameter.

Tests on Queenston shale brick made at the plant of Milton Brick Limited show that both the red- and buff-burning brick will carry a load of 25 pounds per square inch at 1,832° F. under reducing conditions, but will completely fail from melting at 2,012° F. At 1,832° F., the red-burning brick showed more softening than the buff brick, although both had the same shrinkage of 0.75 per cent. after being held at this temperature for 1½ hours. Under oxidizing conditions there was no action of consequence at 1,832° F. At 2,012° F., the buff brick showed no shrinkage after holding 1½ hours, while the red-burning brick showed a shrinkage of 5.3 per cent. under the same treatment. It is evident that the kiln atmosphere will have an effect upon the temperature that common brick will stand.[1]

In many kilns the wall thickness at the fire box is increased to allow for the length of the grate. With the 27-inch wall, the inclined grate or dead-bottom fire box may be used without requiring an off-set or hub, but with a 12- to 22-inch wall more space is required. This increase in wall thickness at the lower part of the wall introduces difficulties in banding and may increase repair charges. A hub extending all around the kiln, as shown in the upper photograph on page 87, allows for this, or the fire boxes are built out, without banding, as in the photograph on page 90. The horizontal grate requires more space, especially where cord wood 4 feet long is burned, and some sort of extension fire box is necessary.

For a 32-foot kiln, 10 fire boxes is good practice, but the number may vary from 8 to 12. A 38-foot kiln will require from 12 to 14 fire boxes, while a 20-foot kiln will usually have 8 fire boxes. Temperature distribution with natural draft seems to make this number desirable.

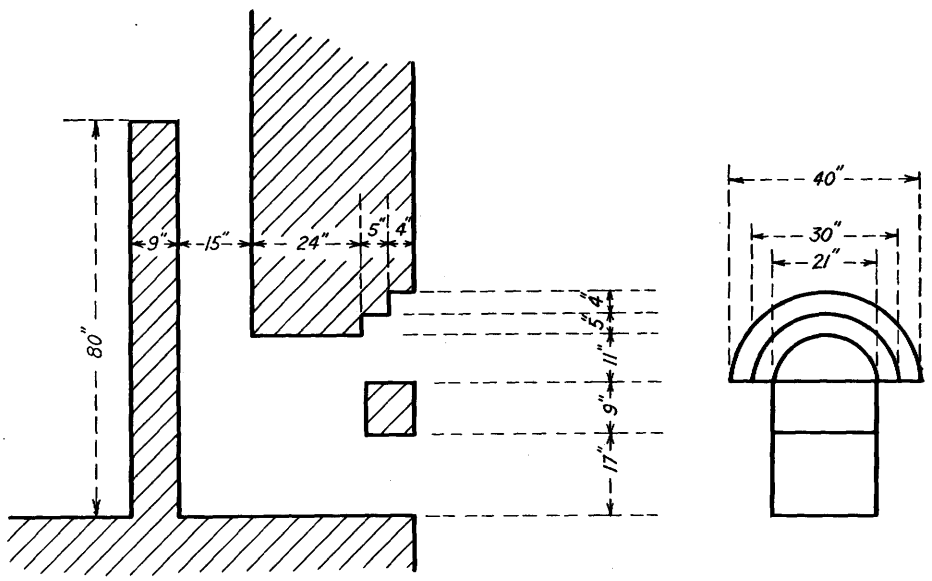
Kiln Design.—The design of openings and flues which carry the products of combustion must take into account the volume of the gases to be carried. Kilns are heated by burning fuel in the fire box. Air necessary for combustion and excess air to dilute the combustion gases as required is admitted over or through the fuel bed. This excess air, as well as the gases from the combustion of the fuel, increases in temperature as it passes from the fuel bed and expands in proportion to the temperature increase. Outside air goes into the fire box at about 60° F., or less, and is heated to about 2,300° F. when it leaves the fire box (with kiln at finishing temperature). One cubic foot of cold air will have expanded to about 4.5 cubic feet and will therefore require much more space as it enters the kiln. If the stack flue reaches a temperature of 1,400° F., the volume at this temperature is about 2.8 cubic feet. In other words, the volume of a gas will double with a temperature increase of 491° F. In kiln design, these volumes must be considered and room allowed for the passage of the gases. Owing to the constant change of conditions as the kiln increases in temperature during the burning period, an exact calculation that will apply at all times is impossible. A damper is used as an aid in controlling the gas flow. During the start of the burn, the normal condition is a sluggish draft, which will improve with increased temperature, so that it is usually necessary to lower the damper at the finish of the burn. The sluggish start may be overcome by arranging for the stack to be hot with heat from another kiln (compartment stack) or by building a fire in the base. A compartment stack may serve two kilns and have a division wall part or all of the way to the top, so that alternate burning of the two kilns will keep the stack warm all the time. A fan exhaust substituted for the stack or forced draft may overcome the sluggish start and save hours from the total burning time. Grate area, size of floor openings, and flue and stack

[1]J. M. Higgins, thesis, University of Toronto, 1930.

areas have been determined largely by the cut and try method. A summary of the data[1] taken from kilns giving good results follows. The letters refer to the positions in the sketch on page 86.

	Per cent.
a—Ratio of grate area to kiln floor area	12.6
d—Ratio of floor openings to kiln floor area	2.8
e—Ratio of main flue area to kiln floor area	1.4
f—Ratio of stack area to kiln floor area	1.6

These figures are for a 28-foot kiln and can be used as a guide for other sizes. Greaves Walker[2] gives the following ratios for grate area: 1 square foot of grate area for 8 square feet of kiln floor area, if burning to cone 1; 1 square foot grate area for 4 square feet of kiln floor area, if burning to



Plan of dead-bottom fire box, burning coal.

cone 18. For salt glazing the ratio is 1:8 or 1:6. He also recommends a fire-box width of 30 inches.

Fire Boxes.—There are 4 types of fire boxes in common use: (1) dead-bottom, (2) inclined grate, (3) horizontal grate, (4) dead-bottom fire box for burning wood.

The sketch above of the dead-bottom fire box, burning coal, is taken from the kilns of the Hamilton Pressed Brick Company, Hamilton. The fire is started on the ground, and it gradually fills up the space to the upper opening. Air entrance is regulated by the amount of green coal piled into the upper opening.

The upper sketch on page 94 shows a fire box with an inclined grate, the type used in the kilns at the plant of the National Fireproofing Company, at Aldershot, Wentworth county, and is built without grate bars. The next sketch is of the inclined type furnished by H. C. Baird, Son, and Company, of Parkhill, and used at the Belle River plant of the Denison Tile Company.

The Baird type is widely used in the Interlake peninsula. The bars are 24 or 30 inches long and are made for 15- and 19-inch fire-box widths. The hopper support at the top makes for easy firing. In some cases bent

[1]U.S. Bur. Standards, Bull. No. 271, p. 10.
[2]Ann. Rept. Can. Nat. Clay Products Assoc., p. 20.

iron or steel bars replace the cast-iron bars and are supported by cross-bars at top and bottom. The slanting grate makes it easy to maintain a compact

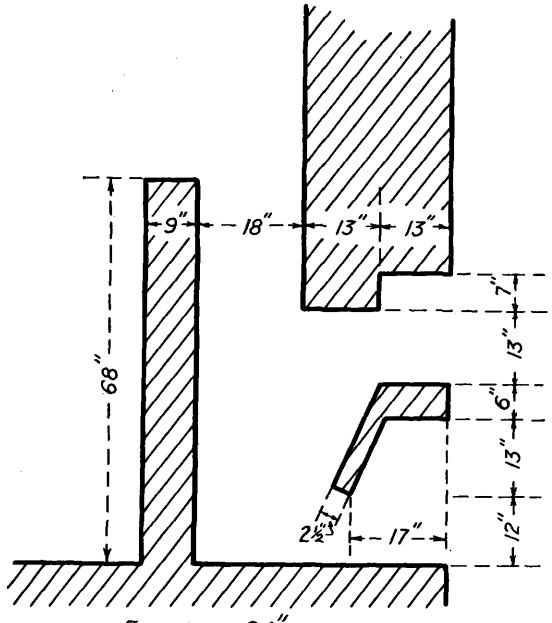


Diagram of an inclined grate without bars.

fuel bed with gradual coking and feeding of the green coal as the fire settles. It is also easy to clean fires through the open space at the bottom or by the

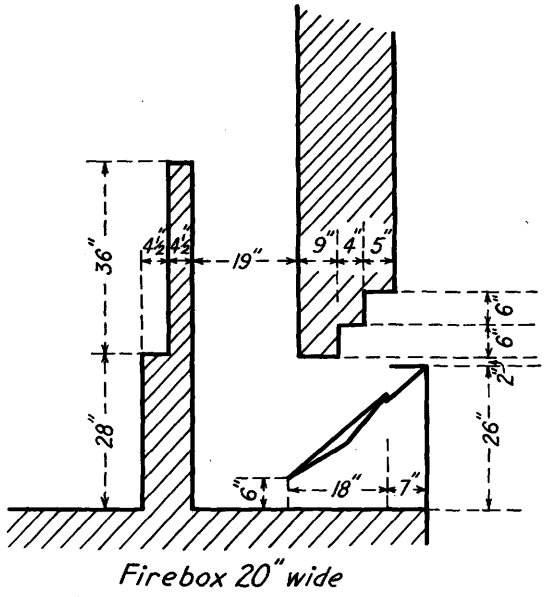


Diagram of an inclined grate with bars.

complete removal of the bars or bent rods. The excess air is controlled by the amount of green coal added, as in the dead-bottom type.

The fire box with a horizontal grate is the type that is probably more widely used than any other. It allows easy calculation of grate area as compared with the dead-bottom and inclined types. It also allows the easier application of forced or induced draft. It requires a thicker kiln wall and the grates are harder to keep clean, but the fire doors and ash-pit doors allow a better regulation of air for combustion. The choice of a type of grate, horizontal or otherwise, seems to be governed by local preference or custom rather than by a careful consideration of the merits of each. The horizontal grate is almost universally used in rectangular kilns, whether scove or down-draft. Nevertheless, all three types, dead bottom, inclined, or horizontal, will give good burning when properly controlled.

The following sketch of a grate used by the Halton Brick Company near Terra Cotta, Peel county, shows only 18 inches vertical height above the grate bars, and it is a question if this is enough room to take care of

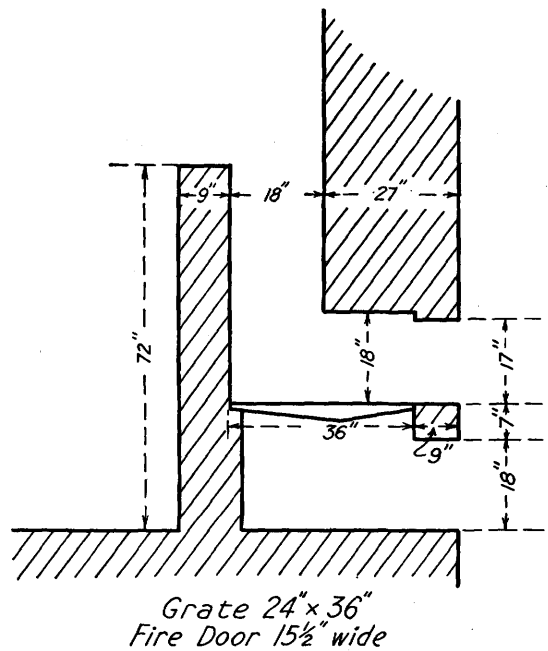


Diagram of horizontal grate with low arch above grate bars.

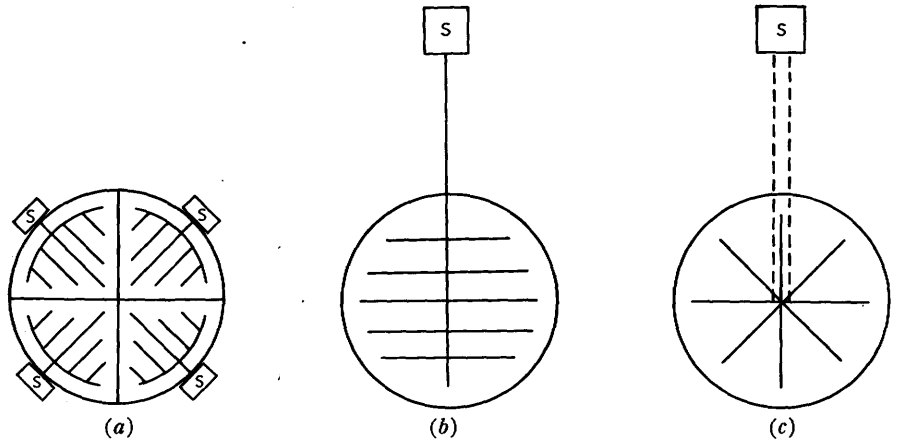
the increased volume of the air and gases as they are heated. This sketch should be compared with that on page 99, which has 40 inches above the grate bars. Greaves Walker[1] recommends a space of 66 to 72 inches from the bottom of the ash pit to the top of the arch over the grate. In this case, there is only 42 inches. There is a tendency to make this dimension too small, which causes a high velocity of gases and higher local temperature and tends to burn out the fire brick in the fire box and the bag walls.

The dead-bottom fire box to burn wood is the same type as was used in the older scove kilns, but has practically gone out of use. Wood, where it is still obtainable at a reasonable price, is more often used on a horizontal grate than in a dead-bottom fire box. Wood cannot be burned in the inclined or coal dead-bottom type. Such fire boxes are 60 inches long to take cord wood, are built with fire doors like the horizontal-grate fire box, and are of much the same design except for the bars.

[1]Ann. Rept. Can. Nat. Clay Products Assoc., 1927, p. 20.

Opening into the Kiln or Bag Wall.—This dimension has not been widely discussed in publications on kiln design. There seems to be a tendency to make it very small, partly to conserve space in the kiln. The temperature here is almost as high as in the fire box, and the gases are near their maximum volume. The National Fireproofing Company, Aldershot, allows an opening of 18 by 27 inches. Some of the sewer-pipe kilns have a bag wall entirely around the kiln 18 inches out from the kiln wall, giving an opening of 18 inches by 9 feet for each fire box. In some kilns the size is as small as 12 by 18 inches. It would appear that a reasonable minimum size is 18 by 27 inches, or between 450 and 500 square inches.

Floor Openings and Flues.—Floor openings should be large enough to carry off the combustion gases and so proportioned in size and placed in



(*a*) Flues in the four-stack kiln.

(*b*) Single outside stack with flues on one level.

(*c*) Single outside stack with centre-well hole.

position that they will force an even distribution of the heat throughout the kiln chamber. The control openings may be in the floor on which the ware is set or may be on a lower level. The setting floor may be solid, directly on the main flues, or of the full checker type with kiln floor brick pavement set on a series of rat holes above the main flues. Such checker floors give about 30 per cent. open space and 70 per cent. solid. The control openings lead into the gathering flues, which in turn go to the main stack flue. The aggregate size of these control openings has been given as about 2.8 per cent. of the total floor area. Because of the top checker floors it was difficult to estimate the effective control opening area of many of the Ontario kilns. A number which were measured varied from 1.1 per cent. to almost 10 per cent. If the size is too small, there is the difficulty of not being able to draw the heat to the bottom of the kiln, as high combustion gas velocity would be necessary. If the size is too large, too much heat will be drawn into the lower flue system, with a loss of efficiency; the damper and stack flue will get too hot; and too much heat will be lost up the stack. These control openings and the damper are largely responsible for the operation of the kilns.

The flue systems in use at the various plants are too numerous to give in detail. Three types, shown in the illustration above, are described in the following paragraphs.

In the four-stack kiln (*a*), the stacks are in or at the wall, the flues are all on one level, and the kiln bottom is divided into four quarters. A series of narrow flues or rat holes covered with perforated kiln floor brick pave the kiln bottom. The rat-hole flues run toward the outside wall, where a

circular gathering flue carries the combustion gases to the four stacks. The rat-hole side walls are 12 to 18 inches deep and are set checker to allow cross-draft. An estimate of the control-opening area is difficult. The heat distribution is controlled by replacing the kiln-floor brick with solid brick at the hot spots to force the draft to the cooler parts.

Sketch (*b*) shows a type of flue system with a single outside stack and the flues on one level. The main stack flue runs across the kiln and extends underground to the stack. Side gathering flues run at right angles and cover the kiln bottom to give good distribution of the heat and are on the same level as the main flue. The control openings are in the crown of the gathering flues and the main flue. As the strongest draft pull is on the stack side, adjustments of the openings are made to compensate for position. A full checker floor may be placed above this. The principal objection to the full checker floor is the difficulty of keeping the under flues free from kiln dirt, such as broken brick, setting sand, etc. Sometimes, also, there are expansion movements that may cause the brick setting to lean; this may be offset somewhat by setting flues in the first 2 or 3 courses of the brick to be burned. But it is usually conceded that the checker floor gives a better temperature distribution and fewer soft brick.

This flue system is a little more expensive to construct than the 4-stack type, as the main flue means rather deep construction and the stack requires a good base and proper design, being higher and more difficult to build. It does, however, give better kiln control and a freedom from cross-draft often observed with the multiple stack, and it allows the use of waste-heat flues more easily than the other.

Sketch (*c*) shows a type of flue system with a single outside stack and centre-well hole. The main flue runs only to the centre of the kiln, but is at a level below that of the gathering flues, and then extends underground to to the stack. The centre is a well, into which radial gathering flues empty. It is often called the wheel-flue system, the spokes being the gathering flues. Control openings in the top of the spoke flues distribute the heat. A full checker floor may be above. The low level of the main flue increases the cost, but greater uniformity of burn is usually obtained and the proportioning of the size of the control openings is easier.

In other types of flues, ring flues may take the place of the spokes, and sometimes two or more flues extend to the stack with separate dampers to regulate the pull on the centre and outside of the kiln chamber. Almost every plant has its favoured system and often no two kilns at the same plant are exactly alike, and the burner must learn the peculiarities of each.

As the flue gases leave the kiln chamber, they are cooler and the volume of the gas is less. Because of this and the fact that the friction is less in one flue than in many, the main flue area may be less than the size of the control flues. The figure given is 1.4 per cent. of the kiln-floor area, or about one-half the size of the control openings.

The stack area should be a little larger than the main flue, as indicated by the ratio given, for good draft conditions. A 40-foot stack is considered to be the minimum height when there is only one stack and it is within 10 feet of the kiln. Additional distance from the kiln means an equal addition to the height of the stack in feet. For the multiple stack kiln, the stacks should run 6 feet above the crown. The life of a stack will be increased if it has an air space of 2 inches between the outside and the lining.

Rectangular Down-Draft Kilns

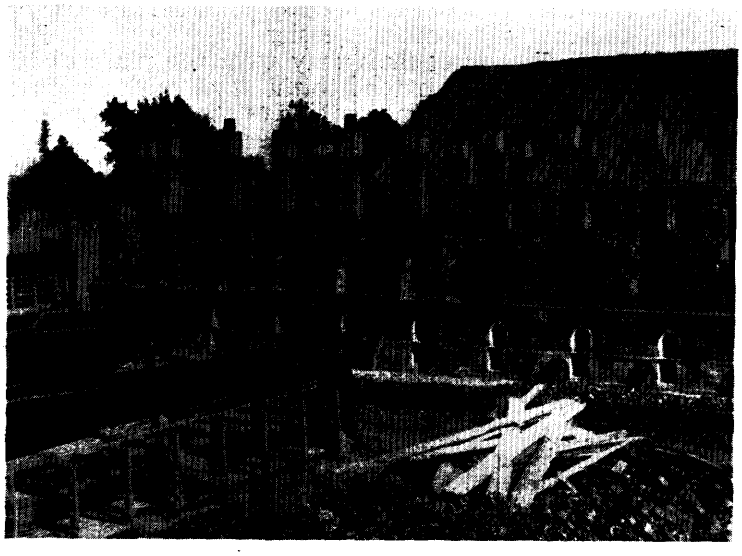
The rectangular down-draft kiln is the same in principle as the round down-draft, the combustion gases passing down through the kiln floor to the stack flue in the same way. Such kilns find considerable favour in the Toronto area but are seldom seen in other sections. The average capacity

is larger, and the rectangular shape fits in a given space better than the round. The kiln setting is more uniform in a rectangular space, and the



A 16- by 84-foot kiln with a capacity of 170,000 brick, Caledon Shale Brick, Limited, Credit Forks, Peel county.

large end doors allow more freedom in loading and unloading. While they have equal length of life with the round kiln, the banding (use of buck-stays) is more expensive and repairs often cost more. The walls are thicker and the burning time is usually longer, giving a slow turnover.



Multiple-stack kiln, Curtis Brothers, Peterborough, Peterborough county.

In size, a normal inside dimension is 16 feet 6 inches by 82 feet long. The capacity is about 130,000 brick.

The upper photograph on page 98 shows a new kiln built to burn shale. Buckstays hold the side walls in place, and the covered crown keeps out the weather. The inside dimensions are 16 by 84 feet, with a normal capacity of 170,000 brick. The end walls are 3 feet thick; the side walls are 49 inches at the fire box and 30 inches above the fire box. The crown is 12 inches thick at the top or centre and somewhat thicker at the sides. The fire boxes have horizontal grates, as is usual with rectangular kilns. The 48-inch wall allows room for this type of grate. The following sketch of a fire box shows good practice as to dimensions. There is ample space over the grate bars for combustion and the opening into the kiln is large. It should be noted that the grate bars are on a level with the kiln floor.

The flue system of rectangular kilns usually consists of a centre main flue running from end to end, about 3 feet by 4 feet in cross-section. It is set low to connect with cross-gathering flues, which run from the centre to the side walls. These cross-flues may be 8 inches wide and 24 inches

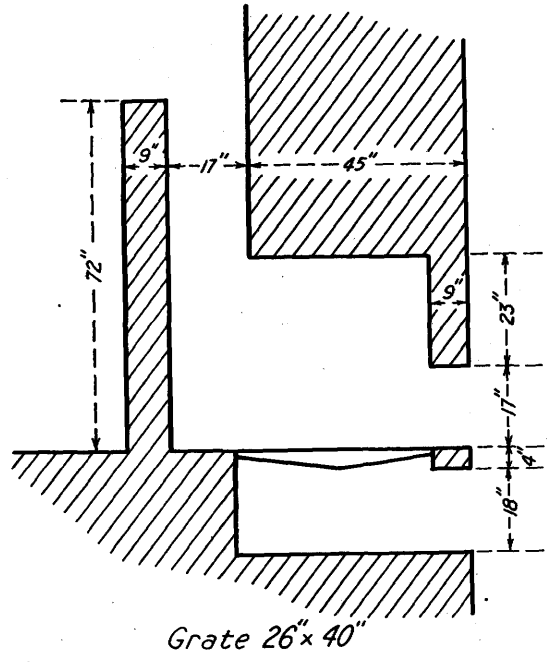


Diagram of horizontal-grate fire box of good dimensions with high arch over grate bars.

deep, and are covered with perforated kiln-floor brick. Often there is a stack at each end, but in some kilns there is one stack at the side with a flue running directly to it from the middle of the kiln. At the plant of the Caledon Shale Brick, Limited, a fan exhaust replaces the stack and rather fast burning is obtained, considering the size of the kiln.

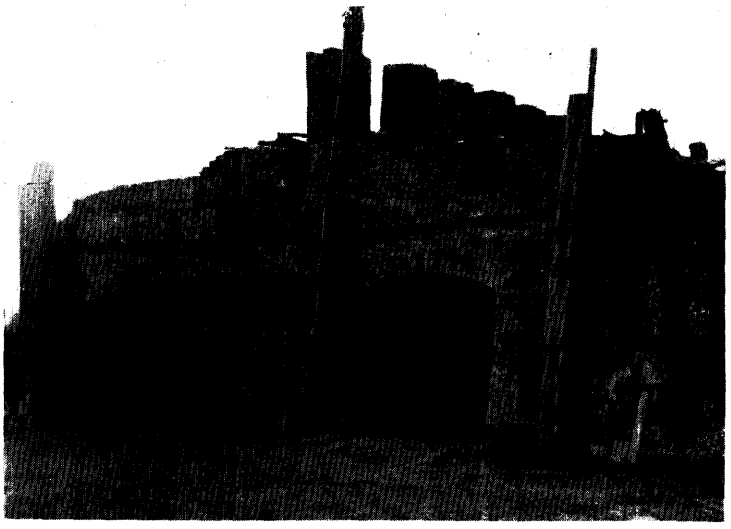
A multiple-stack rectangular kiln, shown in the lower photograph on page 98, is 16 feet 6 inches by 33 feet inside. There are 6 fire boxes and 5 stacks on each side, with an extra stack on each end. The stacks run down through the walls and about 6 feet above the top of the crown. This type of kiln has been used here for 35 years, and the one in the picture is in good condition after 16 years of service. A concrete mat under the kiln, with tile drains, insures a dry bottom and no settling.

An unusual kiln is shown in the photograph on page 100. Two chambers are built side by side. The fire boxes are in the outside wall, and the stacks are in the centre wall, which is common to both chambers.

Alternate firing gives a warm stack for starting the kiln and also gives warm working conditions during setting and drawing. Wooden buckstays are seen in the picture; the heavy walls prevent them from burning. Two other such kilns are found in Ontario, one at Sault Ste. Marie at the plant of James Elliott, Jr., and one at Wm. Elliott's plant in Bruce county.

CONTINUOUS-CHAMBER KILNS

There are three or four continuous-chamber kilns in operation in Ontario. These are of the Youngren type and are very economical in the use of fuel. Waste heat is used for pre-heating the chambers. The fuel is producer gas, and the chambers are only on direct fire for about 30 hours for burning hollow building-block, or 48 hours for burning brick. There are 16 cham-



A two-chamber rectangular kiln, Ott Brick and Tile Manufacturing Company, Waterloo, Waterloo county.

bers in the kiln of normal size, each having a capacity of 60,000 to 80,000 brick. The greatest drawback to this type is that, owing to expansion and contraction during each burn, the crown loses shape and must be repaired every 3 to 4 years. The first cost is also rather high. The kilns now in use are rather old installations, and it is hard to judge if new kilns of this type will be built. Good quality of burning is obtained.

CONTINUOUS RAILWAY-TUNNEL KILNS

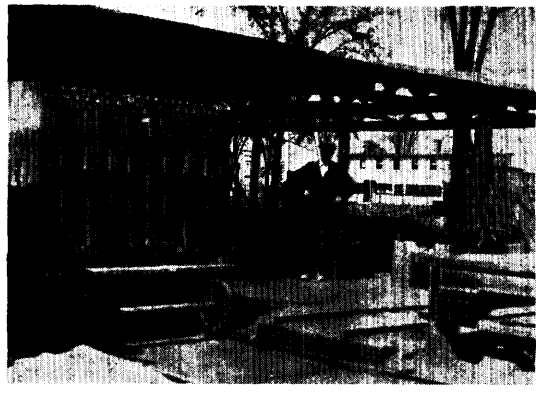
Kilns of this type are being widely used in the United States, but they have made little headway in Ontario up to the present. G. W. Booth[1] was a pioneer in this field and built a kiln of his own design in 1923. This first kiln was 250 feet long. A second one, built a year or so later, was 335 feet long and gave much better results. He has now built a third kiln for Crang-Booth, Limited, Weston, which is 400 feet long with a capacity of 60,000 brick per day. The photograph on page 101 shows a car coming from the kiln. There are no other kilns of this type in Ontario.

Combustion of Fuel and Flue Gas Analysis

To properly burn ware, some knowledge of fuel combustion is necessary. A short discussion will be attempted without introducing very much

[1]Ann. Rept. Can. Nat. Clay Products Assoc., 1925.

chemistry. Coal will combine with air to produce heat which is carried into the kiln. Only part of the air actually combines with the constituents of the coal. This part is the oxygen. Air is composed of 20.9 per cent. oxygen and 79.1 per cent. nitrogen by volume, or 23 per cent. oxygen and 77 per cent. nitrogen by weight. The nitrogen is inert and does not enter into the reaction. It must, however, be heated up to the kiln temperature and goes out the stack with the products of combustion, carrying considerable heat. This cannot be avoided. A fuel of a given composition will always require a definite amount of air to burn a definite weight of fuel, from which a definite amount of heat will be evolved. One unit of heat measure is the British thermal unit (B.t.u.), which is the amount of heat necessary to raise one pound of water one degree Fahrenheit. The B.t.u. value for a coal may be determined and purchases made based upon this.



Loaded kiln-car as it comes from the railway-tunnel kiln, Booth Brick and Lumber Company, New Toronto.

L. P. Collin[1] found that the heating value of the coal used in the Ontario plants varied from 12,100 to 14,100 B.t.u. per pound of coal.

Usually more than the exact amount of air required is introduced into the kiln. The excess air dilutes the hot gases and cools them down. If a high-flame temperature is desired, the amount of excess air must be low. If the amount of air is less than the amount required to burn the coal, a lower flame temperature will be the result. The partly burned fuel gives a smoky fire, reducing and flashing the clay ware. Partially burned fuel gives carbon monoxide in the flue gas. Fully burned fuel gives carbon dioxide. To determine if the correct amount of air is being used, an analysis of the flue gas can be made. The determinations made are carbon dioxide, carbon monoxide, and oxygen. If excess air is present, the analysis will show free oxygen. If insufficient air is present the analysis will show carbon monoxide. In normal burning conditions with some excess air the analysis will show carbon dioxide and oxygen but no carbon monoxide.

Efficient burning and fuel economy can best be obtained with an accurate knowledge of these conditions. Observation of the gases coming from the stack will give an indication of insufficient air, but the amount of excess air going through the kiln cannot be determined except by analysis. Recording and indicating instruments may be purchased to give such records.

During the first part of the burn, when a large amount of moisture is to be carried out of the kiln, an excess of air is to be desired and may be 3

[1]"Cost of Burning Brick and Tile," Investigations in Ceramics and Road Materials, 1924, Mines Branch, No. 645, Ottawa, 1925, p. 13.

to 4 times the amount required to burn the fuel. This excess should be reduced as the burn progresses to about a quarter more than the amount required or even less. This will give higher flame temperature and use less fuel. Too great an excess of air increases the burning cost. Air may enter the kiln through leaking kiln walls, holes in the fuel bed, poorly fitting fire-box or ash-pit doors, or excess draft from the stack. The diagram below gives the curves obtained by H. P. Kimbell[1] for excess air during burns at two Ontario plants. Curves Nos. 2 and 3 are for two plants near Toronto; curve No. 1, which is much better practice, is taken from another source. In kiln manipulation, there are three important factors, as follows:[2] (1) the

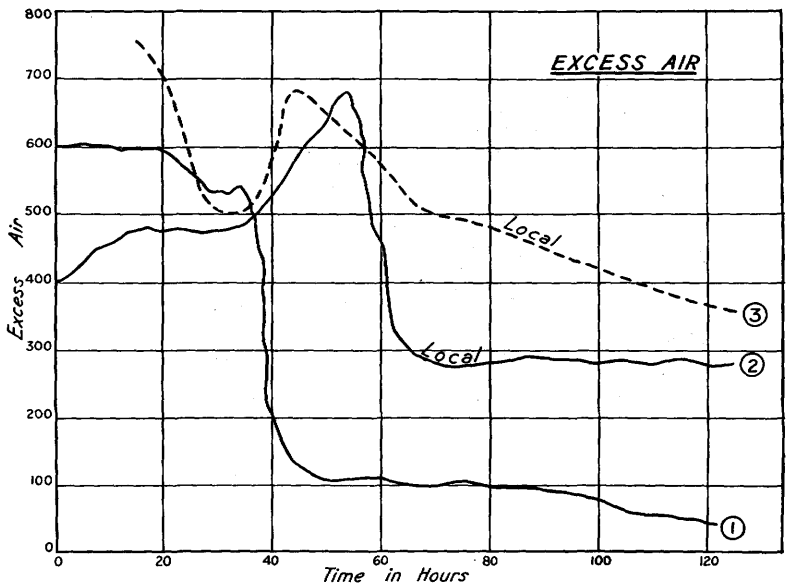


Diagram showing curves for excess air during kiln burning.

development of combustion gases by burning the fuel; (2) the top temperature schedule; and (3) the rate of flow of combustion gases through the system.

The best combustion practice for coal-firing involves regular firing of alternate furnaces, frequent and light firing, coking the coal at the front of the fire box before pushing it back, clean fires, sufficient draft, and the control of secondary air (air entering over the top of the fire bed). The selection of a top temperature schedule seems to depend upon how fast the clay can be fired without damage. The temperature rise of the bottom of the kiln depends upon the rate of gas flow. The rate of gas flow depends upon the rate of fuel combustion. Slow gas movement gives greater transmission of heat to the ware and fuel economy, but carrying of the heat to the bottom of the kiln depends upon a rapid flow to distribute the heat. Heat transfer by radiation or conduction is not sufficient. Convection must be depended upon. In general, then, it is advisable to have a high rate of flow during the water-smoking and oxidizing periods. The rate may be retarded during the middle of the burn to reduce fuel consumption and then increased during the last few hours to even up the kiln temperature.

[1]Bull. No. 8, School of Eng. Research, University of Toronto, 1928.
[2]Kiln Investigations, Mellon Institute of Industrial Research, September, 1928.

Draft and Kiln Pressure

Draft has already been spoken of in connection with the rate of flow of combustion gases. The flow of gases through a kiln with natural or stack draft depends upon the difference in the temperature of the kiln gases and the temperature of the outside air, assuming that the openings into the kiln, through the setting and through the flue, do not introduce too much friction. Hot gas is light and tends to rise, accelerated by a pressure equal to the difference in the weight of the cold outside air and the hot gas. It is found, therefore, that the hot gases entering the kiln will rise to the crown, and the pressure observed at this point is greater than that of the

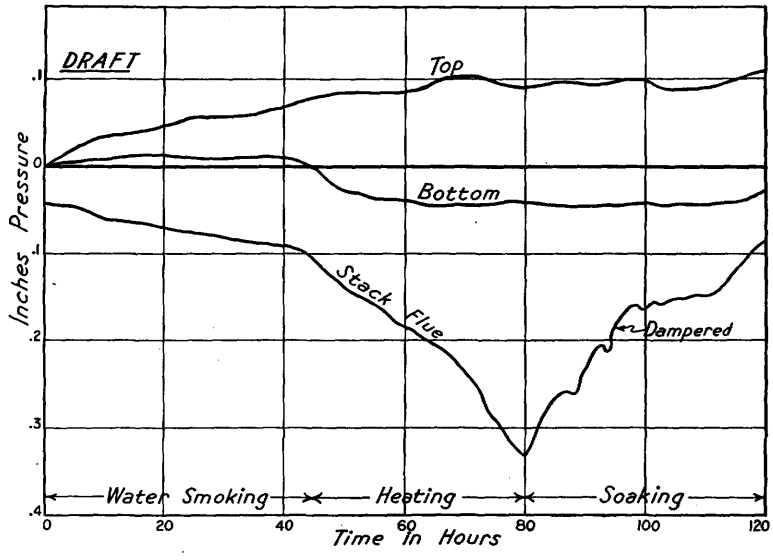


Diagram showing pressure conditions with natural stack-draft.

atmospheric pressure outside. As the gases cool in contact with the ware they become heavier and tend to sink, and while a pressure is often observed in the kiln bottom, especially during the early part of the burn, it is not so great as at the top of the crown. As the stack heats up, its pull or minus pressure increases and often this pull is carried into the bottom of the kiln toward the end of the burn. The diagram below shows typical curves for pressure distribution in a kiln with natural draft.[1] Soon after the water-smoking period the pressure at the kiln bottom changes from positive to negative, showing the effect of the increased stack draft. The curve for the stack flue shows the change in stack pull with increased temperature and with dampering. Fan exhaust will give better control of gas flow than a stack.

Flue gas analysis in conjunction with pressure readings gives a very fair idea of the gas flow. Many kilns are built with the kiln floor on a level with the ash-pit floor, with the grate bars at a higher level. Placing the grate level at or below the floor level and increasing the height of the bag wall will aid in keeping the kiln at greater than atmospheric pressure without decreasing the pressure head available to force the air through the fuel bed.[2] Pressure in the kiln will prevent cold air leaking in through cracks, etc., to cool off the combustion gases and increase the amount of excess air above the point desired.

[1]Ann. Rept. Can. Nat. Clay Products Assoc., 1927, p. 19.
[2]Problems in Firing Refractories, U.S. Bur. Mines, Bull. No. 271, p. 170.

Flashing

Flashing is a superficial colour produced on a clay body by subjecting it to a reducing atmosphere at high temperature, followed by cooling with oxidizing conditions.[1] It is the partial re-oxidation of the dark ferrous silicates or oxide which give the colours usually desired. The reduction may come throughout the burn or just at the finish, with partial oxidation during the cooling. According to A. V. Bleinger,[2] the following factors control the degree of flashing: (1) chemical composition of the clay and character of the iron minerals present; (2) physical condition of the clay; (3) temperature of burning; (4) degree of reduction; (5) rate of cooling. Siliceous clays take a flash more easily than those high in alumina.

The iron is reduced from ferric to ferrous form by contact with the kiln gases, which are only partly burned because of insufficient air or oxygen. The oxygen is taken from the iron because of the deficiency of air, a condition purposely developed in the kiln. As the flashing action is principally due to gases being in contact with the clay face, ware is set to obtain flashing at the points desired. The other faces are protected by close contact with the other ware in the kiln. Experience will give satisfactory control.

Flashed Colours.—Red brick flash to brown or black, depending upon the factors as given. Very fast cooling obtained by breaking down the kiln doors and cleaning out the fire boxes is sometimes resorted to, in order to increase the cooling rate and hold the desired colour. Cream or buff brick, high in lime, give green and yellow-green colours when flashed. Flashing is not difficult.[3] It is accomplished by a heavy firing with coal towards the finish of the burn, or after the kiln is ready to shut off, which produces a heavy smoky flame. At the same time the damper is closed so that a strongly reducing condition is obtained in the kiln. After standing 15 to 20 minutes, a sample brick is drawn and the colour examined, which is darker than the final colour and must be judged by experience. If the colour is not dark enough, the damper is lifted long enough to burn off the rest of the coal and the process is repeated. After this, cooling with raised damper and open doors to cool rapidly with partial oxidation finishes the process. Care must be taken not to allow the heavy firing of coal to increase the kiln temperature to the point of overfiring the ware.

Scum

By scum is meant a white deposit on the surface of the brick, which gives a disagreeable appearance in the wall, often looking like whitewash. This subject has been discussed by L. P. Collin.[4] It is due to soluble salts encountered during the process of manufacture. Efflorescence has a slightly different meaning and is applied to a white deposit which appears on the finished product after it has been taken from the kiln and exposed to weather in stock piles and in walls. Collin's summary is as follows:—

Causes of scumming	Method of prevention
1. Soluble salts in raw material	Weathering, if pyrites is not present. Addition of barium salts. Fast drying.
2. Soluble salts in tempering water	Addition of barium salts. Fast drying.
3. Formation of sulphates in dryer	Prevent sulphur gases entering dryer. Addition of barium salts.
4. Formation of sulphates in kiln from gases or from dryer scum.	Water smoke with sulphur-free fuel. Alternating oxidizing and reducing conditions.

[1]Hewitt Wilson, op. cit., p. 165.
[2]Trans. Amer. Cer. Soc., Vol. 2, p. 74.
[3]Ellis Lovejoy, Burning Clay Wares, p. 37.
[4]"Causes and Prevention of Scumming and Effloresence," Investigations in Ceramics and Road Materials, 1925, Mines Branch," No. 672, Ottawa, 1926.

Causes of efflorescence	Method of prevention
1. Soluble salts in burned ware	Hard burning. Reducing conditions.
2. Soluble salts absorbed from mortar, stone copings, or ground.	Keep from contact with brick and secure proper drainage from stone copings.
3. Soluble salts formed by weathering	Hard burning. Alternating oxidizing and reducing conditions.

Soluble salts in the clay come to the surface during drying, traveling to the surface with the water and being left behind as the water evaporates. The most common offender is calcium sulphate, but there may be others, such as magnesium sulphate, iron sulphate, and vanadium salts. By the addition of barium carbonate or other barium compound to the clay during the process of making it plastic, a chemical reaction forming insoluble barium sulphate is obtained. The insoluble sulphate will not be carried to the surface during drying, and scum is prevented. Methods for adding barium compounds are given by L. P. Collin[1] and include the dry and wet method. The amount required varies from 1½ to 4 pounds of barium carbonate per ton of dry clay. With the dry method, the dry barium carbonate is added by means of a small automatic feeder at the open-top pug mill, being fed at the same time as the clay. Or if the clay is ground in a dry pan, it is added at this point, often with a hand scoop in guessed proportions. With the wet method about 75 pounds of barium carbonate is added to a tank holding 150 gallons of water. A stirring device keeps the barium in suspension. A small stream runs into the pug mill. Both methods have given satisfaction. The main point is to obtain uniform distribution throughout the clay. An excess of barium carbonate will cause scum, so proper proportioning is essential. A number of plants use barium all the time for clear red colours. Lorraine shale in most sections will give better colour when barium is used. Another possible source of scum is the oil used in a lubricated die. Barium will not correct this, and a better quality or some other lubricant is the only cure.

It has been established that 0.5 per cent. sulphur dioxide gas in the dryer atmosphere will cause scum.[2] In the radiation flue type of dryer it may come from leakage of the products of combustion from the flues to the dryer chamber. It may also come from the kiln when waste heat is used or when the products of combustion from the stack flue are pulled into the dryer. The conclusions reached are: (1) Rapid drying with rapid air movement and low humidity will decrease dryer scumming due to sulphur gas. (2) Scumming is more pronounced when the clay surface is wet in the early stages of drying. (3) Sulphur fumes in the dryer may come from the fuel and clinker left in the fire box at the end of the burn. (4) The lowest temperature at which the ware will give off gases is about 1,000° F., but the amount given off below 1,400° F. is negligible. (5) In many cases it is safe to use waste heat at 1,600° F., if the fires are drawn.

The National Brick Manufacturing Association have developed a method for determining the amount of sulphur dioxide in flue gases, which consists of bubbling a measured sample of flue gas through a solution of iodine of known strength, to which a small amount of starch is added. A colour change indicates the amount of sulphur dioxide present.

Burning scum may come from setting wet ware in the kiln, when the burn is started with coal. Condensed moisture takes up sulphur from the kiln gases, forming sulphuric acid which will combine with the materials of the clay to form sulphates. Such sulphates are not decomposed at the temperatures reached in burning brick in Ontario. Starting the burn with sulphur-free fuel, such as wood or coke, and having a strong draft as well

[1]"Methods of Using Barium Carbonate for Scum Prevention in Stiff-Mud Brick," Investigations in Ceramics and Road Materials, 1926, Mines Branch, No. 690, Ottawa, 1927.

[2]Sulphur Gases and Dryer Scumming, Nat. Brick Mfg. Assoc., Bull. No. 105, Danville, Ill.

as dry ware, will reduce or cure this trouble. Coal should have a sulphur content under 1 per cent. While alternation of reduction and oxidation at 1,800° F., as suggested by Collin, tends to break up sulphates, such treatment will have some effect on the final colour of the brick. Hard burning increases the chance that the sulphates will be decomposed owing to reactions between the calcium and the clay constituents. When in combination with the clay, the calcium is harmless.

The presence of soluble salts in the mortar, coping, and ground water was studied by the Pacific Northwest Brick and Tile Association at the University of Washington.[1] The conclusion was that with sufficient water most common mortars will in time give scum. Brick work should not be soaked by drainage of water from leaking drains, cappings, sills, etc., and brick walls should be waterproofed from ground moisture. Portland cement block, artificial stone, and such materials contain soluble salts. An addition of barium carbonate to the mortars gave an improvement. The backing material, as cement block or poured concrete, may contribute to surface scum. The addition of ammonium or calcium stearate to the mortar in the amount equal to 2 per cent. of the cement or lime will greatly reduce scumming.[2]

Distribution of Heavy Clay Products

After burning, the ware is either stocked or shipped. When burning brick in scove up-draft kilns, the brick are usually left in place till sold. They are sorted as to colour and hardness as they are taken out. With round down-draft kilns burning face brick, the same method is followed as far as possible. Orders for various grades or colours, however, often do not agree with production, and stocking is necessary. There is a growing tendency to keep brick stock under cover to protect them from weather and discoloration, which decrease their value.

In the small plant that manufactures for local trade only, the purchaser often comes to the plant to get the brick or tile wanted. Farmers plan to haul their drain tile when their teams are not busy with other things. It is a cash and carry business to a considerable extent. This condition is passing where there is strong competition. The plant must deliver or arrange for delivery. Curtis Brothers at Peterborough own their own horses and wagons and grow the horse-feed on their own farm. The horses are used to haul coal, wood, and clay in winter and to deliver brick in summer. They find that horses are cheaper than trucks. In the Interlake peninsula the tile business is largely local, but trucks are used for hauling. Efficient delivery is an important factor in obtaining business. One plant greatly increased their business by this method. Local agents in every small town obtain a commission on sales, and the personal acquaintance of the agent with the farmer allows a knowledge of planned building or tiling. Trucks deliver tile from this plant 30 to 40 miles in all directions.

In the Toronto area the truck is almost the only mode of delivery for hauls of 50 miles or even more. A 5-ton truck will carry 2,000 brick and can travel from 35 to 40 miles per hour on the roads. The truck may also pull a trailer holding 1,000 more brick. Such an outfit will travel as much as 200 miles a day besides loading and unloading.

Rail shipment is becoming more important every year, and face brick are being shipped all over the province from centres like Toronto. In the past when most walls were solid brick, requiring 20,000 to 25,000 brick for an average house, shipments were not so common as now when the brick veneer house requires only 10,000 to 15,000 brick for the same sized job. Local prosperity often leads to bringing in brick from a distance for archi-

[1]Hewitt Wilson, Jour. Amer. Cer. Soc., Vol. 11, p. 1.
[2]L. A. Palmer, U.S. Bur. Standards, Tech. Paper No. 370.

tectural effects which cannot be obtained from local brick, and rug flashed brick is found in all small towns partially replacing the local product. Drain tile are shipped only to a limited extent, but hollow building-block are shipped as often as face brick.

HEAVY CLAY PRODUCTS PLANTS

In the consideration of each county and district, details will be given regarding the number of plants, capacity, method of manufacture, kind of clay used, and points of special interest in plant design and equipment. Under size the plants are divided into four groups depending upon production as given for brick or an estimated brick equivalent if tile are made.

Group No. 1.....Production over 5,000,000 brick per year.
Group No. 2.....1,000,000 to 5,000,000 brick per year.
Group No. 3.....500,000 to 1,000,000 brick per year.
Group No. 4.....Under 500,000 brick per year.

The grouping applied to some plants may be inaccurate when they are near the line between two groups.

The general map accompanying this report (in the pocket at the back) shows the approximate locations of the plants. The numbers in the report following each plant name correspond to those on the map.

Algoma District

PLANTS: One of group No. 2.
CLAY: Glacial surface clay.
PROCESS: The stiff-mud process is used to make brick and drain tile.

In 1906 there were 3 plants at Sault Ste. Marie and one each at Sudbury and Whitefish.

James Elliott, Jr. (233), Korah

The products are side wire-cut, red-burning brick with both smooth and rug surface. Some of the brick are flashed. Field tile are also made when business justifies it. The production is about 1,000,000 brick a year. The plant is twenty-seven years old. The season is short, there being only four months between spring and fall frosts. The pit of glacial clay has a 6-foot face, with 3 feet of grey clay and 3 feet of blue clay, both red-burning. There is sand and gravel below. The clay is mixed from top to bottom as it is loaded by hand into a car to be hauled to the plant. Mr. Elliott built his own auger machine, which is about the same size as the Baird machine. The hand cut-off was also made in the plant. The ware is wheeled to open-air dry racks consisting of 24 racks, 120 feet long. Canvas curtains can be lowered as a protection from rain or strong wind. There is a shed roof over the kiln, which is of the two-chamber type. Each chamber has a capacity of 85,000 brick and a burning turnover of 14 days, including setting and unloading. Wood, costing $5 per cord, is the fuel used. Mr. Elliott is taking care of the local market by producing a well-burned brick in the colours and textures desired, and very few brick are brought in from the outside. The photograph on page 39 shows a new school building in Sault Ste. Marie in which these brick are used.

Brant County

PLANTS: One of group No. 3.
CLAY: Red and cream-burning glacial surface clay.
PROCESS: Soft-mud and stiff-mud brick are made, also drain tile.

In 1906 there were five plants in this county, four being in Brantford and one in Harrisburg. All but one has discontinued operation.

W. B. Jackson (123), Maitland Street, Brantford

The products are red and cream soft-mud brick, wire-cut stiff-mud brick, and drain tile, 3 to 6 inches in size. No flashing is done. The production is about 600,000 brick and 100,000 tile in a season of five months. The plant is twenty-three years old. The present owner purchased it from the Brantford Brick Company in 1918. The Bechtel carless dryer then in use was discarded, and the usual open-air dry racks were put in. The photograph below shows a general view of this plant, which is very neat and well organized.

The cream-burning clay comes from a bank about 300 feet from the plant, and the supply is ample. The red-burning clay, which overlies the other, is almost exhausted and must be hauled from a distance of 1,000 feet.



Brick plant, W. B. Jackson, Brantford.

It is only one spading deep and on uneven ground, so it is rather difficult to handle. A general cross-section of the deposit taken from the log of a well is:—

	Feet
Red-burning clay	2
Mild clay, burning cream	10
Blue clay, burning cream	60
Rock.	

The clay is hand-loaded to dump carts and allowed to weather and soak in a pile near the machine before being used. For making soft-mud brick, an open-top pug mill feeds a Martin soft-mud machine. For stiff-mud brick an open-top pug mill feeds a Baird auger machine equipped with a Bechtel cut-off. The brick are placed on cars and transferred to the dry racks, then loaded to cars again and taken to the kilns. The transfer tracks at each end of the dry racks are permanent, but the ones running between the racks are portable and are moved from rack to rack as needed. The track units, 20 feet in length, are unusually light and can be easily picked up by two men. The rails are of heavy sheet-iron bent into an inverted U about 2 inches high. The ties are two-by-fours with 2-by-6-inch pieces at one end to support the joint, which is made of a short piece of pipe which fits inside of the U. The brick are burned in two round down-draft kilns and a scove kiln. One kiln has four stacks and is not liked so well as a new

one with one ouside stack, 55 feet high. This new kiln is 26 feet inside diameter and has a capacity of 75,000 brick. Wood is burned. A shed roof over the kilns gives protection from the weather.

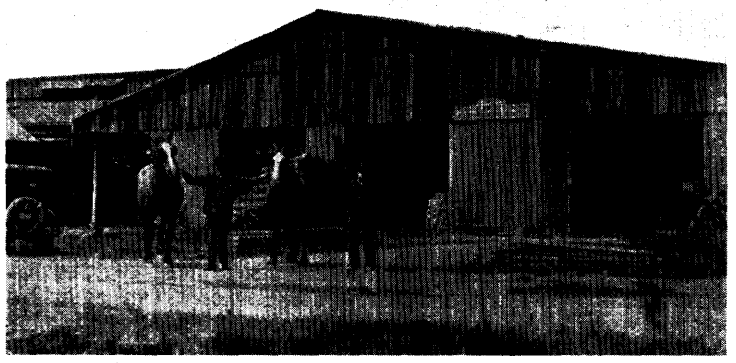
Bruce County

PLANTS: Three—two of group No. 3 and one of group No. 4.
CLAY: Red- and cream-burning glacial clay is used. Cabot Head shale outcrops, but is not used.
PROCESS: Brick and drain tile are made by the stiff-mud process.

In 1906, there were four plants, and at one time since then seven plants were on the government list, but only three are now in operation.

Wm. Elliott (220)

The plant is at the county line and is in Bruce county; Mr. Elliott lives across the road in Huron county, his mail address being Glenannan. The products are drain tile, 3 to 16 inches in size, made from a mix of red



Well-constructed dryer and kiln shed with corrugated iron roof, Wm. Elliott plant.

and cream-burning clay, and end wire-cut and side wire-cut stiff-mud brick, both smooth and rugged. The side-cut brick have three half-inch holes through the flats to aid drying. The production is about 200,000 brick and 300,000 drain tile in a season of five months. The plant is 50 years old and has been owned by Mr. Elliott for 45 years. He has been a leader in the clay industry of the section for many years and is a brother of Jas. Elliott, Jr., of Sault Ste. Marie.

The pit consists of a 6-foot face, 3 feet of red-burning clay overlying 3 feet of grey clay, which burns cream. The clay becomes stony below in some places. They have used clay 35 feet deep. The clay is hand-loaded to dump carts which deliver it to a loading bridge at the foot of an incline. Cars take the clay up the incline to the plant. A small 2½ h.p. gasoline engine and rotary pump keep the pit dry.

Their old soft-mud machine has not been used for twenty years. The clay goes to a single-auger pug mill, a Baird auger machine, and a Brewer hand cut-off made at Tecumseh, Mich. The dry sheds are unusually large and are well constructed, as shown in the photograph above. The roof is of corrugated iron and is extended to cover the kilns as well as most of the stock of burned ware. The kiln is of the twin-chamber type, as shown in the photograph on page 100, with each chamber having a capacity of 85,000 brick or 45,000 tile. A mixture of wood and coal is burned on horizontal grates. The wood costs $5.50 per cord, and the coal $6.50 per ton. This

type of kiln gives such good service that Mr. Elliott hesitates to replace it with the usual round down-draft kiln. A 200-acre farm is operated along with the plant. Two trucks deliver within a radius of 30 to 40 miles.

Thos. G. Donaldson (225), Greenock

The products are drain tile, 3 to 10 inches in size, made from cream- and red-burning clay mixed, and end wire-cut cream-coloured brick. The production is about 250,000 tile and 200,000 brick in a season of five months. The plant is fifty years old but has had several owners, including John McClain and Geo. Bannerman, Jr. The red- and cream-burning clays are at different points on the property. The red clay is 5 feet thick with sand below. The cream-burning clay is grey in colour and has a 15-foot face. A 5 h.p. gasoline engine and pump are required to keep the pit dry. Blue clay is found at a lower level but is not used. Hand-digging and a dump cart are used to win the clay. A single-auger pug mill and a Baird auger machine, powered by a steam tractor on wheels, is used. The brick-drying is done on 9 racks, each 80 feet long, and the tile go to two dry sheds, 50 by 50 feet and 20 by 100 feet. The 22-foot round down-draft kiln has a capacity of 25,000 three-inch tile or 55,000 brick. Wood is burned on horizontal grates.

Winch Brothers (229), Paisley

The main product is drain tile, 3 to 8 inches in size, using red- and cream-burning clay. A few end-cut cream brick are also made. From 15 to 17 kilns are burned in a season of 5 months, the kiln having a capacity of 15,000 tile of mixed sizes. The plant was started in 1860 making slop brick by hand for local use. Machinery was put in about 1890. There was no change in ownership except for about ten years around 1900 when Bell Brothers owned it, later selling back to the original owner. The pit consists of 18-inch red-burning clay overlying 8 feet of grey clay, which burns cream. It is free from pebbles. The log of a well near by indicates 200 feet, or more, of blue clay below. A plow and scraper takes the clay to a car-loading bridge at the foot of an incline leading to the plant. The machinery includes a single-auger open-top pug mill, a Baird auger machine a hand cut-off for tile, and an automatic cut-off for brick. The automatic cut-off for tile does not give good square ends and is no longer used. Three dry sheds, 132 by 40 feet, 100 by 25 feet, and 100 by 25 feet in size are used for tile, and the brick are hacked outside with board covers. There are three round down-draft kilns. Two are 22 feet in diameter and are in good condition; but the third, which is only 16 feet in diameter, is about worn out, being 35 years old.

Carleton County

PLANTS: Two—one of group No. 1 and one of group No. 2.
CLAY: The clays used are marine and Lorraine shale. Chazy, Utica, and Queenston shales are known to outcrop in this county but are not used.
PROCESS: Soft-mud and stiff-mud brick, stiff-mud drain tile, and hollow building-block are made. All are red-burning.

In 1906, there were six plants, but four have discontinued production.

T. E. O'Reilly (58), Hogsback, Ottawa

The product is red soft-mud brick, producing about 1,500,000 in a season of five months. The plant was built in 1896 by the present owner. The brick are used mostly for inside common now, but were used for face brick for years.

A 20-foot face is worked. The top 4 feet is loam, then comes 5 feet of sandy clay, overlying 11 feet of blue clay, all burning to a medium-red.

A blend from top to bottom is used for soft-mud brick. There are a few stones and pebbles.

The clay is well worked in an open-top pug mill, rolls, and a second pug mill before going to a Martin brick machine, made by the Baird company. A 40 h.p. electric motor furnishes the power. Open-air dry racks and scove kilns are used. The scove kilns are set with 3 to 6 brick legs, giving 16,000 to 36,000 brick to a fire hole. By setting 40 courses high and 44 brick wide, the kilns hold from 100,000 to 300,000 brick each. The brick are delivered by truck.

Ottawa Brick and Terra Cotta Company (59), Billings Bridge, Ottawa

The products are red soft-mud brick, red wire-cut shale and clay brick, red drain tile, 3 to 8 inches in size, and red hollow building-tile. Normal production is about 1,000,000 soft-mud brick, 5,000,000 wire-cut brick, and 200,000 drain tile and hollow block. A large stock was on the yard at the time it was visited. The season is eight months long, as the buildings will allow operation in cold weather. The plant was started in 1893 by Morris and Ballantyne and, after changing hands several times, was taken over by Merkley's, Limited, in 1912, who started making shale brick in 1920.

At present marl is being mixed with the red-burning clays to obtain a buff brick. The clay pit has a 50-foot face, consisting of 20 feet of strong plastic clay used in wire-cut brick and blended with shale for hollow block, 20 feet of mild clay used for soft-mud brick with sand added, and 10 feet of blue marine clay which contains lime shells in spots. Below this is 2 feet of gravel overlying shale. The amount of clay is sufficient for any demand for years to come. The shale is difficult to get to because of the overburden, and what is used in the plant is drawn about a mile and a half.

The plant is rather extensive, and a complete flow-sheet will not be given. The pit is worked on two levels with an incline to the plant. Suitable conveyers grind and store the shale, as well as blending it with clay. Two grinders of the ring type (American Ring Pulverizer Company, St. Louis) grind the shale. The larger, No. 30, gives 80 tons per day, requiring 75 horse-power; the smaller, No. 48, grinds 60 tons and uses a 50 h.p. electric motor. The shale is screened over an inclined 3-thirty-seconds-inch perforated plate. Mechanical handling obtains throughout, and there are separate departments for soft-mud, wire-cut, and hollow ware. For soft-mud brick a Hercules machine, bought in 1896, is used, requiring 28 horse-power. For wire-cut brick, rolls and an open-top pug mill deliver the clay to a combined pug-and-auger machine manufactured by the E. M. Freese and Company, Galion, Ohio. The automatic cutter is made by the same firm. This outfit requires 100 horse-power. A duplicate set of machines make the hollow block and tile. Dryer cars take the brick to a 30-track waste-heat tunnel-dryer with 130-foot tunnels. The hollow ware go by elevator on cars to a room over the tunnels. Canvas curtains close off sections of this room, giving a hot-room treatment, with extra heat being furnished by steam coils along the floor. The kilns consist of 2 rectangular down-draft kilns, 81 by 17 feet inside dimension, with a capacity of 200,000 brick each; 7 round down-draft kilns, 23 feet inside diameter, with a capacity of 80,000 brick each; and one scove kiln of the usual type. Pyrometer equipment is used to control the kiln temperatures, and a plate fan takes the place of stacks.

Dufferin County

There are no plants operating in this county at present. Glacial surface clay and Queenston shale are found.

In 1906 a plant at Orangeville was reported as making soft-mud brick, but this has been discontinued.

Durham County

PLANTS: One of group No. 4.
CLAY: Glacial surface clay.
PROCESS: Soft-mud brick are made.

In 1906, there were two plants, one at Port Hope and one at Bowmanville, both of which have discontinued operations.

Hircock Brothers (37), Bowmanville

The product is a fair-red soft-mud brick. The plant is six years old and produces 350,000 to 400,000 brick in a season of 5 months. The clay pit consists of 3 feet of red-burning clay overlying 10 feet of buff- or cream-burning clay, with gravel below. The clay is reasonably free from pebbles. The open-air dry racks have pivot roofs, and special type pallets are used, which may be racked 7 high without the usual rack frame to support them. A scove kiln is used for burning, using wood as fuel. A 25 h.p. motor furnishes power for the Martin soft-mud machine. The clay in the pit is dug over in the fall to allow softening and weathering, as the clay goes directly to the soft-mud machine without the use of rolls or open-top pug mill.

Elgin County

PLANTS: Six, all of group No. 4.
CLAY: Glacial and post-glacial clays.
PROCESS: The stiff-mud process is used in making tile and a few brick and hollow building-block.

In 1906, there were five plants listed. One has continued under a changed name. The rest of the present plants are new ones.

W. McCredie (174), Aylmer

The product is red drain tile, 3 to 16 inches in size. The plant is fifty-five years old and is probably the one owned by Wm. Light in 1906. The single round down-draft kiln, 22 feet inside diameter, having a capacity of 18,000 4-inch tile, is burned eighteen times a season. The red clay is 3 to 10 feet deep, with stony clay below. Cream-burning clay, 3 to 4 feet deep with gravel below, is found in another part of the field. The many years of working has about exhausted the clay on this property, but there is more on nearby farms. A hand-loaded dump cart brings the clay 600 feet to the plant. The machinery consists of a single-auger pug mill, rolls to take out stones, Baird auger machine, and hand cut-off. The dry shed is 55 by 120 feet. Coal is burned on inclined grates in the kiln, which has a stack 30 feet high and 3 feet square inside. Pyrometers are placed in the crown and stack flue to aid the burner.

Thos. Hitch (175), St. Thomas

This plant produces about 100,000 drain tile, 3 to 14 inches in size, 20,000 hollow building-block, and 100,000 end wire-cut brick in a season of six months. Both red and cream-burning clay is used. The selling prices for tile at the yard are given as a matter of record.

Size of tile	Price per 1,000	Size of tile	Price per 1,000
3-inch	$18	8-inch	$80
4-inch	25	10-inch	125
5-inch	40	12-inch	150
6-inch	50	14-inch	250
7-inch	70		

The price of brick is $16 for selected face brick and $15 for run of kiln.

The clay consists of 3 feet of red-burning clay overlying cream-burning clay that could be used down 25 feet. The log of a well indicates that the clay extends for at least 90 feet in depth. Normal summer-yard methods are used, including rolls to remove an occasional lime pebble that gives trouble. A 40 h.p. electric motor runs the Baird auger machine. The dry racks are under shed roofs, the brick being dried in hacks, set in position by a lift barrow. The burning is done in three round down-draft kilns, 22 feet inside diameter, having 4 stacks and 8 fire boxes with inclined grates.

A. Smith and Son (177), Dutton

This plant makes cream-coloured drain tile, 3 to 12 inches in size, and sells to local buyers within a radius of 20 to 25 miles. A few end wire-cut brick are made when there is a demand. Operation is not continuous, as the farm requires considerable attention. The average production per year is 4 to 5 kilns of 15,000 mixed tile each. The selling value of a kiln of ware is about $450. The plant is 40 years old but was not mentioned by Baker in his 1906 report. The clay pit is 15 feet deep with stony clay below. The clay is hand-loaded and hauled to the plant in dump carts, soaked in a pile at the machine, and shovelled directly into a Baird auger machine. A hand cut-off is used. A 30 h.p. steam engine gives the required power. The dry shed is 40 by 70 feet and has a tar-paper roof. The one kiln has 8 stacks and 8 fire boxes. The Boss system of forced draft is used and allows the burning of slack coal. A 6 h.p. fan furnishes the air through 12-inch drain-tile flues with a 3-inch opening at each fire box. The coal must be hauled 4½ miles from Dutton.

Mrs. J. H. Hodder and Sons (178), Dutton

Drain tile, 3½ to 12 inches in size, are made of mixed red- and cream-burning clay. A few stiff-mud brick are made for their own use. L. H. Hodder, a son, now runs the plant and is building a new 22-foot kiln to increase the plant capacity. There is an increasing demand for tile in this section. Last year about 150,000 tile were made in a season of six months. The pit consists of 3 feet of red-burning clay overlying 5 feet of cream-burning clay with gravel below. The clay is practically free from stones. A plow and scraper carry the clay to a bridge loader, from which a car takes it up an incline to the machinery. This consists of a single-auger open-top pug mill, Baird auger machine, and Bechtel cut-off. A 30 h.p. steam engine gives the power. The tile are wheeled to dry racks, and the brick are dried in hacks placed in the drying sheds by lift barrows. A hack contains 90 brick. Two dry sheds 124 by 28 feet and 11 by 80 feet are sufficient to dry ware for an 18-foot kiln. A third shed, 40 by 80 feet, is to be added to take care of a second kiln that is being built. The present kiln is 18 feet in diameter, has 6 stacks, and can be burned off in 48 hours.

Neil F. Campbell and Sons (180), West Lorne

This plant makes brick and tile 4 to 14 inches in size, mixing red-burning with cream-burning clay. The mix is said to give a better tile than by using either clay alone. Five kilns are burned in a season of six months. Each kiln contains about 40,000 tile and 8,000 brick. The plant is thirty to forty years old but was not mentioned in the 1906 report. The present owner purchased it eighteen years ago. The pit is 15 feet deep. After plowing, a scraper pulls the clay to the bottom of the pit where water is added and it is allowed to soak. The wet clay is loaded to cars by hand, and some sand is added to each car. The machinery consists of a single-auger pug mill, Baird auger machine, and a Fate automatic cut-off. A 40 h.p. gasoline engine furnishes power. The dry sheds are in very good

condition and have cement floors. The tile are piled 6 high to dry, while the brick are in hacks and set in position by a lift barrow. The two dry sheds are 40 by 130 feet each. They have swinging side doors to let in air or keep out rain. A photograph of one of the dry sheds is shown on page 75. Another shed, 40 by 40 feet in size, is for brick hacks. The round down-draft kiln is 28 feet inside diameter, with 12 horizontal grate fire boxes burning coal. The main stack flue is 28 by 28 inches; the stack is the same in diameter and is 50 feet high. A pyrometer is used in the crown.

J. C. Telford (199), Southwold Station

This plant makes cream-burning tile, 3½ to 12 inches in size, for local demand, and a farm is operated at the same time. The normal production is 9 kilns per season of six months, with about 15,000 mixed-size tile to each kiln. The plant is over 50 years old and is one of the oldest in the section. It was built by Sam Ham and has changed hands several times, but has been owned by the Telfords for about thirty-five years. It is not on the 1906 list of plants. Before 1915, cream brick were burned in scove kilns and were sold in large numbers in St. Thomas, but now tile only is demanded and a new kiln is being built to take care of this business. The pit has a face of 15 feet of cream-burning clay, which is said to go down at least 40 feet. High water from the creek near by prevents working that deep. The clay is dug by hand and hauled to the plant in dump carts. A combination machine, consisting of a vertical pug mill and horizontal auger machine, made by H. Brewer and Company, Tecumseh, Mich., has been used for thirty years with few repairs. The dry shed is 30 by 100 feet in size, with two deck racks for drying tile. There are also three dry racks, 100 feet long. There are two kilns (one being built), 22 feet inside diameter, having a capacity of 15,000 to 18,000 tile depending upon size. Coal is burned on inclined grates. The stack is about 3 feet square inside and 40 feet high.

Essex County

PLANTS: Eleven—one of group No. 1, six of group No. 2, two of group No. 3, and two of group No. 4.
CLAY: Glacial and post-glacial clay.
PROCESS: Stiff-mud brick, drain tile, and hollow building-block are made.

In 1906, only six plants were listed. Three of these have ceased operation, and new plants bring the present total to eleven. An increased demand for drain tile for the farms and increased building activity in the Windsor area, requiring hollow building-block, are responsible for the growth of the industry in this section.

Windsor Brick and Tile Company (131), near Kingsville

This plant makes about 100,000 red end wire-cut brick, 300,000 hollow building-block, and 400,000 drain tile in a season of eight months. The clay burns red. The plant, which is fourteen years old, was built by Mr. Weigle and was sold to the present owners twelve years ago. The top three feet of red-burning clay is used. The clay below burns cream but contains limestone pebbles, and it is not used. Water is added at the pit before hand-loading to cars of one-yard capacity. The machinery consists of an open-top pug mill, conical rolls to remove stones, an H. Brewer and Company (Tecumseh, Mich.) auger machine, and a J. D. Fate automatic cut-off. A 75 h.p. steam engine furnishes power. There is a 10-tunnel dryer, which is not in operation. Natural drying sheds above and beside the tunnel dryer are used. One two-storey shed is 100 by 35 feet in size and is used for tile. Another shed is used for hacked brick. Of the four kilns, only two were in repair at the time it was visited. These are 29 feet inside diameter

and use 12 fire boxes and inclined grates. A lean-to shed around the kiln keeps out the wind and allows better burning in bad weather. One stack is 60 feet high and the other 30 feet.

Benjamin Broadwell and Son (132), near Kingsville

This plant uses red-burning clay to produce end wire-cut brick, smooth and rugged, clear and flashed colours; drain tile, 3 to 12 inches in size; and hollow building-block. The production is from one kiln, which is burned eleven times a year. The kiln capacity is 100,000 brick or 30,000 tile of mixed sizes. Business is good in this section, and another kiln is planned for this summer. The plant, which is sixty-two years old, was built by Miner and Broadwell and is the oldest in Essex county. It is not mentioned in Baker's list of 1906. The son, B. E. Broadwell, is now the active manager. The plant is neat and well built, as can be seen from the photograph below. Mr. Broadwell, senior, is seen in the foreground.



Dry sheds and kiln, Benjamin Broadwell and Son, Kingsville.

The clay used is only 22 inches deep, but although 25 acres have been worked over there is plenty left on the farm. The clay lower down contains pebbles, which cause trouble. Hand-dug clay comes to the plant in 1-yard cars drawn by horse. The machinery consists of an open-top pug mill, roll crusher to take out stone, Baird auger machine, which has been used for forty years, and hand cut-off. The Baird auger machine is said to be too light for heavy production, and a heavier machine is being considered. The two dryer sheds are 30 by 160 feet and are used for natural drying except one section, 15 by 160 feet, which can be heated with air drawn through steam coils by a Sheldon fan using power from a 20 h.p. steam engine. The kiln is 32 feet inside diameter. The stack is 4 feet square inside and 53 feet high.

Manly F. Miner (133), Kingsville

This plant makes red drain tile, 4 to 12 inches in size. The plant is now operated by Manly F. Miner, but was started forty-two years ago by his father, J. T. Miner, when he came to Canada from Ohio. The grandfather, John Miner, made the first tile manufactured in Cayhauga county, Ohio, and it was at his father's plant that J. T. Miner obtained his experience. This plant is not on the 1906 list. The production is about 14 kilns a year of 30,000 tile each. The equipment is so arranged that four men, with supervision by Manly Miner, do all the work.

In the clay pit, 6 inches of sod is rejected and 22 inches of red-burning clay is hand-loaded to dump carts for the 500-foot haul to the plant. The

clay below is stony and cannot be used. The clay is dumped into a bin for soaking. There are two bins, one on each side of a conveyer feed to the auger machine. These are used alternately, so that all the clay soaks three days before being used. The conveyer carries the clay to the Baird auger machine on the second floor. A hand cut-off is used. A 30 h.p. steam engine furnishes power. The dry sheds are two storey, well built of brick or wood with shingle roofs, and heated when desired by exhaust steam from the engine or live steam from the boiler. One is 300 by 24 feet, and the other is 120 by 80 feet. The tile are burned in a 32-foot round down-draft kiln, having a capacity of 33,000 4-inch tile. Coal is burned on inclined grates. The kiln is lined with fire brick throughout instead of common brick. There are 11 bands to hold the kiln together. The main stack flue is 3 by 3 feet, and the stack is 6 feet square inside and 50 feet high.

Aaron Hill (134), Essex

This plant produces tile, from 4 to 20 inches in size, from red-burning clay, and a few brick as required. The brick are side-cut rug texture and are very good looking for a clay rug brick. Burning is clear-red only. For some reason, very little flashing is done in this section, and it would seem that if it were properly done this rug brick should compete in the Windsor area with the shale rug brick from Toronto. The production is about 1,500,000 tile per year, which is the entire twelve months except for a short shut-down for repairs. All of the plant is under cover with good buildings for winter operation. The plant is twenty-five years old and was started under the name of Hill Brothers. The other brother, Albert W. Hill, now owns a plant at Stevenson, Kent county.

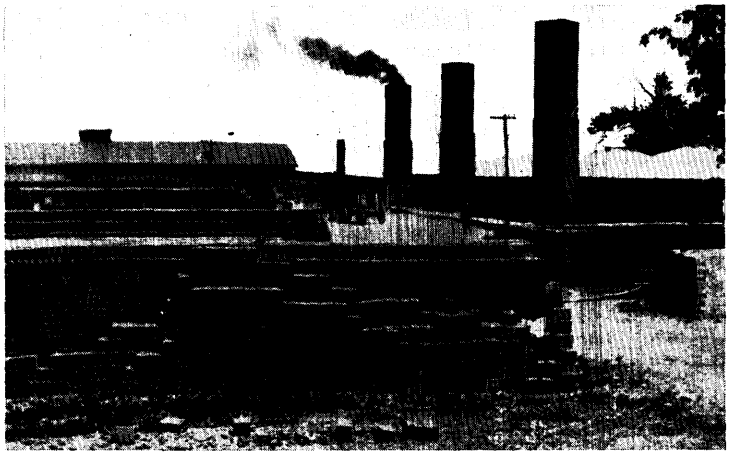
The pit consists of 4 feet of red-burning clay with stony clay below. Mr. Hill is experimenting on a means of separating the stone in order to use this lower clay. He has his own machine shop and does most of the machine work himself. A tank car carries water to the pit to soak the clay before it is loaded to cars. The cars are hauled to the plant by a gasoline locomotive made by Mr. Hill. A continental truck motor is used for power. An automatic elevator and dump carries the car to the third floor, and the clay goes directly to a double-shaft open-top pug mill, also made in his machine shop. The specially designed rolls (see photograph on page 56) take out the pebbles, which are quite common in the clays of this section. The tile are made in a combination pug-and-auger machine, manufactured by the Bonnot Company, Canton, Ohio, having a capacity of 150,000 brick per day. The cut-off is an automatic Fate machine. A 90 h.p. electric motor is used. A smaller Fate auger machine is used to make the small-size tile, up to 6 inches. The tile are set on cars that go to a 12-track tunnel dryer, which may be heated, or to a 4-track slat-floor dryer used in the summer. All the tracks are 100 feet long and have a drop of 24 inches in this distance, as the cars do not have ball-bearings. Waste heat from the kilns is used in the 12 tunnels, and 1,000 4-inch tile or 1,500 brick are dried per 24 hours per tunnel. There is enough waste heat in summer, but in cold weather it is helped by direct fire, carrying the combustion gases 40 feet down each tunnel below the floor in hot-air ducts, which are 8-inch steel gas-pipes. A fan is used to create air circulation and is driven by a 10 h.p. electric motor. There are 4 round down-draft kilns, 25½ feet inside diameter. Waste heat is taken off from the main flue between the kiln and the stack. Coal is burned on inclined grates. The main flue is 3 feet square. There are two kilns to a stack, which are 5 feet square inside and 40 feet high. Firing is done every 15 minutes to give a uniform fuel consumption without smoke. Attention is given to the proper coking of the coal at the mouth of the fire box before it is pushed back. Shed roofs around the kilns, leaving only the crowns exposed, give protection in cold and windy weather. Pyrometers are used in the kiln crowns.

Essex Brick and Tile Company (135), Essex

This plant was not in operation at the time it was visited, but it was expected to start soon. In 1928, the production was 17 kilns in a season of about four months. There is nothing unusual about the plant. The clay is 24 inches deep and is red-burning. It is brought to the plant by car up an incline. The machinery includes an open-top pug mill, rolls, Baird auger machine, Fate cut-off, and steam power. There is a 12-tunnel waste-heat dryer with steam lines to give extra heat, but this equipment is in poor condition. The burning is done in two round down-draft kilns connected to a 40-foot stack. The buildings have a tar-paper roof and are in fair condition. Judging from the culls on the yard, the products are side-cut brick, hollow building-tile, and drain tile.

Belle River Brick and Tile Company (137), Belle River

The plant[1] is owned by the Denison Tile Company, of Windsor. Harry H. Hallatt is manager and T. H. Armstrong, superintendent. It is one of three plants owned by this company, the other two being in Tilbury and



Stock yard and kilns, Belle River Brick and Tile Company, Belle River.

Fletcher. This is a group No. 1 plant, with its production divided about as follows: 25 per cent. brick, 50 per cent. hollow building-block, and 25 per cent. drain tile. The plant is operated twelve months a year, burning on an average 126 kilns and using about 30 tons of clay a day. The plant, which is six years old, was built by James Cooper and was bought by the Denison Tile Company three years ago. Their market is all over Ontario, much of their production being shipped.

The pit is 30 inches deep of red-burning clay with stony clay below. Water is added at the pit, and the clay is soaked before it is loaded to cars by gasoline-power shovel of three-eighths of a yard capacity. The cars are hauled about half a mile to the plant by a Ford engine converted into a locomotive. A 4-screw disintegrator or open-top pug, set below the floor level, takes the clay, which is then elevated by belt to a Baird auger machine and Fate cut-off. The ware is set in rather open fashion on dryer cars to give rapid drying. The machine capacity is about 22,000 side-cut brick per day. A 13-tunnel waste-heat dryer operates all year, and an 8-track slat-floor natural dryer gives added capacity in the summer. The space over the tunnels is used as a dry floor for hollow block and tile. Two

[1]Sold to Fred. Howlett and Sons in 1929.

5 h.p. fans at either end of the dryer control the circulation. The 6 round down-draft kilns are 27 feet inside diameter and have inclined grates. The main flue is 30 by 32 inches inside. The stacks, serving two kilns, are 4 feet square inside and 40 feet high. Pyrometers and cones are used to judge kiln temperatures, and the settle is measured as well. The kiln capacity is greater than required for the production, and a rapid turnover with open setting is used to give plenty of waste heat for drying. Brick are burned in 3½ days and tile in 2½ days. The faster burns are said to be cheaper in the long run as no soft ware is found in the bottoms. Experiments are being made with flashing and salt glazing for colour control. A very good rug brick is made from the clay, and the colour is an excellent red. The bag openings from the fire box into the kiln chamber were recently increased in size from 19 by 20 inches to 19 by 28 inches with much better burning behaviour. The photograph on page 117 shows the stock of building block in the foreground and the 6 kilns with three stacks at the right.

Sherman Clay Products, Limited (138), Ruscom

The production is about 400,000 hollow building-block and 500,000 drain tile in a season of six months. The plant is ten years old and was bought six years ago by the present owner. They use 3 feet of red-burning clay, which overlies stony clay. The clay is soaked in the pit, hauled by horse to the foot of an incline, which takes the clay to the machines. The equipment consists of an open-top pug mill, Baird auger machine, and Fate cut-off, all requiring a 50 h.p. electric motor. The ware is wheeled to the dry floors of a 3-storey building with a total dry-floor space of 37,000 square feet. Drying is natural with no extra heat. The building is of wood with tar-paper roof and has an elevator. Of the three round down-draft kilns, two are 29 feet inside diameter, and the other is 31 feet. The average kiln capacity is 24,000 4-inch tile, which sell at $20 per 1,000. Coal is burned on inclined grates. Lean-to sheds surround the kilns and give protection from wind. The stacks are 35 feet high and 6 feet square outside. There are two kilns to a stack. A pyrometer is used in the kiln crowns.

D. Voakes and Son (139), Ruscom

The product of this plant is red-burning drain tile, 4 to 12 inches in size. They make about 275,000 in a season of five months, with an average production of 2,000 to 5,000 a day. The plant, which is twenty-two years old, has changed hands four times in the last fifteen years and has often been idle. The present owner bought it in 1920. There is 3 feet of red-burning clay with stony clay below. It is gathered with a horse and scraper and hauled 150 feet to the plant. The equipment consists of a Baird auger machine, Fate automatic cut-off, five dry sheds, 20 by 90 feet, built of wood with corrugated iron roof, and two round down-draft kilns, 23 feet inside diameter. Coal is burned on inclined grates. The stack is 40 feet high. Pyrometers are used in the kiln crowns.

Staples Brick and Tile Company (140), Staples

This is another small plant making red drain tile, 4 to 10 inches in size. The normal production is 20 kilns of 16,000 4-inch tile, or 4-inch equivalent per kiln, in a season of 5½ months. The plant is nine years old. There is 2½ feet of red-burning clay with stony clay below. The clay is soaked and hand-loaded to cars, which are horse-drawn to an incline. The equipment consists of an open-top pug mill, a Baird auger machine, and a Fate automatic cut-off, using steam power. Dryer cars take the ware to a 15-track natural air dryer, 70 feet long. The tracks are 3 feet above the ground to allow circulation below. There is one round down-draft kiln, 26 feet inside

diameter, in which the tile are set when about half dry, or when they will stand the kiln load. The stack is only 20 feet high. Mr. Hillman, the owner, has started to build a waste-heat dryer.

Herbert Hallatt and Sons (141), Comber

The products are end-cut brick, side-cut rug brick, hollow building-block, and drain tile, 4 to 8 inches in size. The normal production is about 36 kilns a season of five months. The kiln capacity is about 27,000 brick or 6,000 tile of mixed sizes. The plant is thirty years old and was rebuilt five years ago. The Hallatt family is prominent among the clay manufacturers of this section. One son is at this plant, another owns a plant at Merlin, and the third son is manager of the Denison Tile Company, of Belle River, Tilbury, and Fletcher.

The clay is red-burning, 3 feet deep, with stony clay below. The clay is soaked in the pit, aided by covering with 18 inches of straw in the fall to hold the ground moisture and prevent deep freezing. A car carries the clay up an incline to a double-shaft open-top pug mill, a Baird auger machine, and the usual cut-off machines. Brick are hacked, 56 brick to a hack, and placed in the dry sheds with a lift barrow. One to two weeks are required to dry in normal weather. The dry shed is 60 by 100 feet; the ground floor is cement, and the second floor slats. Cross-flues under the cement floor are supplied with waste heat from the kilns, and this aids the drying. A 5 h.p. fan is used for circulation. The building is wood with composition roofing. The kilns are 26 feet inside diameter and have 8 fire boxes of the incline type. Eight radial flues run to the base of a centre stack, which is 36 inches inside diameter and extends about 10 feet above the top of the kiln crown. A sheet-iron damper is used on the top of the stack. The kilns are built in a sheet-iron shell instead of being banded.

Geo. M. Wright and Sons (142), Comber

The plant is now in charge of F. M. Wright, a son of Geo. M. Wright. The product is mostly drain tile with a few brick. Normal production is 1,000,000 tile per season of eight months. The plant is thirty-five years old and was bought by the present owner seventeen years ago. The clay is red-burning, 30 inches deep, with stony clay below. The clay near the plant has been used, and a long haul by horse of 1,600 feet is necessary. The land where the clay has been removed from 20 to 30 inches deep is not reclaimed and used for farming; it is low and wet and can hardly be drained.

The clay is soaked in the pit and hand-loaded to cars. The equipment consists of an open-top pug mill, a Baird auger machine, and a Fate cut-off. The ware is placed on dryer cars and taken to an 8-track waste-heat dryer, 80 feet long. There is a dryer floor above the tunnels that is used for larger tile, obtaining heat from the tunnels. A 7 h.p. electric motor and fan pulls the waste heat from the kilns or from a direct-fire grate to supply extra heat as needed. There are 2 round down-draft kilns, 26 feet inside diameter, with a capacity of 18,000 tile each of mixed sizes. The one stack is 38 feet high and 30 inches square inside.

Frontenac County

In 1906, there was a plant at Kingston, but none are now in operation. Both Baker and Keele state that clay suitable for brick-making is not extensive and would be glacial in character. Marine clay is not found.

Grenville County

In 1906, there were plants at Kemptville and Prescott. Later there was one at Merrickville, but this has not been operated for years. There

are no plants operating at the present time. The clay available is marine and glacial.

Grey County

PLANTS: Three—one of group No. 2 and two of group No. 4.
CLAY: The clay used is glacial and post-glacial. Queenston and Lorraine shales are under the surface deposits at Meaford, and Joseph Keele speaks of Lorraine shale being used several years ago, but neither shale is used at present.
PROCESS: Soft-mud brick and stiff-mud brick and drain tile are made.

In 1906, five plants were in operation. All but the one at Owen Sound have disappeared; but two others, not on the old list, are now operating.

Samuel Batchelor (247), Proton Station

This plant is operated along with a farm and produces red soft-mud brick and cream drain tile, 3 to 6 inches in size. The normal production in a season of five months is four kilns of 65,000 brick each and one kiln of 30,000 tile of mixed sizes. They sell to local trade only. The plant is thirty years old but not listed in 1906. The present owner bought it seven years ago.

The red-burning clay near the plant is exhausted and is hauled a quarter of a mile from a pit 3 feet deep. The cream-burning clay is at the plant and is 2 to 8 feet deep with sand below. The equipment consists of an Iron Quaker machine for making soft-mud brick and an open-top pug mill with a Baird auger machine for tile. There are 12 dry racks 120 feet long and a shed 24 by 100 feet for drying tile. A round down-draft kiln, 22 feet inside diameter with two stacks, burns the ware. Wood is used for fuel.

Owen Sound Brick Company (248), Owen Sound

This plant makes about 1,100,000 red soft-mud brick each season from May 25 to September 15. The average daily production is 16,000. The plant is from thirty-five to forty years old and was bought by the present owner in 1911. The clay is red-burning. The face worked is 5½ feet, and the deposit below is too sandy to be used. The clay is dug by hand and loaded on to a horse-drawn car for the 300-foot haul to the incline. The equipment consists of an open-top pug mill, a Martin soft-mud machine, which has been used for thirty years with normal repairs, and a 25 h.p. electric motor. The brick are taken by horse cart to the 16 dry racks, which are 200 feet long and hold 8,000 brick each. The burning is done in a scove kiln and two rectangular down-draft kilns, 18 by 48 feet inside, with a capacity of 140,000 brick each. One kiln has an outside stack 3 feet square inside dimension and 60 feet high. The other kiln has 14 small wall stacks and 2 larger outside stacks. The kiln crowns are said to last eleven or twelve years, and the side walls last much longer. Soft wood is the fuel.

R. Casemore and Son (249), Shallow Lake

This plant uses red-burning clay to manufacture drain tile, 3 to 8 inches in size, and end-cut brick, both smooth and rugged. The cream-burning clay here is said to be of poor quality and is not used. Normal production is 130,000 brick and 125,000 tile in a season of five months. The plant was started by R. J. Doyle thirty years ago, was bought by W. Smith in 1910, was idle fourteen years, and was taken over by R. Casemore and Son two years ago. They use 3 to 4 feet of surface clay which has sand below. A 60 h.p. steam engine gives power. The equipment includes a Ford dump truck to bring in the clay, soak pit, conveyer to open-top pug mill, Baird auger machine, and automatic cut-off. The ware is wheeled to dry racks under a shed roof. There is one 22-foot round down-draft kiln with a capa-

city of 70,000 brick or 33,000 3-inch tile. The kiln has 6 stacks and 6 horizontal grates built out from the kiln wall to take wood.

Haldimand County

This county has no plants at present, and Joseph Keele does not report any important clay deposits suitable for the manufacture of brick or tile. In 1906, there was a plant at Canfield using the Red top and Erie clays of Baker's classification.

Halton County

PLANTS: Three—two of group No. 1 and one of group No. 2.
CLAY: Queenston shale is used at these three plants; although Lorraine and Cabot Head shales are available, they are not used.
PROCESS: Dry-press and stiff-mud brick are made.

In 1906, two plants were listed at Milton. Terra cotta was made to some extent at the Milton Brick plant, but this has been discontinued.

Milton Brick Limited (101), Milton

This company has two plants at Milton and one at Streetsville, Peel county. F. R. McConnell is the superintendent.

Plant No. 1.—This plant produces side wire-cut and dry-press brick, red and buff, clear and flashed colours, with smooth, rug, bark, and other special textures. Normal production is about 60,000 brick a day during a 12-month year. The plant is forty years old and has never changed ownership. It has been an important producer of brick for the Toronto area for years. As both red and buff-burning Queenston shale occurs in the same face, a proper selection of material to control colour is a problem. The top 2 to 6 feet are stripped because of pebbles. A small amount of gypsum (calcium sulphate) found at certain levels makes necessary the use of barium carbonate in the brick to prevent scum. All the shale is plastic except the light-buff, which is short. The shale pit has a 40-foot face and may be divided roughly into 10 feet each of red-, buff-, red-, and light-buff-burning shale. One half-yard electric and 2 steam shovels of half-yard and seven-eighths-yard capacity work on three levels to win the shale. The half-yard electric shovel is considered to be better than the steam ones. Dump automobile trucks take the shale to both plants, as they are only a quarter of a mile apart. This allows the working of only one pit and better selection of shale for colour.

The equipment of plant No. 1 consists of 6 dry pans, perforated plate screens 33 inches by 12 feet long, 5 dry presses for dry-press brick, open-top pug mill, auger machine, and cut-off manufactured by E. M. Freese and Company, Galion, Ohio, for stiff-mud brick. An overhead trolley takes the dry-press brick directly to the kiln, and cars take the stiff-mud brick to a 20-track tunnel dryer. The tunnels are 100 feet long and will dry 3,000 brick per tunnel every twenty-four hours. The dryer is the radiation-flue type using coal. Cast-iron plates cover the top of the radiation flues. Natural draft is used. There are 15 rectangular down-draft kilns, 16 feet 4 inches between the bag walls and 60 feet long. The capacity is 180,000 brick. There are 10 fire boxes with horizontal grates on either side of the kiln. A centre flue is 36 by 36 inches and runs the full length of the kiln to a stack at each end. The floor on either side of this flue is solid, and a division wall is placed in the flue at the centre. The grate bars are on a level with the kiln floor, and this aids in getting the bottom hot. There are two stacks for two kilns. The stacks have two compartments, 2 by 4 feet and 35 feet high. Pyrometers are used in the centre of each crown.

Plant No. 2.—Three dry pans supply screened shale for 3 Berg and 1 Boyd dry press. The two presses used produce 19,000 brick each a day. The brick go directly to 8 kilns of the same type and size as those described at plant No. 1. This plant is forty-two years old and was bought by the present owners fifteen years ago.

The Queenston shale face directly behind this plant has 12 different layers, giving different colours, in a depth of 80 feet, and it is almost impossible to sort for colour control. It is not used at present. At plant No. 1, there are 8 different layers, 5 of which are used.

Toronto Brick Company (102), Milton

This company owns the Don Valley Brick plant and the John Price plant of Toronto and is interested in plants producing sand-lime brick and cinder building-block. W. M. Paterson is superintendent. The product at the Milton plant is dry-press brick, red, buff, and flashed. The normal production is 20,000 a day, during a season of 8 or 9 months. The plant was built in 1911 by the Brandon Brick Company and was bought by the Toronto Brick Company in 1919.

Most of the 35-foot face burns red, but there are 5 seams, 5 to 12 feet thick, which range in shade from light-red, reddish-buff, light-buff, light-red, and dark-red, in order from bottom to top. Blasting is done in the shale pit with 40 per cent. dynamite, using an air jack hammer to drill the holes. The clay is hand-loaded from 5 benches to dump carts, which take the shale to the plant. The grinding is done in 3 dry pans where the required amount of water is added. After being screened over five-sixteenths-inch perforated plate screens, 5 by 14 feet, the shale goes to 4 Berg dry presses (Berg Machine Manufacturing Company, Toronto). The pressed brick are wheeled to 7 rectangular down-draft kilns, 16 feet 6 inches between the bag walls and 63 feet long. The kilns have a capacity of about 180,000 brick each. The main flue goes down through the centre with a stack at each end. The balance of the floor is solid. Steam is introduced at each fire box to aid combustion and this practice is considered to be worth while. A quarter-inch pipe drawn down to a small opening supplies steam under an iron plate at each fire box. A 25 h.p. boiler gives enough steam for one kiln while on fire. The grates are on the same level as the kiln floor. The stacks are 32 inches square inside and 60 feet high. There are two pyrometers in the crown of each kiln.

Interprovincial Brick Company (103), Milton

This plant is owned by the Cooksville Company, which also controls plants at Cooksville, Cheltenham, and Port Credit. James Beehoo is superintendent. The production is about 30,000 wire-cut brick a day. The brick are red, buff, and flashed. Operations are carried on the year round. The plant was built in 1913 and was known under several names before being purchased by the present owners two years ago.

The Queenston shale is stripped of a few feet of top clay, which contains pebbles, and is loaded by steam shovel to cars which take the raw material up an incline to the plant. The machinery consists of dry pan, combination Freese pug mill and auger machine, and cut-off. Cars take the stiff-mud brick to a 10-track tunnel-dryer, 110 feet long. Each tunnel will dry 2,800 brick per day. There are 4 rectangular down-draft kilns, 30 by 60 feet outside, each having a capacity of 160,000 to 180,000 brick. The burning schedule of these kilns is $3\frac{1}{2}$ days to load, 7 days to burn and cool, and $3\frac{1}{2}$ days to discharge. It is stated that careful firing with a minimum of smoke improves the colour. At some of the plants using Queenston shale the buff colour is improved by the addition of about 10 per cent. pulverized lime.

Hastings County

PLANTS: Two—one of group No. 3 and one of group No. 4.
CLAY: Glacial and post-glacial clays.
PROCESS: Brick are made by the soft-mud process.

In 1906, four plants were operating, two of which, at Stirling and Madoc, have disappeared. The other two are still operating, but under different names.

Bay of Quinte Brick Works (46), Belleville

The production is about 600,000 red soft-mud brick in a season of five months. Brick have been made at this location for sixty-five to seventy years. The older plant was owned by Mr. Foster, and then by M. Lingham till 1920. D. W. Rollins, who now operates it, leased it in 1920. The brick are used for small jobs, mostly as inside brick. A large job like the new High School in Belleville would take the normal production of the plant for several years, and of necessity the brick are shipped in from Toronto or Montreal. The pit is worked 2 to 3 feet deep. The clay is hauled to the plant in wagons and soaked in a pile near the Martin soft-mud machine that forms the brick. A team of horses furnishes power and the writer believes that this county has the last plants to operate a machine in this way. A good day's production is 10,000 brick. There are 14 pivot-roof dry racks, each 165 feet long, under which the brick are hacked 10 high to dry. The burning is done in scove kilns using wood as fuel. Mr. Rollins states that teams are cheaper than motor trucks for brick delivery up to 12 miles from the plant. For longer distances the truck is cheaper.

Tweed Brick and Tile Works (48), Tweed

The plant is leased by the J. T. Houston Company, a contractor and builders' supply company, of Tweed and Belleville. The brick are largely used in their business. The production is about 300,000 soft-mud brick in a season of 4½ months. A fair production for a day is 7,000 brick. The plant is more than 35 years old, and the present owners leased it in 1920. The deposit consists of 3 to 4 feet of red-burning clay with sand below. Dump carts bring the clay to a Martin soft-mud machine, using horse-power. The usual dry racks and scove kiln are used to finish the process. The wood fuel costs about $3 a cord and is cut in winter by the men who make brick in summer. There is an old tile kiln but it has not been used for years.

Huron County

PLANTS: Five—one of group No. 3 and four of group No. 4.
CLAY: Glacial and post-glacial clays.
PROCESS: Stiff-mud drain tile and a few brick are made.

In 1906, there were thirteen plants, one of which manufactured hollow building-block. All of these older plants have discontinued operations, except three at Crediton. Local demand does not seem to require more plants.

Wellington R. Haist (210), Crediton

The product is cream-coloured drain tile, 3 to 12 inches in size. The normal production is 8 to 10 kilns a season of 17,000 3-inch or equivalent, each. Mr. Haist expects to built a third kiln this year to increase capacity. The kilns are burned about once a month in the season of five months. The plant is seventy years old and has been in the family for forty-five years. Wood is cut in the winter for fuel.

The pit, which is worked about 8 feet deep, consists of 3 feet of red-burning top clay and 5 feet of sandy cream-burning clay below. A blend

gives a satisfactory body for drain tile. It is piled under cover near the machine, soaked, and shovelled into a Baird auger. A hand cut-off is used. Power is furnished by a steam engine. There are three dry sheds, 18 by 120 feet, with wide shelves at the sides to take the tile. Two round down-draft kilns burn wood as fuel. One is 20 feet inside diameter and has 8 fire boxes and 4 stacks built in the wall. The other is 19½ feet inside diameter and has the 4 stacks built separate from the kiln to prevent them being pushed over by the kiln expansion. There are only 3 bands on these kilns, and they are not holding together very well.

Aaron Wein (211), Crediton

The production consists of about 150,000 tile, 3 to 12 inches in size, and 50,000 brick, using cream-burning clay. The season is five months long. The plant is rather old and was owned by George Mantel and Joe Haist before being purchased by Aaron Wein seven years ago. The 8-foot face is blasted to loosen the clay. The face consists of 3 feet of medium-red-burning clay, 1 foot of sand, 2 feet of sandy grey clay, and 2 feet of blue clay. The blue clay goes lower, but poor drainage prevents its use. The clays are blended as they are hand loaded to dump carts. The mix is soaked in a pile near the machine, then conveyed to an open-top pug mill, Baird auger machine, and hand cut-off. A steam tractor furnishes power. Cars take the ware to dry racks in three sheds, 22 by 100 feet each. One kiln burns wood and is a 22-foot round down-draft kiln with a capacity of 19,000 3-inch tile. The 4 stacks in the wall are 12 by 12 inches inside. The kiln has 7 bands. The other kiln is 20 feet inside diameter with a capacity of 18,000 3-inch tile and burns coal on inclined grates. Wood is rather hard to get. Mr. Wein says the kiln crowns last 20 to 25 years.

Frederick Kerr (212), Crediton

The normal production is 300,000 cream-coloured drain tile, 3 to 12 inches, and 100,000 cream-coloured brick each season of five months. Mr. Kerr does not think it would pay to run the plant all year because of the additional cost of buildings and equipment. He runs a farm and a saw-mill as well as the tile plant. The plant is fifty years old. At first slop brick were made by hand; about 1897 an auger machine was installed. The clay pit consists of 3 feet of red-burning clay, 6 feet of sandy yellow clay with sand layers, and 3 feet of blue clay at the bottom. Below this depth the blue clay is stony. The mixture burns to a cream colour. The clay is dug by hand and hauled by dump cart to the plant, where it is soaked in a pile at the machine. The equipment includes rolls to remove stones, combination pug mill and auger machine made by the Fate Company, and a hand cut-off. The Fate auger machine has been in service for fifteen years without repairs and has a larger capacity than the Baird auger. The plant makes 16-inch tile without difficulty.

The power plant consists of a 42 h.p. Diesel engine, which uses fuel oil at a cost of $1.50 per day. It requires no attention after being started. It is said to be cheaper than electric or steam power. L. E. Shaw, Limited, of Chipman, N.B., have installed a 60 h.p. and a 120 h.p. Fairbanks-Morse Diesel engine in their new plant because of the low power-cost. There are three dry sheds, 20 by 110 feet each, and 2 kilns, which are under a good shed roof of corrugated iron to protect them from the weather. The kiln walls are 12 inches thick and are said to last 15 years or more; 24-inch walls were tried but were discontinued. The thin wall allows the kiln to be fired once every eight days. Five bands hold the walls in position. The crowns are grouted with cement. Coal is burned in one kiln and wood in the other.

Wm. M. Sproat (215), Seaforth

This plant manufactures cream-coloured drain tile, 3½ to 12 inches, and cement tile, 10 to 16 inches in size. The production is about 500,000 mixed sizes in a season of six months. Business is increasing and Mr. Sproat expects to build another kiln this year. The prices for 1929 were as follows:—

Clay tile		Cement tile	
Size	Price per 1,000	Size	Price per 1,000
3¼-inch	$18	10-inch	$100
4-inch	28	12-inch	150
5-inch	40	14-inch	200
6-inch	55	16-inch	300
7-inch	70		
8-inch	85		
10-inch	135		
12-inch	170		

Mr. Sproat runs a farm as well as the plant and does not feel that he could run the plant all winter to advantage. The plant is 60 years old and



Wm. M. Sproat homestead, 60 years old, Seaforth.

was started to furnish brick for his father's house, which is shown in the photograph above. The brick, which are hand-made, are just as good as when made. Mr. and Mrs. Sproat are seen in the foreground of the picture.

The pit consists of 2 feet of red-burning clay overlying 3 feet of grey clay, which burns to a cream colour when blended. A Ford truck hauls the clay 1,000 feet to the plant, where it goes to an open-top pug mill, a Baird auger machine, and a Fate automatic cut-off. Power is supplied by a 35 h.p. gasoline engine, which costs about $5 per day to run. There are 6 dry sheds, 10 by 120 feet each, and 2 round down-draft kilns, 22 feet inside diameter, having 4 stacks each. Coal is burned on inclined grates.

Ralph Thompson (222), Henfryn

The products are red drain tile, 3 to 12 inches in size, and a few end wire-cut brick. The production is 14 kilns of 18,000 tile of mixed sizes each season of five months. The plant is thirty-five to forty years old and was bought by Mr. Thompson seven years ago. The clay pit is 5 feet deep, consisting of 3 feet of strong red-burning clay and 2 feet of cream-burning clay below. The clay extends deeper, but water prevents its use. The usual Baird auger makes the tile. There are three dry sheds, 24 by 150 feet in size, and the tile are set 2 or 3 high on slat floors. The 2 round down-draft kilns are 22 feet inside diameter and have 8 fire boxes with inclined grates to burn coal. There are 3 bands to a kiln, but they do not hold well. The walls are 12 inches thick above the fire boxes. One stack, 3 feet square inside and 45 feet high, serves both kilns.

Kent County

PLANTS: Sixteen—one of group No. 1, six of group No. 2, one of group No. 3, and eight of group No. 4.
CLAY: Glacial and post-glacial clays are used, most of which are red-burning. Huron shale outcrops near Croton but is not used.
PROCESS: One plant makes soft-mud brick. The others make stiff-mud brick, drain tile, and hollow building-block.

In 1906, six plants were listed, three of which made hollow building-block. All but one of these are still in operation. There has been a decided increase in business. The photograph opposite is a view of St. Andrews church, built in 1869, at Williams and Wellington Streets, Chatham, and shows the type of older building seen in this section. The brick are red soft-mud and are still in very good condition.

Denison Tile Company (143), Tilbury

The products are side wire-cut brick, smooth and rug, end wire-cut hollow brick, hollow building-block, and drain tile, 3 to 12 inches in size. The capacity is about 40 tons per day, operating 12 months in the year. The plant was rebuilt in 1914 after a fire and is fairly modern.[1] Harry H. Hallatt is manager, and R. L. Ash is superintendent.

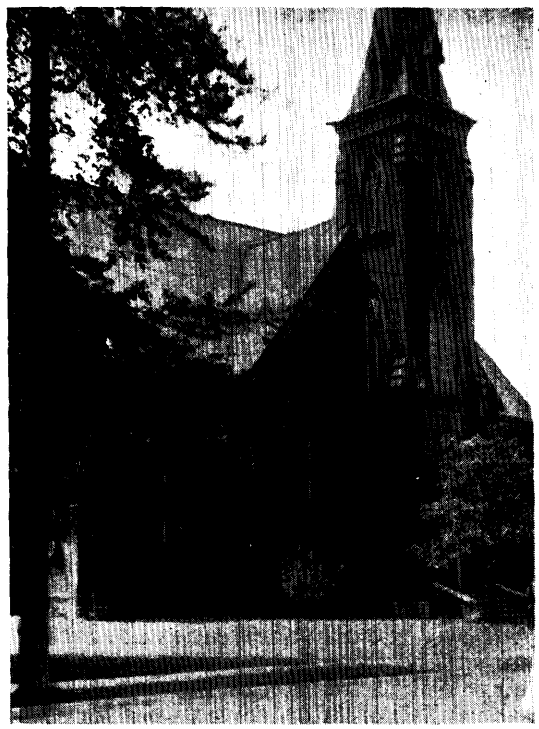
The deposit consists of 3 feet of red-burning clay overlying a stony clay, which extends down about 40 feet, becoming more calcareous at depth. A gasoline-engine power shovel loads the clay to 1-yard cars, which are hauled 1,000 feet to the plant by a converted Ford locomotive. The clay enters the plant on the level, is dumped into a 4-auger disintegrator, and is conveyed by belt to a Brewer rolls and a combination pug mill and auger machine manufactured by the J. D. Fate Company, of Plymouth, Ohio. A rotary rugger gives the desired texture. The ware is placed on cars and sent through an 18-tunnel dryer, which has a dry floor above for large-size tile. The dryer is 90 feet long and is built with brick walls and cement roof. Waste heat is brought from the kilns, through a 4- by 5-foot flue, by a 7½ h.p. motor fan made by the Sheldon Company, Galt, Ont. A 6 h.p. fan is used at the exit. Extra heat for the dryer is provided by the radiation surface of 2 ordinary house-furnaces set in a single brick housing. No combustion gases go into the dryer. A pyrometer in the waste-heat intake shows 150° to 250° F. There are 6 round down-draft kilns, 24½ feet inside diameter, having a capacity of 75 tons of hollow ware each. These kilns are encased in a 3-sixteenths inch steel-riveted shell over quarter-inch asbestos sheeting. Six-inch bands, three-eighths of an inch thick at the top and bottom, aid the shell in holding the walls in place. The main flue is 3 by 3½ feet, and the waste heat is taken from the stack flue. This does not cool off the ware so fast locally as when the heat is taken off from between

[1]Sold to Fred Howlett and Sons in 1929.

the bag walls. The buildings are of steel-beam construction, and the metal is painted every two years to prevent rust. The machine shop for the three plants owned by the company is located here. Both pyrometers and cones are used to judge kiln temperatures.

Albert W. Hill (144), Stevenson

The production is about 2,000,000 tile, 4 to 16 inches in size, a year, operating 12 months. Mr. Hill built the plant sixteen years ago. The structure is of brick with steel beams and posts and composition roof. A large elevated tank gives fire protection. The kiln shed is of brick with



St. Andrews Church, Chatham, built of red stock (soft-mud) brick.

corrugated iron roof, leaving the kiln crowns, which are cement-grouted, exposed. A photograph of this kiln is shown on page 89. There is 12 feet of clear space around the kilns. Natural gas from wells on the property is used as fuel. Mr. Hill states that when gas costs more than 25 cents per cubic foot, it is cheaper to burn coal. He could not afford to buy gas at 55 cents, the present price. The gas is also used in a gas engine for power. The plant is very neat and well built for all-year production.

The pit consists of 3½ feet of red-burning clay with stony clay below. A Bay City power-shovel loads the clay to 1-yard cars, which are horse-drawn to the plant. The machinery consists of a 4-shaft disintegrator, rolls, Brewer combination auger and pug mill, and hand cut-off. Large tile are dried on top of a 12-track waste-heat tunnel dryer, 100 feet long. The track drops 2 feet in every 100 feet, as the cars do not have roller bearings. Six cars are taken from each tunnel daily. The main waste-heat flue is 3 feet square, and the cross-head flue of the dryer is 4 feet square. Waste heat is taken from the stack flue and to prevent leakage, double

dampers, six inches apart with an air space in between, are used. There are 5 round down-draft kilns, 26 feet inside diameter, having a capacity of 24,000 4-inch tile each. The stacks are 60 feet high. Almost all the tile are shipped by rail, and a siding runs along the kiln shed. Pyrometers are used in the kilns.

B. Jasperson Brick and Tile Company (145), Coatsworth

The production is about 50 per cent. drain tile, 25 per cent. hollow building-tile, and 25 per cent. brick, all made by the stiff-mud process. The normal production is 33 kilns of 21,000 4-inch tile, or equivalent, in a season of eight months. The plant is eighteen years old, but was largely rebuilt eleven years ago after a fire. The deposit consists of 3 feet of red-burning clay with stony clay below. The clay is hand-loaded to a horse-drawn car. The equipment consists of an open-top pug mill, conical rolls with stone picker, belt conveyer, Brewer Company auger machine, and 90 h.p. natural-gas engine for power. Dryer cars are set 3 tile high and go to a 12-track dryer. The track has a 15-inch drop in 100 feet. The space over the dryer tunnels, 55 by 100 feet, is used as a floor dryer for large ware. There is also a summer dry-shed, 16 by 160 feet. A 12 h.p. fan pulls waste heat from the cooling kilns. There are 5 round down-draft kilns, 28 feet inside diameter. Coal is burned on inclined grates. The stacks are 4 feet square inside and 55 feet high, with 2 kilns to one stack. The buildings are brick with tar-paper roof.

Wm. Hallatt Clay Products, Limited (146), Merlin

Wm. Graham is superintendent of this plant. Red drain tile, 4 to 15 inches in size, makes up about 95 per cent. of the production, the other 5 per cent. being hollow building-block and brick. Mr. Hallatt also contracts to lay tile and has three ditching machines going all summer. The plant runs all year with a steady production of 10,000 4-inch tile, or equivalent, a day, giving 3 kilns per week. This schedule is rigidly adhered to, and the programme is known six months in advance. The plant is sixteen years old, and because of increased business a new plant is being planned.

The clay pit is 2,500 feet away, as the clay near by is exhausted. Six inches of straw is put over the clay one year in advance of working, to prevent drying in summer and freezing in winter. The clay, which is 2 feet deep, is hand-loaded to cars and drawn by horse to the plant. The machinery consists of a 4-shaft disintegrator, conical rolls for stone, Fate Company combination pug mill and auger machine, Fate automatic cut-off, and 50 h.p. electric motor for power. Cars take the ware to a 12-track waste-heat tunnel dryer, equipped with a 5 h.p. fan. Extra heat is furnished by a direct-fire grate, with the products of combustion going into the dryer. A slight scum is seen on the tile. The 4 round down-draft kilns are 26 feet inside diameter and have a capacity of 20,000 4-inch tile each. The main stack flue is 3 feet square; the stack is the same in cross-section and 35 feet high. A portable rotary pump with a 5 h.p. gas engine is used to pump the flues dry after heavy rains. There are two kilns to one stack. One kiln has a sheet-iron shell instead of bands and is well liked. Pyrometers are used in the kiln crowns. Most of the tile are delivered by truck.

Wm. Gardiner (147), Blenheim

This plant makes about 400,000 drain tile, 3 to 12 inches in size, in a season of six months. The plant was started in 1890 and there has been no change in ownership. The deposit consists of 2 feet of red-burning clay with stony clay below. The clay is hand-loaded to cars and soaked in a pile at the machine. The equipment consists of open-top pug mill, rolls, Baird auger

machine, hand cut-off, and 50 h.p. electric motor. There is a 13-track open-air dryer and a 2-storey dry shed, 30 by 100 feet, for tile. There is also a dry floor, 25 by 100 feet, over the track dryer. It takes from one to three weeks to dry the tile. Two round down-draft kilns, 18 and 30 feet in diameter, burn the ware. Coal is used as fuel.

Jas. Cornhill and Sons, Limited, Chatham

Plant No. 1 (148).—This plant makes from four to five million red soft-mud brick in a season of six months. The father of the present owner started the plant in 1865, making brick by hand. The local clay is about exhausted, and they expect to change over to the stiff-mud process soon; a new plant is just being completed. The clay used is sandy and suited to the soft-mud process. Hand-loaded cars take the clay to an open-top pug mill, rolls, and an Auto-Brick machine, which makes 33,000 brick per day. A wire-rope conveyer takes the brick on pallets to a steam rack-dryer, which is 14 shelves high and 200 feet long, with racks on either side of the conveyer. The racks hold one day's production and are filled and dried each 24 hours. Cars take the brick to permanent wall scove kilns, which burn gas. Coal is used in the boilers that furnish steam for the dryer and for power.

Plant No. 2 (151).—This is a new plant which will produce red stiff-mud brick and drain tile. The auger machine is manufactured by the Fate-Root-Heath Company, of Plymouth, Ohio. It requires 90 horse-power and is of large capacity. There is a 10-track waste-heat tunnel dryer, 100 feet long. A 25 h.p. variable speed motor and Keith fan will control the circulation and allow the addition of more tunnels. The waste-heat flue is 4½ feet square. There are four 25-foot round down-draft kilns, and it is planned to burn gas at 55 cents a cubic foot as an experiment, in which the gas company is co-operating.

Denison Tile Company (150), Fletcher

This is one of the three plants owned by the company. The products are drain tile, 3 to 12 inches in size, hollow building-block, and end wire-cut brick. The normal season is 10 months, and about 150 kilns are burnt. The plant was built in 1913 and rebuilt in 1916 after a fire. It was bought from Mr. Armstrong by the present owners in 1925.[1] The deposit consists of 3 feet of red-burning clay with stony clay below. The clay is soaked in the pit and covered with straw. The cars, on which the clay is loaded, are horse-drawn to the incline which takes the cars to the second floor. The equipment consists of a 4-shaft Fate disintegrator, conical rolls, Fate combined pug mill and auger machine, and automatic cut-off. Dryer cars take the ware to a waste-heat dryer having 15 tracks 80 feet long. The dryer is built with hollow-block walls and a concrete roof. A 5 h.p. Keith fan working at 250° F. brings waste heat from the kilns. An exhaust dryer fan is of the same size. The six 24-foot round down-draft kilns have inclined grates. There are 2 kilns to one 40-foot stack. Coal is used as fuel. A brick wall around the kiln breaks the wind, but there is no roof. The plant is well built and can be operated the year round.

Dover Brick and Tile Company (152), Dover Centre

The production is about 800,000 red drain tile in a season of seven months. The plant was built about 1912 and was bought by the present

engine using natural gas for power. There is a 6-track waste-heat dryer and a 5-track natural dryer with shed roof. The 2 round down-draft kilns have a capacity of 23,000 4-inch tile each and are served by one stack, 40 feet high. A gasoline tractor-engine powers the waste-heat fan. Extra heat is furnished by a direct-fire grate burning coke. The combustion gases go into the dryer. The buildings are wood with corrugated iron roof.

S. Lindsay (156), Tupperville

The production is about 400,000 red drain tile, 4 to 12 inches in size, in a season of six months. The plant is forty-three years old and there has been no change in ownership. It is a good summer yard. The buildings have corrugated iron roofing, and everything about the plant is neat and in good order.

The clay is 2 feet deep and is taken to a car-loading bridge by a scraper after plowing. The machinery includes an open-top pug mill, a Baird auger machine, a hand cut-off, and a 50 h.p. gasoline engine. A special transfer-and-lift car takes the tile on pallets to the dryer. The pallet replaces the usual car and is much cheaper. The dryer has 22 tracks and is 100 feet long. Another lift car takes the pallets to the kilns. There are 2 round down-draft kilns, 25 feet inside diameter, using coal on inclined grates.

C. R. Gammage (160), Dresden

Red- and cream-burning clay are mixed to make 350,000 drain tile, 4 to 12 inches in size, in a season of six months. The plant was built by Warren Leatherdale 20 years ago and was bought by Mr. Gammage in 1919. The plant is neat, and the buildings have corrugated iron roofs and are in good condition.

The deposit consists of 3½ feet of red-burning clay overlying 5 feet of cream-burning clay. The clay is soaked and blended at the pit and hand-loaded to cars. The machinery consists of a single-auger pug mill, a Baird auger machine, and a hand cut-off, using steam power. There is a dry shed, 35 by 280 feet, and 2 round down-draft kilns, 22 and 24 feet inside diameter. A 40-foot stack serves both kilns. The tile are largely delivered by truck. Joe Shaw is superintendent.

Thos. E. Martin (161), Thamesville

This plant makes red drain tile, 4 to 12 inches in size, and a few end-cut brick. The normal production is 8 kilns in a season of five months, each kiln holding 20,000 tile. The plant was built by Mr. Martin's father about fifty years ago and has always been owned by the family.

The red-burning clay is worked to a depth of 5 feet. Below is 3 feet of sandy clay with some gravel, and then blue clay is reached. The process is normal, using a Baird auger machine. Drying is done in sheds or in an open-track shed dryer. There are 2 round down-draft kilns burning coal on horizontal grates, which are designed to burn wood. The kiln capacity is 21,000 4-inch tile. The one stack is 3 feet square inside and 48 feet high.

D. A. Hitch (162), Ridgetown

The production is about 300,000 red drain tile, 3 to 14 inches in size, in a season of five months. The father of Mr. Hitch built the plant forty-three years ago. Two feet of top clay, which burns red, is used, the clay below being stony. The worked-over land is used for pasture but is not farmed. The usual process with a Baird auger machine is used. The dryer shed is 100 by 125 feet, and there are 2 round down-draft kilns, 20 and 23 feet in diameter. Each kiln has 4 stacks.

H. W. Parks (157), Dresden

This plant produces red drain tile, 4 to 12 inches in size, burning 28 kilns in a season of six months. The average kiln capacity is 12,000 4-inch tile. The plant, which is forty-one years old, is the oldest in this section. There has been no change in ownership.

The clay pit is 12 feet deep, red-burning at the top and lighter in colour at the bottom. It extends down 8 feet more, but poor drainage prevents it being used. It is stated that blue clay is reached at 20 feet and rock at 80 feet. The clay is hand-loaded to cars and delivered to a Baird auger machine and hand cut-off. A 25 h.p. steam engine furnishes the power. Dryer cars go to 12-track dryer sheds, 180 feet long, with pivot roofs. There are 3 round down-draft kilns, 18, 24, and 26 feet inside diameter, burning coal on inclined grates. Pyrometers are used in both crown and bottom. A centre stack and an outside stack carry away the combustion gases and give an unusual construction. A shed roof protects the kilns from the weather.

Wm. Dalton (159), Dresden

The plant is 10 miles northwest of Dresden. The production is about 150,000 red drain tile per season of five months. The necessity of hauling coal 6 miles makes it difficult to operate the plant. The local wood supply has been used up. The plant was started by Mr. Dalton's father in 1909. The clay, which is 2½ feet deep, is formed in a Baird auger machine, the power being furnished by an old steam tractor on wheels. There are 2 dry sheds two storeys high, measuring about 25 by 150 feet each. The one kiln is of the round down-draft type and has four stacks. It has a capacity of 18,000 4-inch tile.

Norman McEachern and Sons (171), Highgate

This plant burns about 20 kilns of red drain tile, 4 to 12 inches in size, and a few brick each season of five months. The plant is forty-five years old and was formerly known as the Moody plant. The present owner purchased it in 1925. There is the usual summer-yard equipment, including a Baird auger machine, dry sheds, and 2 round down-draft kilns, 20 and 22 feet inside diameter, having 4 stacks each. A scove kiln is used to burn the brick.

Lambton County

PLANTS: Nine—two of group No. 2, one of group No. 3, and six of group No. 4.
CLAYS: Glacial and post-glacial clay and Hamilton shale. Huron shale is exposed at Kettle point but is not used.
PROCESS: Stiff-mud drain tile, with some brick and hollow block.

In 1906, there were four plants listed. All are still in operation, and the number has increased to nine.

Douglas and Douglas (153), Wilkesport

The production is about 250,000 red drain tile, 3½ to 16 inches, in a season of five and a half months. The plant is thirty-one years old and has had several owners, including J. H. Sipprell and Mr. Bishop. It was bought by the present owners in 1924. The pit consists of 6 feet of red-burning clay with stony clay below. The clay is dug by hand and worked by the usual open-top pug mill, Baird auger machine, and Fate automatic cut-off. There are three 2-storey dry sheds, 25 by 100 feet, and 2 round down-draft kilns having a capacity of 20,000 4-inch tile each. There are 4 stacks to a kiln. Each stack has three dampers to three separate flues. Wood is burned.

Fred. Howlett and Sons (163), Brigden

This plant was known as the Brigden Brick and Tile Company but was purchased by Fred Howlett and Sons in 1928. It is forty to fifty years old and was built by H. Hales. Twelve years ago it was enlarged and rebuilt, and the production is now 900,000 4-inch tile, or equivalent, in a season of nine months.

The pit consists of 7 feet of red-burning stoneless clay with blue clay below, which is not used. The clay is dug by hand, loaded to side-dump cars, and hauled by horse to the incline. The equipment consists of a single-auger open-top pug mill, a new J. D. Fate and Co. combination pug mill and auger machine, and a Fate automatic cut-off. There is a 12-track waste-heat dryer, 100 feet long, with a drying floor above, and a 4 track open-shed summer dryer of the same length. A 5 h.p. fan pulls the waste heat from a flue between the bag walls of the kilns. Extra heat is taken from the stack flue, drawing the combustion gases into the dryer. The two round down-draft kilns are 24 feet inside diameter with a main stack flue, 30 inches square. The stack is 3 feet square inside and 35 feet high. A wall is built around the kilns to break the wind. Coal is burned on inclined grates. There are three pyrometers in each kiln, two in each crown, and one in the stack flue. The plant is well built and in good condition.

Fred. Howlett and Sons (164), Petrolia

Red drain tile makes up 90 per cent. of the production, the balance being brick and hollow block. The plant is about fifty years old and has never changed hands. The clay in an 8-foot face is blended, as it becomes sandy at the bottom. There is blue clay below, but it is not used. Hand-loaded cars are drawn by horse to an incline leading to the plant. The machinery includes a single-auger open-top pug mill, a Baird auger machine, and a hand cut-off. Cars take the ware to a 6-track waste-heat dryer, above which is a dry floor for larger-size pipe. A 7½ h.p. Sheldon fan controls the waste heat, and extra heat is supplied from a fire box that allows the burned gases to enter the dryer. There are 3 round down-draft kilns, 22 feet inside diameter, with a main flue 30 inches square and a 45-foot stack 3 feet square inside. The stack is lined 30 feet up with a 4-inch air space between the walls. Two pyrometers are in each kiln, the crown and bottom.

Chas. Middleton (165), Wyoming

This plant makes about 150,000 red tile per season of five months. It is fifty years old and has not been kept in good repair. Mr. Middleton has owned it for fourteen years. The clay pit is 4 feet deep, and the usual method of manufacture is used.

W. S. Watson (166), Thedford

Red drain tile, 3 to 12 inches in size, are made. From 12 to 15 kilns are burned in a season of six months. Each kiln will hold 20,000 tile. The plant is over fifty years old and was formerly owned by A. Elliott. Jonas Cornell, of Parkhill, a past president of the Canadian National Clay Products Association, was interested in this plant and helped to interest H. C. Baird, of Parkhill, in the manufacture of clay-working machinery.

Hamilton shale is used for tile-making. This is the only place in Ontario where it is used. The shale is plastic, will stand rapid drying, and works well in the die machine but shows considerable scum because of the

sulphur content of the clay. An analysis, given by M. B. Baker, is as follows:—

	Per cent.
Silica	54.96
Alumina	19.15
Ferric oxide	6.68
Lime	4.02
Potash	3.47
Sulphur trioxide	.93
Loss on ignition	8.48

No effort has been made to overcome the scum by the use of barium carbonate. Mr. Watson bought the plant three years ago.

There are two different layers of shale, one lying above the other and exposed at different points on the property. One outcrop of the upper layer is 20 feet of buff-burning shale with an overburden of 10 feet of sand and a 6-inch stony layer. The lower layer, which is used, is 14 feet of red-burning shale. The shale is well weathered and does not require grinding. It is soaked in a pile and shovelled to a Baird auger machine, which forms the tile. Steam power is used. There are two dry sheds, 20 by 100 feet in size, and a 23-foot round down-draft kiln with two stacks. Wood is used as fuel.

John Dolan (167), Warwick

The production is about 150,000 red drain tile, 4 to 10 inches in size, in a season of five months. The plant was built forty years ago by Robert McCormick and was bought by John Dolan in 1914. In the pit there is 2 feet of surface clay over stony clay. A steam tractor furnishes power to the Baird auger machine. There are 2 dry sheds, 15 by 100 feet each, and a 19-foot round down-draft kiln, which has 4 stacks and burns wood on horizontal grates. Years ago cream-coloured soft-mud brick were made in large numbers, burned in scove kilns, and used for local buildings; but this demand has disappeared.

McCormick Brothers (168), Kingscourt Junction

Cream-burning clay is used to manufacture drain tile, 3½ to 10 inches in size. The plant is run with a farm and is operated when farm work does not interfere. Only local business is taken care of. The production, therefore, is very uncertain. The plant is thirty-five years old and was built by the present owner. In the pit there is 3 to 4 feet of cream-burning clay with gravel below. A Baird auger machine is used. There are 2 dry sheds and a 22-foot round down-draft kiln. A second kiln was being built at the time the plant was visited.

J. C. Waide (169), Alvinston

The plant produces cream-coloured tile, 4 to 12 inches in size, using glacial surface clay. The normal production is 20,000 tile per week. As Mr. Waide bought the plant only last fall (1928), the annual production in a season of five months is uncertain. The plant is about fifty years old and was formerly known as the Alvinston Brick and Tile Company. The manufacture of brick was discontinued in 1914. The usual Baird auger machine and open-top pug mill are used. A 40 h.p. electric motor furnishes power. Dryer cars take the ware to 2 dryer sheds, one 90 feet long and the other 140 feet long. Four round down-draft kilns are 22 and 24 feet inside diameter. Coal is used as fuel, and there are 4 stacks per kiln. J. C. Waide was in business for years in London before taking over this plant.

Forest Tile Yard (172), Forest

W. J. McFarland is the owner of this plant. The production is about 250,000 red tile, 3½ to 12 inches in size, in a season of six months. The plant was started in a small way in 1926. Two feet of surface clay from along the creek is mixed with a sandy 6-foot face from another part of the property. The sandy clay contains pebbles, which cause some trouble in working and are removed as far as possible by a pair of rolls before the clay goes to the Baird auger machine. A 25 h.p. electric motor furnishes power. There is a natural dryer shed, 30 by 100 feet, with tracks and cars. Two tracks are enclosed to allow the use of heat from an old boiler. The one kiln is a 20-foot round down-draft one with four stacks and burns wood. Its capacity is about 20,000 tile of mixed sizes.

Lanark County

PLANTS: One of group No. 4.
CLAY: Marine and post-glacial clays are available, but the deposits are not extensive.
PROCESS: The one plant makes red soft-mud brick.

In 1906, there were three plants, but only one still operates.

Thos. Godfrey and Company (57), Carleton Place

About 300,000 red soft-mud brick are made each season of four months. The plant is about forty years old and has changed locations several times as the clay became exhausted. It was owned by Taylor, Willoughby, and Burgess before being purchased in 1914 by Thos. Godfrey. Only 2 to 3 feet of clay is used, as it becomes stony below. Sand, which must be added to make soft-mud brick, is hauled seven miles, mostly in the late fall. A Martin soft-mud machine uses a 10 h.p. motor and makes 5,000 brick a day. There are 7 dry racks 260 feet long and a scove kiln for burning (see photograph on page 84).

Leeds County

No plants are now operating in this county, although there were two making soft-mud brick in 1906. The clay available is red-burning glacial and post-glacial and some marine clay.

Lennox and Addington County

PLANTS: One of group No. 3; another plant is about to recommence operations after being idle.
CLAY: Marine and glacial clays. There is Chazy shale near Tamworth, but it is not used.
PROCESS: Soft-mud brick and stiff-mud tile are made.

In 1906, there were two plants, both of which are still in operation.

John Chapman (54), Napanee

The production is about 500,000 brick and 300,000 drain tile in a season of five months, using red clay. The plant is forty years old, or more, and was built by Geo. Whittington. It was bought by the Napanee Brick and Tile Company in 1913, went into bankruptcy, and was bought in 1917 by John Chapman. The clay pit contains three kinds of clay, varying in plasticity, and must be carefully sorted to obtain a good product. The clay is blended in stock piles and is shovelled to rolls. It then goes to a J. D. Fate Company auger machine to make tile and to an Iron Quaker machine to make soft-mud brick. A 50 h.p. motor furnishes the power. A Boss waste-heat dryer has been modified to dry with natural air and no

waste heat. The original installation never gave satisfaction. There are three 30-foot round down-draft kilns having a capacity of 80,000 brick each. The Boss system of forced draft is used with a 3-inch air line to each fire box and is very well liked. There has not been a case where the forced draft has been discarded when once installed. Each kiln has a 35-foot stack, 2 feet square inside.

Tamworth Clay Products Company (55), Tamworth

This plant has not been in operation for some time but was reported as being reorganized in 1929. The products and production are still uncertain. The old plant consisted of a soft-mud machine, dry racks, and scove kiln, and used a surface clay.

Lincoln County

PLANTS: Two plants of group No. 2.
CLAY: Glacial clay and Queenston shale. Cabot Head shale outcrops near Grimsby but is not used.
PROCESS: The shale is made into dry-press, stiff-mud brick and drain tile. The glacial clay is made into soft-mud brick.

In 1906, there were three plants. The one owned by Watt and Smith at Attercliffe has disappeared, but the other two are still in operation.

Grimsby Brick and Tile, Limited (108), Grimsby

This plant makes wire-cut and dry-press red brick from Queenston shale and plans to make some drain tile. The average production is about 25,000 brick a day for a season of nine months. The plant is sixty years old and is said to be the first plant to make dry-press brick in Ontario. It was owned by the Beamsville Brick and Terra Cotta Company, Geo. Crain, and Tollman and Farrell before being purchased by the present owner two years ago.

The shale pit has been worked over 10 feet deep by previous owners, and the present operation is on a 10-foot face at a lower level. The shale obtained at this level burns to a good red, but there are buff-burning layers below. The shale is blasted and hand-loaded to cars, hauled up an incline to the plant, and dumped into a storage bin large enough for a two weeks' supply. A conveyer beneath the floor takes the shale to crushing rolls and a 9-foot dry pan. A 3-thirty-seconds-inch perforated plate screen, 32 inches by 12 feet in size, is set at an angle of 45 degrees. The fines go to the dry press. For stiff-mud brick, a 3-sixteenths-inch mesh wire screen is used, and the fines go to an open-top pug mill, auger machine, and automatic cut-off. Another auger machine is being installed for tile. Drying is done in a 5-track tunnel dryer, 90 feet long, which is hardly large enough for the stiff-mud capacity of the plant. There are 4 rectangular down-draft kilns with a capacity of 110,000 brick each, and two round down-draft kilns, 20 feet inside diameter, primarily for tile. Mr. King, the superintendent, states that coal-burning on inclined grates started in Ontario about 1895 at the Fruitland Brick Company, Fruitland, Ont. This plant has disappeared.

Fred R. Paxton (109), St. Catharines

This plant makes about 1,500,000 red soft-mud brick in a season of five months. Most of them are used as face brick, as there is little demand for common brick. The plant was built in 1903 by Paxton and Bray, but Mr. Bray left the company a few years ago. There was a plant near by owned by J. M. Carter, but it is not operating.

The brick are made from surface clay in an Arnold Creager Company machine of the semi-automatic type, are dried in open-air racks, and burned

in 2 rectangular down-draft kilns and 2 rectangular up-draft kilns. The down-draft kilns have 4 flues drawing from 4 points of the centre flue of the kiln and going to a single stack. The up-draft kilns give 25 per cent. soft-burned brick and are being changed to down-draft. Mr. Paxton is burning hard to give a dark brick, which when properly laid gives the impression of age in a new building. The new building for the Y.M.C.A. and Y.W.C.A. in St. Catharines is built of these brick. Coal is used as fuel.

Middlesex County

PLANTS: Twelve—one of group No. 2 and eleven of group No. 4.
CLAY: Glacial and post-glacial clay. Hamilton shale is exposed in this county but is not used.
PROCESS: Soft-mud and stiff-mud brick, drain tile, and a few hollow building-block are made.

In 1906, there were eleven plants, six of which are still in operation; five new ones have been added.

D. A. Janes (183), Mount Brydges

This plant makes cream-burning drain tile, 3 to 12 inches in size, and end wire-cut brick, with a production of about 250,000 tile and 100,000 brick in a season of six months. The plant is forty-seven years old and has had no change in ownership. Hand-made slop brick were produced when the plant first went into operation. In the pit, hand-digging allows a proper proportioning of sandy and plastic clay. The machinery consists of rolls, open-top pug mill, Baird auger machine, and Fate cut-off. A 50 h.p. steam engine furnishes power. There is a dry shed for tile and racks for brick; there are also two 22-foot round down-draft kilns for burning. One kiln has 4 stacks, and the other a single outside stack. The kilns have a capacity of 15,000 4-inch tile each. Wood and coal mixed are burned on horizontal grates. Mr. Janes favours a 22-foot kiln as compared to a 30-foot one, because it gives faster turnover and less drying space is required to stock between burns.

Geo. E. Phinn (184), Strathroy

Normal production is 5 kilns of 15,000 4-inch tile each season of five months. The plant was built in 1880, making by hand and burning in scove kilns. E. D. Frank owned the plant until 1928. The clay pit consists of 2 feet of medium red-burning clay, 4 feet of grey clay burning red, and 4 feet of blue clay burning cream, with sand below. The usual Baird auger machine is used with a 40 h.p. gasoline engine for power. The tile dry on racks and are wheeled to two round down-draft kilns, 22 feet inside diameter, with a single outside stack. There is a shed roof over the kilns.

Robert McMahon (185), between Strathroy and Kerwood

This is a small plant making about 60,000 tile in a season; a farm is also worked. The plant is thirty to forty years old and was started by Richards and Kerwood to make stoneware. Mr. McMahon bought it about ten years ago.

The 10-foot face of clay runs from medium-red at the top to cream-coloured at the bottom when burned. The clay is wheeled 50 feet to the Baird auger machine. After drying in the dry shed, the burning is done in two small down-draft centre-stack potter's kilns, holding about 6,000 tile each.

Jas. Richardson and Son (186), Kerwood

The plant produces cream-coloured drain tile, 3½ to 12 inches in size, for local trade. They burn about 15 kilns in a season of five months each,

holding 12,000 4-inch tile, or equivalent. The plant is forty years old. There is no demand for cream-coloured brick now.

The clay deposit consists of 2 feet of red-burning clay, 8 feet of grey clay burning cream, and 15 feet of sand with blue clay below. The top 10 feet are mixed and used for tile. The clay is loosened by blasting and soaked in the pit before loading. A 60 h.p. Diesel engine furnishes power to the Baird machine as well as to the saw and other equipment and has given satisfaction. The tile are dried in a 2-storey dry shed, 40 by 60 feet in size, and burned in 2 round down-draft kilns, 20 feet inside diameter. The kilns are under a shed roof. Brick are dried in open racks and burned in a scove kiln.

H. C. Baird, Son, and Company, Limited (187), Parkhill

This company was established in 1869 and is primarily known as manufacturers of clay-working machinery, being the pioneers in Ontario. They also operate 2 plants making brick and tile to demonstrate the use of their equipment and to supply the local demand. Three generations have been represented in the ownership of this plant: H. C. Baird, Oliver Baird, and A. O. Baird, the present manager. The manufacture of clay-working machinery was started about 1885. The Kells auger machine, the Martin soft-mud brick machine, and the Iron Quaker soft-mud machine are well known and are widely used in Ontario. Other clay-plant equipment is also made, such as rolls, pug mills, cutting tables, moulds, and kiln supplies.

Plant No. 1.—The soft-mud brick plant owned by this company operates about three months a season, the same men spending about half their time at this plant and half at the stiff-mud plant a quarter of a mile away. The production is about 500,000 brick in a season.

The pit consists of a 12-foot face of sandy grey surface clay, which is loaded by horse and scraper to cars placed under a loading bridge. Side-dump cars deliver to an open-top pug mill and Iron Quaker soft-mud machine. A 20 h.p. steam engine supplies power. Ten dry racks 100 feet long are used for natural drying. The burning is done in 2 round down-draft kilns, 22 feet inside diameter, each having a capacity of 50,000 brick. The kiln walls are 16 inches thick. The fire boxes are built out to take wood. There are 3 flues from each kiln to the stack and 3 dampers, one pulling from the centre and the others from a ring flue near the wall. The stack is 60 feet high and 3 feet square inside and serves both kilns. There is a shed roof over the kilns.

Plant No. 2.—The other plant manufactures drain tile and is managed by W. A. Sutherland. They burn 12 kilns of cream-coloured tile, 3 to 12 inches in size, in a season. Each kiln will hold 20,000 4-inch tile, or equivalent. The clay at this location is more plastic, having 1 foot of red-burning clay over 10 feet of cream-burning clay. The red clay is discarded. A plow and scraper brings the clay to a loading bridge as in the other plant. The equipment is a Baird auger machine and hand cut-off. Natural drying is done on cars on 14 tracks, 120 feet long, with shed roofs over each 2 tracks. The large tile go to a dry shed, 20 by 120 feet. There are 3 round down-draft kilns, 22 feet inside diameter, burning wood. They are under a shed roof. A 48-foot stack, 3 feet square inside, serves two kilns, and the third kiln has 4 stacks. The 4-stack kiln is said to give the best burns.

Chester McComb (188), Elginfield

Red- and cream-burning clay is mixed to make drain tile 3 to 14 inches in size and a few end wire-cut brick. The production is about 7 kilns of 30,000 tile each in a season of six months. The plant is thirty-two years old, and there has been no change in ownership. There is 3 to 5 feet of red-burning

clay overlying 5 feet of blue clay, which burns cream-coloured. The log of a well is said to give blue clay to a depth of 45 feet, but the creek level prevents lower working.

The equipment is normal, consisting of a Baird auger machine, steam power, natural-drying sheds, one 30-foot round down-draft kiln, and a 45-foot stack, 3 feet square inside. The kiln has a 16-inch wall and only 3 bands. It was often noticed that with this construction cracks develop that must mean loss of heat and large excess air within the kiln. Such banding has lasted 15 years or more without failure of the kiln, but it does not seem to be good practice.

Phinn Brick Company, London

Phinn Brothers bought several plants in town, but only two, now owned by Geo. A. Phinn, are at the present time running. There used to be 8 or 10 plants here.

Plant No. 1 (189), Adelaide Street at Victoria.—Cream-coloured soft-mud brick are made at this plant, the production being about 1,000,000 brick in a season of six months, or about one-half the capacity. The plant, which is thirty years old, was built by Waide Brothers and bought by the present owner eight years ago. A 15-foot bank of sandy clay is used in an automatic brick machine manufactured at Lancaster, Pa. Power is supplied by a 25 h.p. electric motor. The machine is hand-operated in order to get better quality as required for face brick. After open-air drying in 14 racks, 120 feet long, the brick are burned in 3 permanent wall scove kilns, burning coal on horizontal grates and having a capacity of 300,000 brick each. There is one 20-foot round down-draft kiln with 4 stacks and inclined grates for burning coal.

Plant No. 2 (193), Pipe Line Road.—Cream-coloured drain tile, 3 to 12 inches in size, are made and a few hollow block. The production is about 500,000 4-inch tile, or equivalent, in a season of six months. This plant is so built that it could operate all year if business justified it. The plant was built by J. W. Cawrse thirty years ago but has been recently remodelled, with substantial buildings for all-year operation.

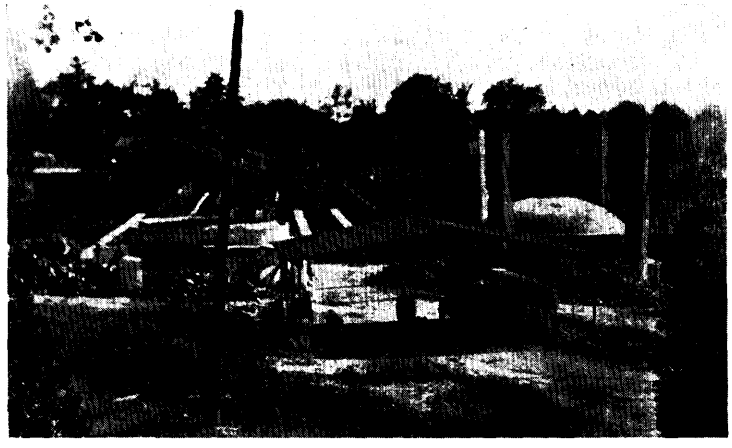
The pit has an 8-foot face consisting of 1 foot of plastic red-burning clay overlying 7 feet of rather sandy cream-burning clay, which when mixed is satisfactory for tile. The clay is hand-dug and formed in a Baird auger machine. There is a large Freese pug mill and auger machine, requiring 85 h.p., but with the present plant production it is not used. A 7-track waste-heat car tunnel-dryer, designed by Phinn Brothers and built by the Booth Brick Company, of Toronto, is used. An overhead recirculation of the drying air by fan is a novel feature. The waste heat comes from 4 kilns and is taken from the stack flue during cooling. Unfortunately with the present burning schedule there is not enough waste heat to give high drying efficiency. The factory building is of brick and steel construction, 81 by 256 feet, and there is room to double the size of the dryer. The 4 round down-draft kilns are 30 feet inside diameter and are connected to one stack, 45 feet high and 4 feet square inside. Coal is used as fuel. There are pyrometers in each kiln, top and bottom.

W. J. Jervis (195), Dorchester Station

This plant, which is neat and well organized, burns about 12 kilns of cream-coloured tile, 3 to 12 inches in size, in a season of six months. The kiln has a capacity of 15,000 tile of mixed sizes. The photograph on page 139 gives a general view of the 4-stack kiln and of a second kiln under construction. The plant was built forty years ago by Mr. Sharp and was bought

by the father of the present owner twenty-five years ago. Baker did not list it in 1906.

There is 12 to 15 feet of grey clay, which burns cream-coloured. It is soaked in the pit and hand-loaded to cars, which automatically dump into a single-auger open-top pug mill which feeds a Baird auger machine. Low wooden platform cars take the tile, set one deep, to 16 open-air dryer-tracks, 125 feet long. A shed roof on hinges of an unusual type allows exposure to air and sun and gives protection in case of rain (see photograph on page 75). There are also two dry sheds, 30 by 75 feet, which are not used all the time. The one round down-draft kiln is 22 feet inside diameter and



General view of plant, W. J. Jervis, Dorchester Station.

has 4 stacks. The fire boxes are built for wood, but Mr. Jervis is changing to coal, as wood is hard to get.

Wm. H. Deller (196), Thorndale

This plant mixes red- and cream-burning clay to make about 300,000 tile, 3 to 16 inches, in a season of six months. Mr. Deller runs a farm as well as the plant. The plant, which is 35 years old, was built by Robert Crosby and bought by the present owner sixteen years ago. The clay is hard to select, being stony in places. The top 18 inches must be rejected. About 2½ feet of clay is used, the red- and cream-burning clays coming from different sections of the field. Sand and gravel are found below. A Baird auger machine is used, and the drying is done in two sheds, 35 by 125 feet in size and two storeys high. There are two 24-foot round down-draft kilns, each having a 30-foot stack 3 feet square inside. Coal is used as fuel.

Wm. McGrenere Brick and Tile Company (208), Pipe Line Road, London

This is a small plant making about 450,000 cream-coloured soft-mud brick in a season. The plant was built in 1913 and has only operated part of the time since. In 1929, Mr. Goring bought it, and no estimate of production could be made. An 8-foot face of clay consists of 2 feet of grey clay overlying 6 feet of blue clay, with more blue clay below. The equipment consists of an Iron Quaker soft-mud machine and a Baird auger machine, which is not used. There are 10 open-air dry racks, 90 feet long. The 3 round down-draft kilns are not in condition to use, and the burning is being done in a scove kiln.

Muskoka District

PLANTS: Two—one of group No. 3 and one of group No. 4.
CLAY: Algonquin Lake clay.
PROCESS: Soft-mud brick and stiff-mud brick and drain tile are made.

In 1906, there were three plants. Two of these are still in operation.

Watson Brick Company (79), Bracebridge

This plant makes about 500,000 red soft-mud brick and 30,000 red drain tile in a season of four months. The plant is thirty years old and has had no change in ownership.

There is a 25-foot face of clay, consisting of strong clay at the top, which becomes more sandy at the bottom. It is hand-loaded to cars and taken by incline to an open-top pug mill and Martin soft-mud brick machine. The average production is 12,000 brick per day. The drying is done in 12 open-air pivot-roof racks, 130 feet long, and the brick are burned in scove kilns. The tile-making equipment consists of an open-top pug mill, Baird auger machine with a hand cut-off, 2 dry sheds, 25 by 100 feet, and one round down-draft kiln, 22 feet inside diameter. There is a corrugated iron roof over the scove kiln. A 40 h.p. motor furnishes power. Wood is used as fuel and costs $4 a cord at the plant.

Stevens Brothers (80), Huntsville

The plant makes about 400,000 red end wire-cut brick and 15,000 red drain tile in a season of four months. L. H. Ware built the plant in 1900 and sold to the present owner in 1912. The clay is worked by plow and scraper on the surface but is said to be 8 feet deep, with sand below. The clay goes through 2 open-top pug mills before going to the Baird auger machine, which will make about 8,000 brick per day. The brick are hacked and taken by lift barrows to dry sheds, 33 by 160 feet in size. The tile are handled in the same way. Burning is done in one 22-foot round down-draft kiln, having a capacity of 45,000 brick. A 2 h.p. gasoline engine and fan aids the stack draft at the beginning of the burn. There is a shed roof over the kiln. Steam power is used.

Nipissing and Timiskaming[1] Districts

PLANTS: Two—one of group No. 2 and one of group No. 4.
CLAY: Glacial surface clay.
PROCESS: Soft-mud brick are made.

In 1906, there were five plants, but three have discontinued operations.

R. Wallace and Son (232), North Bay, Nipissing District

The production is 1,600,000 brick in a season of four months. The plant is thirty years old and was bought by the present owner eighteen years ago. Joe Cashmore, the superintendent, has been making brick in North Bay for forty years. Eight feet of surface clay is used, grading from yellow-grey to blue, all of which burns red. The clay is loaded by horse and scraper to cars placed under a loading bridge and taken by an incline to a Martin soft-mud machine with a 30 h.p. motor. There are 18 dry racks, 200 feet long, and 3 scove kilns burning wood, at $4.50 a cord.

New Liskeard Brick Works, New Liskeard, Timiskaming District

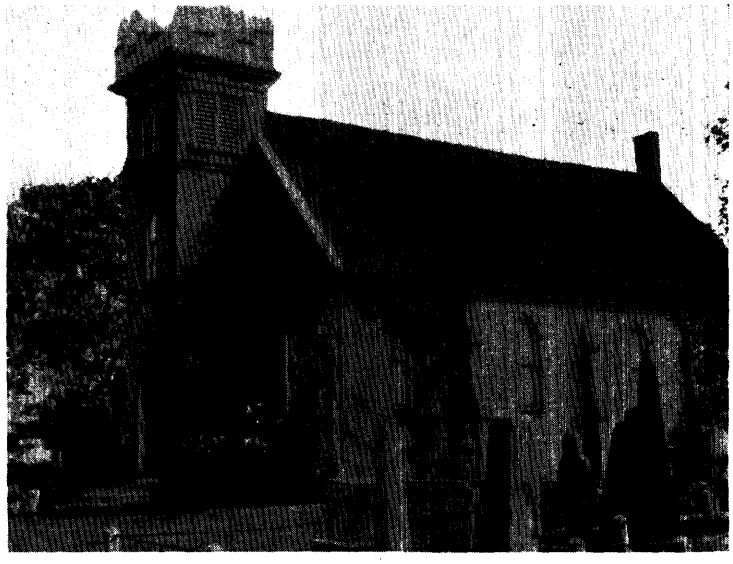
This plant has not been in operation and was not visited, but is reported as starting again, making 400,000 soft-mud brick per season.

[1]In 1906, Nipissing district included what is now Timiskaming district.

Norfolk County

PLANTS: One of group No. 3.
CLAY: Glacial or post-glacial clay.
PROCESS: Stiff-mud drain tile and a few stiff-mud brick are made.

In 1906, there was a plant at Simcoe, but this is not in operation now. The photograph below is a view of St. Johns Evangelical Church, about two and a half miles from Simcoe on the Port Dover Road. The brick were made by hand by Chas. Mason and his father, Peter Mason, fifty years ago (1879). These cream or buff soft-mud brick are in very good condition and are good examples of the early brick made in this section.



St. Johns Evangelical Church near Simcoe, built in 1879 of hand-made brick.

Port Rowan Brick and Tile Company (117), Port Rowan

W. P. Masters, who owns this plant, makes 400,000 drain tile per season of six months. A few stiff-mud end wire-cut brick are also made. The plant was built twenty-two years ago by J. L. Buck and bought by Mr. Masters in 1916. In the clay pit there is a 17-foot face, consisting of:—

	Feet
Stripping	1
Red-burning brick clay	2
Mild grey clay, which burns cream-coloured	6
Strong blue clay, which burns cream-coloured	8

The blue clay continues below this level. The entire face, except the stripping, is blended for making tile. The equipment consists of an open-top pug mill, combination rolls and auger machine, manufactured by Bechtel's, Limited, of Waterloo, Ont., and an automatic cut-off, powered by a 25 h.p. gasoline engine. There are 4 open-air dry sheds, 25 by 150 feet. The tile are set on pallets and moved with a special lift barrow. There are 2 round down-draft kilns, 27 feet inside diameter, with a capacity of 30,000 tile each. There are two stacks, 30 feet high, for each kiln, and three flues to each stack. Wood is burned as fuel.

Northumberland County

PLANTS: One of group No. 4.
CLAY: Glacial surface clay.
PROCESS: Soft-mud brick are made.

In 1906, there were two plants, but one has been discontinued. The photograph below shows a good example of the early white or cream-coloured soft-mud brick made in this section.



Wesleyan (Methodist) Church, Division and Chapel Streets, Cobourg, built in 1852 of white stock (cream-coloured soft-mud) brick.

McIvor Brothers (44), Cobourg

The plant was not in operation when the writer visited it. The product is red soft-mud brick. The clay contains quite a few pebbles, some of which are limestone. It is because of these pebbles that the future of the plant is uncertain. The yard is of the summer type, having a capacity of about 500,000 brick per season. It was owned by H. Hall in 1906 and is about 25 years old. The machinery consists of an open-top pug mill and an Iron Quaker soft-mud machine. There are open-air dry racks and a scove kiln.

The brick of this section often contain stones. If they are not composed of lime, they burn without doing damage to the brick and there is no ill effect after years of service. At the McIvor plant some of the stones contain lime.

Ontario County

PLANTS: Two—one of group No. 3 and one of group No. 4.
CLAYS: Glacial and post-glacial clays. Chazy shale outcrops at Longford Mills but is not used.
PROCESS: Soft-mud brick and stiff-mud brick and drain tile are made.

In 1906, there were two plants. These have been discontinued, and two others have taken their places.

A. Snelgrove (30), Beaverton

The production of this plant is 400,000 tile, 2½ to 8 inches in size, and 100,000 red soft-mud brick or wire-cut brick in a season of five months.

The plant was started in 1909 by the present owner. The pit includes 1 foot of loam, which is not used; 2 feet of sandy clay, which is used for red soft-mud brick; and 8 feet of grey clay, which is more plastic and is used for tile. The clay below contains pebbles. The pit is worked with a plow and scraper, the clay being taken to a loading bridge (see photograph on page 48). Cars take the clay up an incline to the open-top pug mill and Martin soft-mud machine for soft-mud brick or to a Baird auger machine with hand cut-off for tile. Drying is done in 4 to 10 days on dry racks. Three round down-draft kilns, 22 to 25 feet in diameter, are used, each having 8 stacks and 10 fire boxes burning wood. A 50 h.p. electric motor furnishes power.

Whitby Brick and Clay Products Company (36), Whitby

Mr. Devereux, the superintendent, was sick at the time it was visited, and the plant had not started operation for the summer. Drain tile is the only product. The plant was started in 1918 and has operated most of the time since. Both red- and cream-burning clay are obtained from a 5-foot face in the pit. The usual equipment of open-top pug mill, Baird auger, 50 h.p. motor, open-air dry racks, and 2 round down-draft kilns, 22 feet inside diameter, is found at the plant. Coal is burned on inclined grates. There is one stack, 35 feet high.

Oxford County

PLANTS: Three—two of group No. 3 and one of group No. 4.
CLAYS: Glacial surface clay.
PROCESS: Soft-mud brick and stiff-mud drain tile, and a few stiff-mud brick and hollow building-block are made.

In 1906, there were six plants, but only three are now in operation.

Albert Dellar and Son (118), Brownsville

The plant makes 500,000 drain tile and a few end wire-cut brick in a season of seven months. Red- and cream-burning clay is blended for the manufacture of tile. The plant was built twenty-five years ago by John Kaar and was purchased by Albert Dellar and Son six years ago. The Bechtel dryer, which uses waste heat, has been replaced by the usual drying shed, which is considered to be better. The 9-foot clay face consists of 3 feet of red-burning clay overlying 6 feet of mild blue clay, which burns to a cream colour. A nearby creek prevents the blue clay from being worked any lower. Some sand is mixed in when making large-size tile, which range in size from 3 to 16 inches. A clay-gatherer brings the clay to an open-top pug mill and Baird auger machine. A 65 h.p. oil engine gives the power required. The dry shed is 100 by 90 feet, and the tile are set two deep while drying, which takes 3 days on an average in summer. The dry shed is constructed of wood with a corrugated iron roof. There are 2 round down-draft kilns, 24 and 26 feet in diameter, which burn coal on inclined grates. The main stack flue is 40 inches square, and the 2 stacks are 40 and 54 feet high. Both stacks are 40 inches square inside. A pyrometer is used in each crown. The tile are delivered by truck up to 20 miles and shipped by rail for greater distances.

Cowell Brothers (119), Tillsonburg

The production is largely tile, although there is equipment for making end wire-cut and soft-mud brick. About 100,000 tile and 100,000 brick are made in a season of five months. The father of the present owner built the plant 45 years ago; it was bought by L. H. Sinden twenty years ago and bought back by Cowell Brothers in 1922. The Town Hall at Tillsonburg,

the Arlington Hotel, and about 80 per cent. of the older houses are said to have been built from brick coming from this plant. The plant has not been kept in repair. There is 4 feet of red-burning clay over 7 feet of blue clay, which burns to a cream colour. The equipment consists of a dump cart, 25 h.p. electric motor, open-top pug mill, Baird auger machine, Bechtel cut-off, soft-mud machine, dry racks, and a round down-draft kiln.

Deller Brothers (120), Norwich

This plant produces about 700,000 cream-coloured drain tile, 3 to 16 inches, and a few hollow block, in a season of six months. The plant is fifty years old and has been owned by Deller Brothers for 35 years. The pit consists of 1½ feet of red-burning clay over 8 feet of cream-burning clay, with clay containing limestone pebbles below. The clay is dug over in the fall and taken to the plant in dump carts. Sand is added as required. A 50 h.p. motor is used to run an open-top pug mill, a Baird auger machine, and a Fate cut-off. There are two dry sheds, 40 by 120 feet each in size, with corrugated iron roof and hinged sides. There are 4 round down-draft kilns, 20 to 25 feet in diameter, with two 25-foot stacks to each kiln. The stacks are 14 inches square inside. Pyrometers are used in the kiln crowns. Delivery is made by truck.

Parry Sound District

In 1906, there were two plants making soft-mud brick of sandy glacial clay, but both have discontinued operations.

Peel County

PLANTS: Nine—four of group No. 1 and five of group No. 2.
CLAY: Queenston and Lorraine shales. The glacial surface clays in this county are not used. Cabot Head shale outcrops at Inglewood and Cataract but is not used.
PROCESS: Dry-press brick, stiff-mud brick and hollow building-tile are made.

In 1906, there were three plants, but the number has since grown to nine. The presence of both Queenston and Lorraine shale close to the Toronto market has caused the increase in the number of plants. At present brick from this section is being shipped all over Ontario and to many points outside of the province. Many of the older buildings of Peel county are made from soft-mud brick. The photograph on page 145 shows the Wesleyan Church, situated on Centre Road, 4 miles north of Cooksville. It was built in 1843, and the brick are red soft-mud with cream-coloured soft-mud brick and stone trim. Only a few of the brick are showing the effect of time.

Cooksville Company, Limited (24), Cooksville

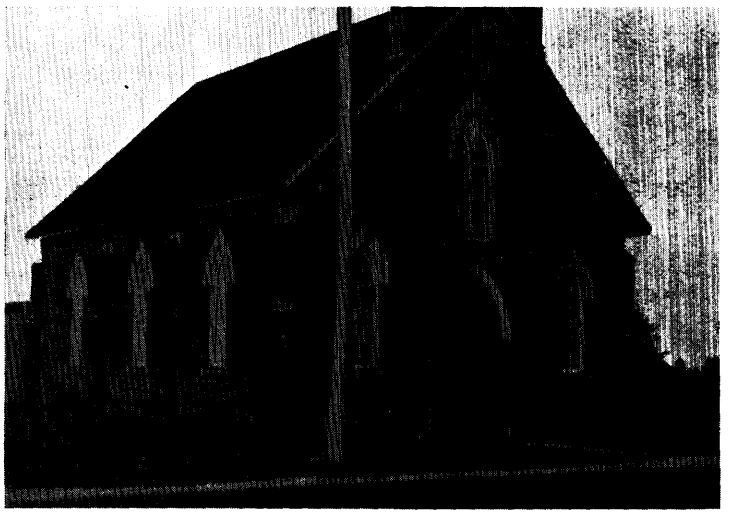
The general offices of the company are at 26 Queen Street East, Toronto, and they operate 4 plants, at Cooksville, Milton, Cheltenham, and Port Credit. A. U. Coté is general manager. The plant at Cooksville is the largest of the group and produces stiff-mud wire-cut and dry-press brick; face brick, both red and flashed, using Lorraine shale; and buff brick, using Queenston shale brought in from other properties. They veneer brick by the patented Poston process and manufacture hollow building-block, hollow chimney-block, and commercial stack-block. They also manufacture Haydite, a light-weight shale aggregate for concrete.

The kiln capacity is 60 per cent. of the making capacity, and all the equipment is not operated at the same time. The plant, which operates twelve months a year, was bought by the present owners in 1915 and was

rebuilt into a modern factory in 1924 after a fire (see frontispiece and photographs on pages 42, 43, and 44). The plant capacity is as follows:—

	Capacity per day
2 Auger machines, 60,000 brick each	120,000 brick.
1 Dry-press	22,000 brick.
1 Hollow-tile auger	50 tons.

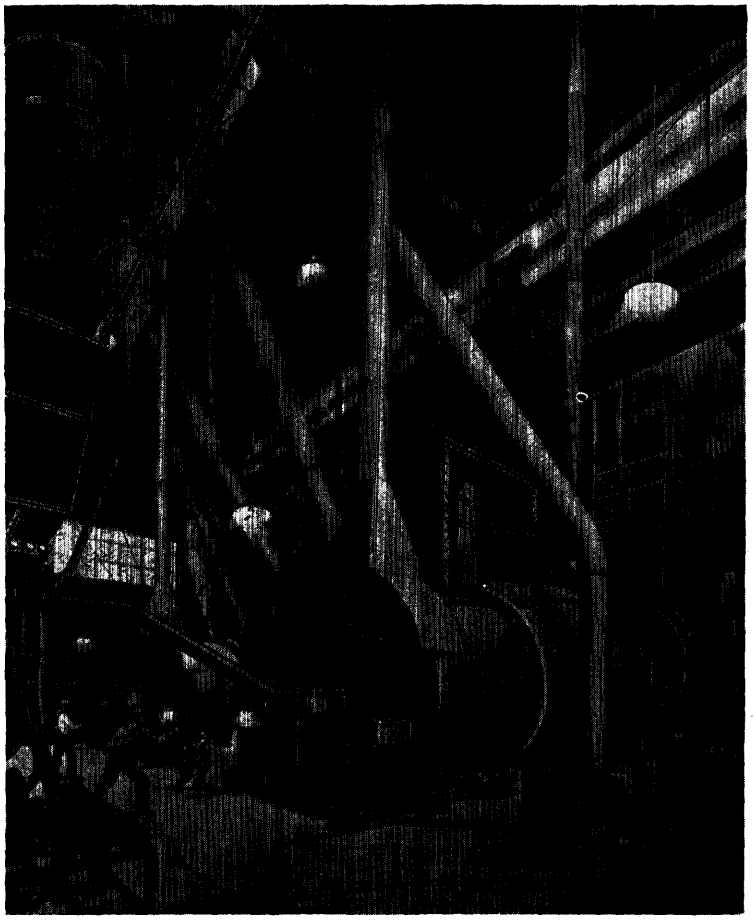
A 20- to 25-foot face of Lorraine shale is used and worked by steam shovel. The top shale is more plastic than the lower part, and it is blended from top to bottom. Several layers of slate and limestone run through the deposit, and about 10 per cent. is rejected either at the pit or on a picking belt before it goes to the dry pans. Barium carbonate is added to prevent scum. There are 3 power shovels: 2 steam and 1 gasoline. Two steam locomotives, one standard and one narrow-gauge, haul the clay cars to the dumping pit in the storage shed. An overhead crane with a clam-shell bucket moves the shale back to storage or delivers it to the feeders for the



Wesleyan (Methodist) Church, near Cooksville, built in 1843 of red soft-mud brick, with cream soft-mud brick and stone trim.

conveyer belts, which feed the dry pans. The crane has a 3-yard bucket and requires 150 h.p. to operate. The storage shed is 45 by 200 feet in size and has a capacity for 2 months' operation. Apron feeders, manufactured by the Link Belt Company, deliver the shale to a picking belt, from which the smaller pieces of slate and limestone are removed by hand. The belt delivers to two 10-foot American grinders without screen plates (Hatfield-Penfield Steel Company), requiring 75 h.p. each, and two Clearfield dry pans with screen plates, requiring 50 h.p. each. Four elevators take the material to 8 W. S. Tyler hummer screens, 4 by 4 feet. A special 15-cycle generator is necessary to operate these screens. Large steel storage-bins receive the fines from the screens, and the shale is delivered by disc feeders to the dry press or to the 3 open-top pug mills, which deliver to the 3 auger machines. The open-top pug mills, which are manufactured by the International Clay Machine Company, of Dayton, Ohio, are 12 feet long and require 50 h.p. each. The brick are made in two International auger machines requiring 75 h.p. each and equipped with Chambers automatic cut-offs. The hollow ware is made on an International combination pug-and-auger machine, requiring 150 h.p. and equipped with a Chambers cutter. The dry-press brick go directly to the kilns. The other ware go on dryer

cars to a 28-tunnel car dryer, 111 feet long, of the Raymond type, having radiation flues under each tunnel and burning coal on horizontal grates. There are two natural-draft stacks, 40 feet high. The burning is done in 3 Youngren chamber continuous kilns, with 16 chambers each. Producer gas is used for firing, each chamber using gas for 48 hours of the 14 days required to burn. Each chamber is used once in thirty days and has a capacity of 60,000 brick. Very good colours are obtained in this type of



Rotary kiln for burning Haydite, Cooksville Company, Limited.

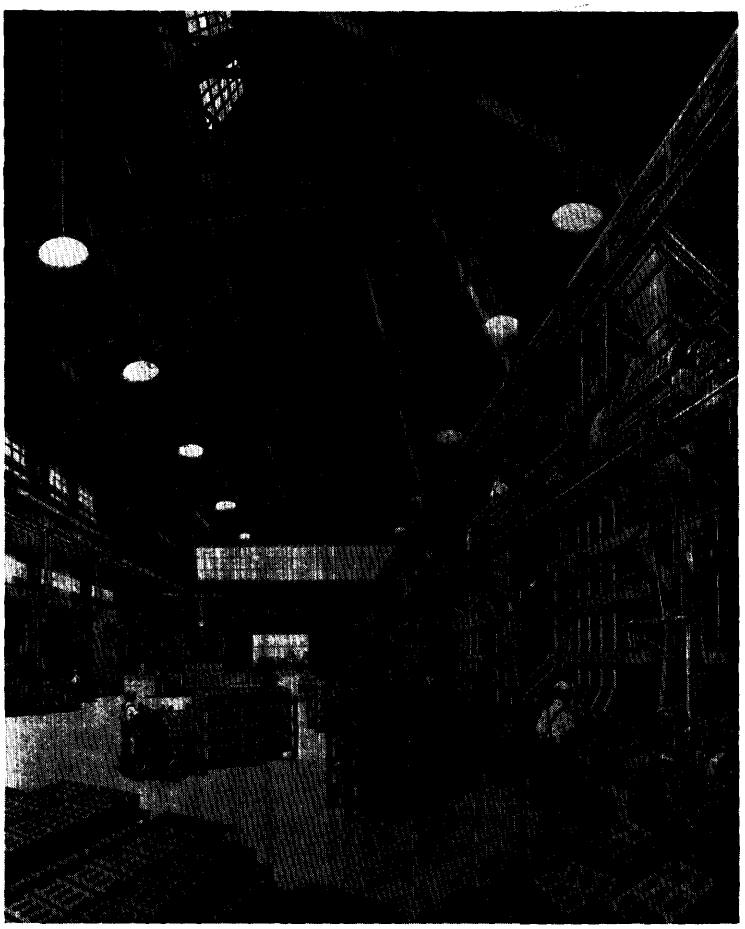
kiln. Depressed track allow easy loading for shipment or for sending to the stockroom. A considerable part is delivered by truck.

Haydite is a new and important addition to the production of this plant. It is nothing more than overfired or bloated shale. After the shale is ground to a suitable size, it is mixed with fuel and burned in a rotary kiln of the cement type. The rapid heating without oxidation of the organic matter causes it to overfire and bloat, being full of gas bubbles. This clinker is crushed and screened to various sizes and is used in concrete to replace sand and gravel. The result is a light building-material that is said to be more satisfactory than the usual concrete. The demand for this product is increasing, and as this company controls the Canadian rights it

will be an important part of their production. Haydite is sold in 3 sizes as an aggregate:—

	Weight per cu. ft.
A—Up to $\frac{3}{16}$-inch	45 lbs.
B—$\frac{3}{16}$- to $\frac{1}{2}$-inch	38 lbs.
C—$\frac{3}{16}$- to $\frac{3}{4}$-inch	38 lbs.

Hollow building-block units are also made in their own moulding plant. Haydite concrete weighs 100 pounds per cubic foot and is said to equal in



Haydite block-moulding department, Cooksville Company, Limited.

strength the normal concrete weighing 150 pounds per cubic foot. This allows the use of lighter-weight steel in buildings and bridges.

Milton Brick Limited (81), Streetsville

This is one of the three plants owned by this company; the other two are at Milton. The products are rug wire-cut face brick, red and flashed, and hollow building-block, including the patented Heath Cube block. The daily production is about 55,000 brick, or equivalent, in a season of ten months. The plant was built in 1912 by Mr. Stillnaugh and was bought by the present owner in 1916.

A 35-foot face of Queenston shale, 600 feet long, is used. While all parts burn red, certain sections give better colour, and selection is necessary.

Drilling for blasting is done with a well-digger from the top. Sixty per cent. ammonia dynamite is used. A half-yard Thew steam shovel loads the shale to 2-yard cars, which are horse-drawn to the foot of the incline to the plant. A five-eighths-inch cable is used on the incline. The machinery includes two 9-foot Baird dry pans, requiring 42 h.p. each; perforated-plate stationary inclined screens, 3 by 16 feet, set at 45 degrees; disc feeder to a 12-foot open-top pug mill; and combination pug mill and auger machine, manufactured by E. M. Freese and Company, requiring 200 h.p. The cutting table is made by the same firm. Cars take the ware to a 22-tunnel dryer of the radiation-flue type, using natural draft and burning coal. The burning is done in 7 rectangular down-draft kilns, 16½ by 78 feet inside dimensions, having a capacity of 250,000 brick per kiln. There are 24 horizontal-grate fire boxes for each kiln, burning coal. Two stacks, 50 feet high and 6 feet square inside, serve each kiln, drawing from either end of a central flue, which extends from end to end of the kiln. A depressed loading track allows railway shipments, and the Toronto area is served by truck delivery.

F. B. McFarren, Limited (82), Streetsville

This plant was started in 1915 as the Streetsville Brick Company and has been operated off and on until 1929, when it was purchased by the present owner. It is being remodelled. The present production is about 20,000 wire-cut stiff-mud brick, red or flashed, made from Queenston shale. The equipment consists of an E. M. Freese and Company stiff-mud outfit; a 6-tunnel car dryer, 95 feet long, with radiation flues under each track; and 2 rectangular down-draft kilns, 16 by 61 feet inside dimensions. The kilns are of the centre-flue type, having one stack for two kilns.

Brampton Pressed Brick Company (83), Brampton

This plant produces 1,500,000 dry-press brick in a season of about seven months. The Queenston shale used for the brick burns red to buff. Flashing is also done to vary the colour. Some seasons drain tile is made from the red-burning surface clay found above the shale. The plant was built by James Packham thirty-five years ago and changed to its present name, with W. J. Packham as manager, twenty years ago. In the pit there is 6 feet of blue-grey surface clay, 8 feet of Queenston shale burning a good red, and 10 feet of shale, red- and buff-burning mixed, which is sometimes sorted and made into buff brick. Shale continues below this level. The shale is worked in two levels for selection, hand-loaded to cars, ground in a dry pan, screened, and pressed in a Berg dry press. A piano-wire screen is used, and a 60 h.p. electric motor furnishes power. The dry-press brick are burned in rectangular up-draft kilns. The tile-making equipment consists of open-top pug mill, rolls, and auger machine manufactured by the American Clay Machinery Company. There are two dry sheds, 24 by 100 feet, and a 30-foot round down-draft kiln. Both wood and coal are used as fuel.

Terra Cotta Brick Company (84), Terra Cotta

This plant makes red, buff, and flashed dry-press brick from Queenston shale. The face is made up as follows:—

	Feet
Sod or loam, which is rejected	1
Red-burning shale, rather soft	4½
Buff-burning shale	4
Medium-red-burning shale	9
Shale below.	

The plant runs about seven months a year, producing 16,000 brick a day. It was built about 1910, was bought by H. Logan in 1914, and sold to Ott Brothers in 1928.

The shale is drilled by hand, blasted with 60 per cent. dynamite, and hand-loaded to cars from three benches. It is ground in an H. E. Frost Company (Galesburg, Ill.) dry pan, screened through a perforated plate screen, 3½ by 12 feet in size, set at a 45-degree angle, and pressed in a Berg dry press. A 75 h.p. steam engine furnishes the power. The burning is done in 2 round down-draft kilns, 32 feet inside diameter, having a capacity of 100,000 brick each, and two scove kilns. Wood and coal are used as fuel.

Halton Brick Company (86), Terra Cotta

The production is 3,000,000 dry-press Queenston shale brick, which burns red, buff, and flashed, in a season of nine months. The plant was built by the company eighteen years ago. The pit is in layers, as follows:—

	Feet
Overburden	6
Light-buff burning shale	3
Red-burning shale	8
Dark-buff burning shale	2
Dark-red burning shale	9
Shale below.	

Hand-loading is necessary to sort the shale. The equipment consists of dry pan, piano-wire screen, Berg dry press, 200 h.p. steam engine, 5 round down-draft kilns, 34 to 38 feet inside diameter, a 55-foot and an 80-foot stack for the five kilns. The kiln capacities are as follows:—

Diameter	No. of brick
34 feet	118,000
36 feet	130,000
38 feet	150,000

There is an auger machine of good capacity for making wire-cut brick, but it is never used.

Interprovincial Brick Company (87), Cheltenham

This plant is owned by the Cooksville Company. The normal production is about 7,000,000 dry-press red, buff, and flashed brick during a season of ten or eleven months. The plant may be operated all year if desired. The plant was built in 1912 and was purchased by the present owners in 1928.

Queenston shale is the raw material, and different colours are obtained from three different parts of the property. Careful sorting is necessary, so hand-loading is used. Two Berg dry pans (Berg Machine Manufacturing Company, Toronto), each requiring 30 h.p., grind the shale. After passing through perforated plate screens, it is formed in a Berg dry press having a capacity of 22,000 brick per day. The press requires 10 h.p. The brick go directly to 5 rectangular down-draft kilns having a capacity of 230,000 brick each. Pyrometers and cones are used to control the burning. A depressed track allows easy shipping. The buildings are of brick and are in good condition. The former owner built a railway tunnel kiln, but it is not in operation.

Caledon Shale Brick, Limited (89), Credit Forks

The normal production is 700,000 brick per month for a season of nine months. They are wire-cut brick, using Queenston shale, 90 per cent. being red or flashed and 10 per cent. buff and flashed buff. The plant was built in 1913 but was shut down for seven or eight years and has changed hands several times. The present owner bought it in 1927.

The 100-foot shale face is topped by 30 feet of glacial drift as overburden. A half-yard steam shovel is kept busy with this overburden. The buff-burning shale is sorted out by hand as it is loaded to cars and worked

separately. A 400-foot incline leads to the plant. The equipment consists of 2 C. W. Raymond (Dayton, Ohio) 9-foot dry pans, perforated plate screens, Raymond 12-foot single-auger open-top pug mill, Raymond auger machine, and cut-off, requiring a total of 250 h.p. Dryer cars take the brick to a 12-tunnel Raymond 100-foot dryer. Six tunnels are furnished with waste heat, and the others are of the normal radiation-flue type. Sheldon fans (Galt, Ont.) control the ventilation. The burning is done in an old Haag continuous-tunnel kiln, rebuilt into 4 down-draft kilns, and in a new rectangular down-draft kiln, 16 by 84 feet inside, of very good design, having a capacity of 170,000 brick (see photograph on page 98). The main centre flue is 38 by 48 inches and draws to both ends to a flue connected with the stack fan. The exhaust fan for all the kiln flues is of the plate type, 8 feet in diameter and 4 feet wide, connecting to a 25-foot stack. This fan gives an excellent control of the draft.

Port Credit Brick Company (251), Port Credit

This plant is now owned by the Cooksville Company and is being remodelled for operation in the spring of 1930, after being idle since 1923. The raw material is Lorraine shale and has been described as a very good deposit. It is situated on the lakeshore and gives opportunity for shipment by boat. The present plant contains both dry-press and auger machines, a 22-tunnel car dryer, 6 rectangular down-draft kilns, 18 by 65 feet, and two stacks about 65 feet high. The plant was reported by Baker in 1906 as one of the largest and best in Canada. The Hoffman continuous kiln has disappeared, and the plant has been largely rebuilt since then.

Perth County

PLANTS: Three of group No. 4.
CLAY: Glacial surface clay.
PROCESS: The stiff-mud method is used to make brick and drain tile.

In 1906, there were six plants, but three have discontinued operations.

Red Star Brick and Tile Yard (202), Stratford

This plant makes 90,000 red drain tile, 3 to 12 inches in size, and 180,000 red end wire-cut brick in a season of five months. It was known as the Close Brick Company in 1906 and is now operated by W. H. Barnhardt. The deposit has 2 feet of red-burning clay overlying clay that contains gravel. The clay is hand-loaded to dump carts. The equipment consists of a single-auger open-top pug mill, Baird auger machine, automatic cut-off, electric power, 16 dry racks 135 feet long for brick and one dry shed 40 by 135 feet for tile, and 4 round down-draft kilns, 22 to 25 feet inside diameter, with 4 stacks each. A fifth kiln has fallen in and cannot be used.

Dublin Brick and Tile Yard (205), Dublin

This plant is operated by Albert Kramer and produces about 360,000 cream-coloured drain tile, 3 to 12 inches in size, in a season of six months. The plant was built by F. L. Sadler fifty-two years ago and was taken over by Mr. Kramer in 1928. He works a 6-foot face of red-burning surface clay, using an open-top pug mill, Baird auger machine, and Fate automatic cut-off. The power is steam. There are 4 dry sheds, 20 by 120 feet, and one round down-draft kiln, 20 feet inside diameter, burning coal on inclined grates. The kiln has 6 stacks. He expects to build another kiln to take care of increased business.

John C. Weitzel (209), Tavistock

This small plant makes about 100,000 red tile, 3 to 8 inches, in a season of five months. The plant was built by Mr. Sharp 60 years ago, was owned

by F. Entricken twenty-five years ago, and was bought by the present owner in 1919. The deposit has 4 feet of red-burning clay with sandy clay below. The machinery includes a Baird auger machine, hand cut-off, 2 dry sheds 30 by 100 feet each, 30 h.p. gasoline tractor engine, and one round down-draft kiln, 18 feet inside diameter, with 4 stacks and 6 fire boxes in two groups of three on either side of the kiln. The kiln capacity is 14,000 tile of mixed sizes.

Peterborough County

PLANTS: One of group No. 2.
CLAY: Glacial surface clay.
PROCESS: Soft-mud and stiff-mud brick and drain tile are made.

There has been no change in plants since 1906. The Curtis plant has been making brick for about seventy-five years and they have samples of



St. Pauls Presbyterian Church, Peterborough, built in 1864 of red soft-mud brick from Curtis Brothers' plant.

brick at the plant which were made by hand one hundred years ago in this city. A good example of the older building in which the Curtis brick are used is shown in the photograph above of St. Pauls Presbyterian church, Murray and Water Streets, Peterborough. It was constructed in 1864 of hard-burned red soft-mud brick, and it looks as good as ever.

Curtis Brothers (41), Peterborough

This company produces about 2,000,000 brick and 140,000 cream-coloured drain tile in a season of five months. The brick include red, buff, and flashed soft-mud and end wire-cut brick, smooth and rugged. The plant was started in 1855 by Lazarus Curtis. On his death it was operated by his son Mark Curtis and is now owned by three grandsons, Charles, Albert, and George. About 80 per cent. of the buildings in Peterborough were built of their brick. By burning the brick hard and producing the textures and colours demanded by the trade they have been able to hold the local business, and very few shale brick are seen in the city. They have two plants, situated about a quarter of a mile apart.

Plant A.—Plant A uses either red or cream-burning clay. The cream clay comes from the pit near the plant, and the red clay must be hauled

some distance as the supply is exhausted near by. The equipment includes an open-top pug mill, Martin machine for soft-mud brick, and a Baird auger machine for drain tile and end-cut brick. The brick are dried in 9 racks, 185 feet long, and the tile go to 6 racks, 140 feet long, or to a dry shed, 50 by 100 feet. Three rectangular down-draft kilns with stacks on the walls have a capacity of 100,000 brick each (see photograph on page 98).

Plant B.—In plant B, red soft-mud brick only are made. An Iron Quaker soft-mud machine makes the brick, which are dried on 15 dry racks 160 feet long and burned in two kilns of the same type as those at the other plant. Curtis Brothers have been very progressive in obtaining the textures and colours desired by the local builders and have secured several patents on methods of obtaining them. From the appearance of the buildings all over town, it is hard to realize that all the brick came from this plant, using surface clay as a raw material.

Prescott County

PLANTS: One of group No. 2.
CLAY: Marine clay.
PROCESS: Soft-mud brick are made.

In 1906, no plants were listed, but the one described below must have been in operation.

Edwin G. Steele (68), Vankleek Hill

Mr. Steele operates two plants. As both have the same equipment and production, only one will be described. The Potter plant is on the C.N.R., and the Resbeck plant is on the C.P.R., allowing shipping on both lines. Each plant makes about 1,000,000 red soft-mud brick in a season of four months. The Potter plant is 80 years old and was built by J. C. Potter.

The clay pit consists of 3 feet of loam and 3 feet of strong clay, overlying gravel. It is hand-dug, and the top 6 feet are blended as it is loaded to cars. The equipment consists of an open-top pug mill, Iron Quaker soft-mud machine, 17 h.p. steam engine, 54 dry racks 50 feet long, and scove kiln. The average production is 15,000 per day. The summer shed over the machines is better than average, being well built of wood with corrugated iron roof. A door hinged at the top opens to the machine and gives protection to the men in wet weather. The scove kiln has a good shed roof with corrugated iron at the top to prevent burning. Brick can be easily loaded all winter from under this roof. The plant is well organized and is in better condition than the average summer yard.

Prince Edward Island County

In 1906, there was a plant at Picton, but this has discontinued operations and at present there are no plants running in the county.

Renfrew County

PLANTS: Five—two of group No. 2 and three of group No. 4.
CLAY: Marine clay is largely used. Utica shale outcrops near Lake Clear but is not used.
PROCESS: Soft-mud brick, stiff-mud brick, drain tile, and hollow building-block are made.

In 1906, there were five plants listed as making brick and tile. They are all still in operation, although two have changed hands since then.

Dochart Brick and Tile and Terra Cotta Works (63), Arnprior

This plant produces about 1,300,000 brick, 400,000 drain tile, and 24,000 hollow building-block in a season of six months. Business is improv-

ing. The plant was built fifty years ago by Wm. Baker and is now operated by the son, Geo. E. Baker. There is a 50-foot face of red-burning marine clay. The face is 400 feet long and is said to be 60 feet deep. Sand is found on another part of the property, and this is blended with the clay when soft-mud brick are made. The clay-winning is done by hand digging and loading from two points on the property. Horse-drawn cars go to an incline and storage bin of 6 days' capacity, in which the sand and clay are blended as required. A second car, fed by gravity, takes the clay to the machines. For soft-mud brick there is an open-top pug mill, rolls, and a Hercules soft-mud machine (Horton Manufacturing Company, Painsville, Ohio), requiring 75 h.p. with a capacity of 20,000 brick per day. For stiff-mud brick and hollow ware, there is an open-top pug mill, rolls, J. T. Fate combination pug mill and auger machine with automatic cut-off, requiring a total of 75 h.p. Cars take the ware to an 18-track tunnel waste-heat dryer having two Sheldon fans, using 15 h.p. each to control the circulation. There is also a dry shed, 30 by 110 feet, which receives waste heat from the kilns. There are 7 round down-draft kilns, 20 feet inside diameter, which burn wood. Each kiln has a 30-foot stack, 16 by 24 inches inside.

John E. Waite (64), Foresters Falls

This plant is making only drain tile at present but has made brick when there was a demand. The normal production is 30,000 to 50,000 tile in a season of four months. A farm is also operated by Mr. Waite and his two sons. James Johnson built the plant in 1895, and it was bought by Mr. Waite in 1898. The pit consists of 8 to 10 feet of strong clay, which is mixed with sand to give the proper plasticity. The sand is hauled about a mile. The clay is said to be 50 feet deep, with sand below. The colour of the burned ware is only a fair red. The equipment includes a Baird auger machine, 18 h.p. gasoline engine, and an Iron Quaker soft-mud machine. There are two dry sheds, 25 by 125 feet in size, and dry racks for brick. A 19-foot round down-draft kiln burning wood is used to burn the tile. The stack is 30 feet high and 16 by 24 inches inside. Brick are burned in a scove kiln.

Jas. Johnson, Sr. (65), Pembroke

This plant makes about 100,000 red soft-mud brick in a season of three months. It did not operate in 1928, as there was little demand for brick. A farm is also run. Jas. Johnson started making brick in this section 60 years ago, but the present plant is only 35 years old. The clay pit consists of 12 feet of red-burning clay. An Iron Quaker soft-mud machine forms the brick. There are 6 dry racks, 105 feet long, and the burning is done in a scove kiln with wood as fuel.

Pembroke Brick Company (66), Pembroke

This plant is owned by James R. Lockhart but is not operated every year for want of business. They make on an average 350,000 red soft-mud brick in a season of four months. The plant was built by J. A. Thibadeau and was sold to Mr. Lockhart 20 years ago. The equipment consists of rolls, open-top pug mill, Iron Quaker soft-mud brick machine, dry racks, and scove kiln. The clay face is 12 feet high with sand at lower levels.

Jamieson Lime Company (67), Renfrew

This company bought out the Thomas Henderson and the F. Hilliard plants in 1911, and they now operate only one of them. The production is 1,200,000 brick and 300,000 drain tile in a season of five months. The products are shipped by rail as well as being sold for local use. The clay

pit has a 12-foot face and consists of 4 feet of good red-burning clay overlying 8 feet of clay which burns to a light-red. Below this is at least 10 feet of buff or cream-burning clay, which is not used at present. The process includes hand-loading to cars, which are pulled up an incline to the plant. For soft-mud brick, rolls and an Arnold Creager machine are used (Arnold Creager Company, New London, Ohio). For tile a Baird auger and Bechtel's automatic cut-off are used. The average production is 18,000 brick a day, and 34 horse-power is required. There is a shed dryer and four round down-draft kilns, 25 feet inside diameter, which burn wood. Wood costs $4 per cord at the plant. There are 4 stacks to a kiln, each being 16 inches square inside. A small portable fan and gasoline engine aids the draft during the first part of the burn. The kiln capacity is 80,000 brick. The plant is well organized and kept in good condition.

Russell County

In 1906, there were two plants listed as making brick, but these have disappeared. Joseph Keele states that there is marine clay, Chazy shale, and Lorraine shale in this county, but at present no plants are operating.

Simcoe County

PLANTS: One of group No. 4.
CLAY: Glacial clay.
PROCESS: Soft-mud brick and stiff-mud drain tile.

In 1906, there were six plants, but only one is now operating.

Wm. T. Maw (75), Minesing

This plant is operated by two brothers who make about 120,000 red soft-mud brick and 80,000 cream drain tile a summer as well as run their farm. The business is a local one only. The plant was built thirty years ago by David Kendrill, an uncle of the present owners. It was purchased by W. T. Maw seventeen years ago.

The top 3 feet of surface clay is used for soft-mud brick, and the stronger blue clay below burning to a cream colour is used for tile. The blue clay is said to be 70 feet deep. An Iron Quaker soft-mud machine is used for brick, and a Baird auger machine for tile. A 25 h.p. steam engine furnishes power. There are dry racks, 100 feet long, and 2 round down-draft kilns, 25 feet inside diameter, which burn wood in 8 dead-bottom fire boxes. Each kiln has 4 stacks. The kiln capacity is 40,000 brick and 5,000 tile.

Timiskaming District

In 1906, Timiskaming was part of Nipissing district; it has, therefore, been listed with Nipissing on page 140.

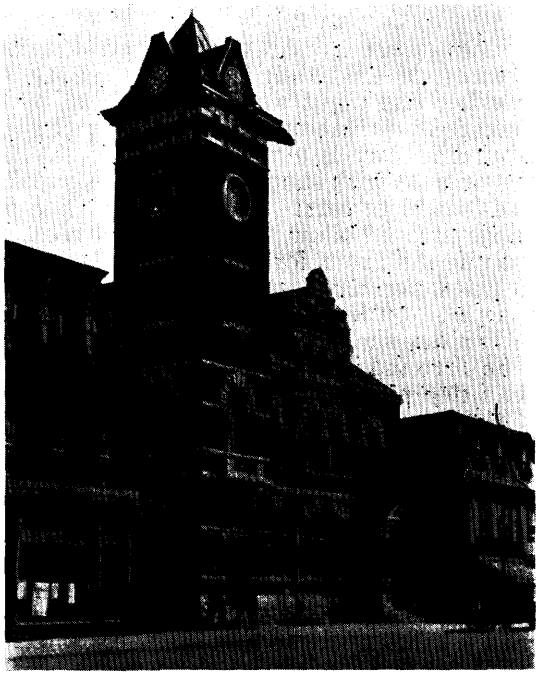
Victoria County

PLANTS: Two of group No. 3.
CLAY: Glacial or post-glacial clay.
PROCESS: Soft-mud brick and stiff-mud tile are made.

In 1906, the same two plants were listed, but one has changed hands. The photograph on page 155 shows the post office at Lindsay, one of the better early buildings of this section, built in 1888, using soft-mud brick from one of the above plants, with stone trim. It is a very neat building and still in good condition.

Chas. Wagstaff (32), Lindsay

This plant produces about 100,000 brick and 300,000 tile, 3 to 8 inches in size, per season of three and a half months. The plant, which was built about 1875, was owned by S. J. Fox, M.P.P., in 1906, and bought by the present owner in 1912. The pit consists of 1½ feet of red-burning clay with sandy layers overlying 4 to 6 feet of grey clay, which burns to a cream colour. Gravel is found below. The clay is blended to get the proper consistency and soaked in a pile near the plant. Lime pebbles cause some loss. Clay is hauled in the fall for the next season's work. For making tile, a Baird auger machine is combined with a vertical pug mill; a Martin machine makes the soft-mud brick. A 50 h.p. steam engine furnishes power. There is an old steam-coil dryer with a fan which is not in use, and the drying is done in racks. There are 6 small rectangular down-draft kilns built in one



Post office, Lindsay, built in 1888 of soft-mud brick.

block of unusual design. Four burn tile, and two brick. An extra fire box must be built in the door-way for each burn. Wood is used as fuel.

Frank Curtin (33), Lindsay

This plant produces about 600,000 red- and cream-coloured soft-mud brick in a season of five months. The plant was started in 1860 by the grandfather, Patrick Curtin, was taken over by the son Frank, and the grandson John now operates it. A farm is also operated. The red-burning clay on the farm is about used up and will last only about 4 years more. The top 1½ feet burns red, and below is 8 feet of sand and clay mixed, which burns cream. The clay is underlain by gravel. The clay is hauled in the fall and winter, and left to soak in the stock pile. Cars take the clay to an incline to the plant. The equipment consists of an open-top pug mill, Martin soft-mud machine 18 h.p., 12 dry racks 170 feet long, and 3 scove kilns. The brick are sold from the kilns.

Waterloo County

PLANTS: Four—one of group No. 2, two of group No. 3, and one of group No. 4.
CLAY: Glacial clay.
PROCESS: Stiff-mud brick, tile, and hollow building-block.

Bechtel Brick Company (243), Waterloo

This plant is now owned by the Ott Brick and Tile Manufacturing Company, of Kitchener, but was not in operation at the time of the writer's visit. Judging from the stock in sight they make wire-cut brick, red and flashed, hollow building-tile, and some cream-coloured stiff-mud brick, from surface clay. There is a dry shed 120 feet long and a two-compartment rectangular down-draft kiln of the type shown in the photograph on page 100.

Ott Brick and Tile Manufacturing Company, Limited (244), Kitchener

This plant produces about 2,000,000 brick and 400,000 drain tile and hollow block in a season of six to eight months. Both red- and cream-burning clays are used. The plant was built in 1885 by Frank Herman, and after several changes in ownership was bought by Ott Brothers in 1897. The supply of red-burning clay is almost exhausted. There is 16 feet of cream-burning clay available with sand and gravel below.

The clay is hand-loaded to cars. There is an incline to the plant, and the well-built buildings are of hollow tile with wood roof. The equipment includes an open-top pug mill, rolls for stone, Baird auger machine, 125 h.p. required for 25,000 brick per day, and an automatic cut-off. There is a 6-track waste-heat dryer, 150 feet long, and a dry floor above the tunnels for tile. There is also a dry shed, 30 by 150 feet, and a hack shed for brick, 30 by 150 feet. The 5 round down-draft kilns are 28 and 32 feet inside diameter. There is a dry press and a large Fate auger machine of 75,000 brick capacity, but these machines are not in use. Two of the kilns have 6 stacks each, two others have a 60-foot stack between them, and one kiln has a single 45-foot stack. The 32-foot kilns are considered to be too large to handle easily, and the 28-foot kiln is liked better. Pyrometers are used in the crowns.

M. C. Stroh (245), Conestogo

This plant produces cream-coloured drain tile, 3 to 12 inches in size, end wire-cut brick and side-cut brick, red, cream, or mixed in colour. The 24-foot kiln is burned 6 times a season and has a capacity of 100,000 brick. Brick and tile are set in the same kiln. The plant was built by H. D. Dahmer in 1908 and was purchased in 1914 by Mr. Stroh.

The pit consists of 18 inches of red-burning clay, 10 feet of grey clay burning to a cream colour, and 10 feet of blue clay burning cream. A dump cart takes the clay to the plant. There is a 60 h.p. steam engine, but only about 35 h.p. is required. The machinery consists of rolls, open-top pug mill, Baird auger machine, and automatic cut-off. The dry shed is 100 feet square. The round down-draft kiln has 4 stacks and burns wood.

Koebel Brothers (246), St. Clements

The plant makes 500,000 stiff-mud brick and 200,000 drain tile in a season of 7 months. The plant, which is sixty-eight years old, was built by Jacob Pebbler; it was bought by Joseph Koebel thirty-six years ago and is now run by his sons. The pit contains 12 inches of red-burning clay, 3 feet of grey clay burning to a cream colour, and 4 feet of blue clay, also burning cream. The blue clay is not plastic enough to be used alone in the stiff-mud process. The clay is hand-loaded to dump carts and delivered to an open-top pug mill, Baird auger machine, and automatic cut-off. A 20 h.p. steam

engine furnishes the power. There are 2 dry sheds, 2 dry racks, and an enclosed dryer, 110 feet long, which can be heated for use in spring and fall. A 7½ h.p. fan pulls waste heat from the kilns to the dry shed. Two kilns are used for burning. One is a rectangular down-draft kiln with a capacity of 40,000 brick, and the other is a new round down-draft kiln, 26 feet inside diameter, with a capacity of 70,000 brick. This new kiln has 4 stacks and burns coal on horizontal grates. Pyrometers are used in both crown and bottom.

Welland County

In 1906, there were two plants listed, but none are now in operation. The surface clay in this section is inclined to be stony in many places. Salina shale outcrops at Bridgeburg, but is not used.

Wellington County

PLANTS: Two of group No. 4.
CLAY: Glacial clay.
PROCESS: Stiff-mud drain tile.

Stephen E. Donaldson (239), Fulton Mills

Mr. Donaldson's son runs the plant and the farm. While the plant has operated every year, the production has varied considerably. It was built by Mr. Bell forty to fifty years ago and was purchased by the present owner in 1914. The pit consists of 3 feet of red-burning clay and sandy clay below. The clay is hauled to the plant in dump-carts after soaking in the pit and delivered to an open-top pug mill, Baird auger machine, and hand cut-off. A steam tractor furnishes power. The dry shed is 30 by 115 feet in size, and there is a rectangular down-draft kiln, 12 by 28 feet inside, with two stacks at one end and one at the other. As wood is hard to get, coal will be used in future.

Amos C. Martin (240), Wallenstein

This plant produces drain tile, 2½ to 12 inches in size, from a mixture of red- and cream-burning clay. Each season of five and a half months 22 kilns are burned; each kiln will hold 15,000 tile of mixed sizes. The plant was built by Henry Stroh forty years ago and was bought by Mr. Martin nine years ago. Wood is used as fuel. Mr. Martin is a machinist and keeps his plant in the best of condition. He built a mechanical clay-digger which acts like the Buckeye digger and also a novel kiln shed, which is shown in the photograph on page 89. The roofs are of corrugated iron and are painted as often as needed.

In the pit there is 1½ feet of red-burning clay overlying 4 feet of cream-burning clay. The clay extends 6 feet or more below the present working. The working face is blended by the mechanical digger, which delivers to a motor dump car on a track leading to the plant. The machinery includes an open-top pug mill, Baird auger machine, and hand cut-off. The dry shed area is 30 by 120 feet and 20 by 70 feet. There is one round down-draft kiln in a kiln shed, 48 by 80 feet. A 50 h.p. steam engine furnishes power.

Wentworth County

PLANTS: Eight—one of group No. 1, five of group No. 2, one of group No. 3, and one of group No. 4.
CLAY: Glacial surface clay and Queenston shale. Cabot Head shale outcrops at Stoney Creek, but is not used.
PROCESS: Soft-mud brick, stiff-mud brick, drain tile, and hollow block are made.

In 1906, twelve plants were listed. Many of those near Hamilton have gone, as the local clay is exhausted and it was necessary to move or stop operations. Queenston shale has increased in importance as a raw material

for face brick, and the clay is now used almost entirely for common brick. The Aldershot plant of the National Sewer Pipe Company (see page 169) also makes drain tile pipe.

National Fireproofing Company of Canada (2), Aldershot

This plant has a capacity of 120 tons a day and produces all kinds of hollow building-block by the stiff-mud process. It was built in 1910 and operates all year. One of the outstanding jobs in which this plant's tile were used is the Parliament Buildings at Ottawa. Queenston shale is mixed with a certain percentage of sewer-pipe clay found at the surface above the shale. The clay pit is 5½ feet deep and is blended as it is dug by a Buckeye mechanical clay-digger (see photograph on page 49). The clay is hauled to the plant storage in 2-yard cars by a 4-ton American Machine Company gasoline locomotive. The shale is blasted, using 40 per cent. dynamite, after drilling with an Ingersoll-Rand jack-hammer. The shale is crushed in a roll crusher, pulled up the pit incline with a wire rope and 25 h.p. motor, and taken to the plant storage by the locomotive. Clay and shale are proportioned by hand on a conveyer which feeds a 9-foot Berg dry pan requiring 50 h.p. Electric motors are used throughout. The fines go to a Tyler hummer 7-mesh screen, 4 by 5 feet in size, and then to a storage bin from which it is delivered by a feeder to the pug and auger machines. There are two sets of machines to prevent hold-ups due to changing dies or repairs. Each set consists of a 9-foot open-top pug mill requiring 50 h.p. and an auger machine requiring 120 h.p. All the machinery is made by E. M. Freese and Company, Galion, Ohio. The dies are made in the machine shop at the plant. A hand cut-off is used to obtain accurate work. Dryer cars take the ware to a 16-track radiation-flue dryer requiring 48 hours or to a waste-heat dry floor above the tunnels requiring 24 hours. Transfer tracks take the ware to 8 round down-draft kilns. These kilns are 32 feet inside diameter and have a capacity of 110 tons each. For each two kilns, there is a 2-compartment stack, 50 feet high and 3½ by 6 feet inside size for each kiln. The burning is done in 72 hours, using coal fuel in a modified dead-bottom fire box with a coking plate. Depressed tracks allow easy loading to railway cars. This is a modern well-organized plant and one of the best in the province.

Crawford Brothers (91), King Street West and Macklin Street, Hamilton

The production in a season of four months is 300,000 end wire-cut brick of mixed red- and cream-burning clay. The plant is forty-five years old and has had no change in ownership. For years the product was used as face brick, but there is little demand now for surface-clay brick. The clay at this location will soon be exhausted. Dump carts bring the clay to an open-top pug mill and Baird auger machine. A 25 h.p. motor is used. There are 11 dry racks 80 feet long and 2 scove kilns. The sand and gravel below the clay is used to make cement block.

Frid Brothers (92), Macklin Street and Dundas Road, Hamilton

This plant makes about 1,500,000 red- and cream-coloured soft-mud brick in a season of six months. The plant is twenty-five years old. Some of the selected brick are used for face, but most of them are common brick. The pit consists of 6 feet of red-burning clay, 18 inches of sand, and 6 feet of cream-burning clay with clay and gravel below. The property is being graded as the clay is used and will be sold as building lots. The manufacture of brick will not be continued very long. The clay is hand-loaded to wagons, which deliver to rolls, elevator, open-top pug mill, and Iron Quaker soft-

mud machine equipped with a 20 h.p. electric motor. There are 11 dry racks 200 feet long and 2 round down-draft kilns for burning. Three scove kilns are also used. The round kilns have a capacity of 100,000 brick each. Brick have been made in this location for fifty years.

Hamilton Pressed Brick Company (94), Kensington Ave. S., Hamilton

This plant produces in each season of eight months 3,000,000 dry-press and stiff-mud brick, both red and flashed, from Queenston shale. The plant, which was built in 1907, is operated by Robert New, and there has been no change in ownership. The shale face is 30 to 80 feet, with a few thin layers of buff-burning shale running through it. Above is 5 to 10 feet of surface clay. The entire face is used without any sorting. The shale is loaded by hand to small three-quarter-yard mine cars and pushed 100 feet to the plant.

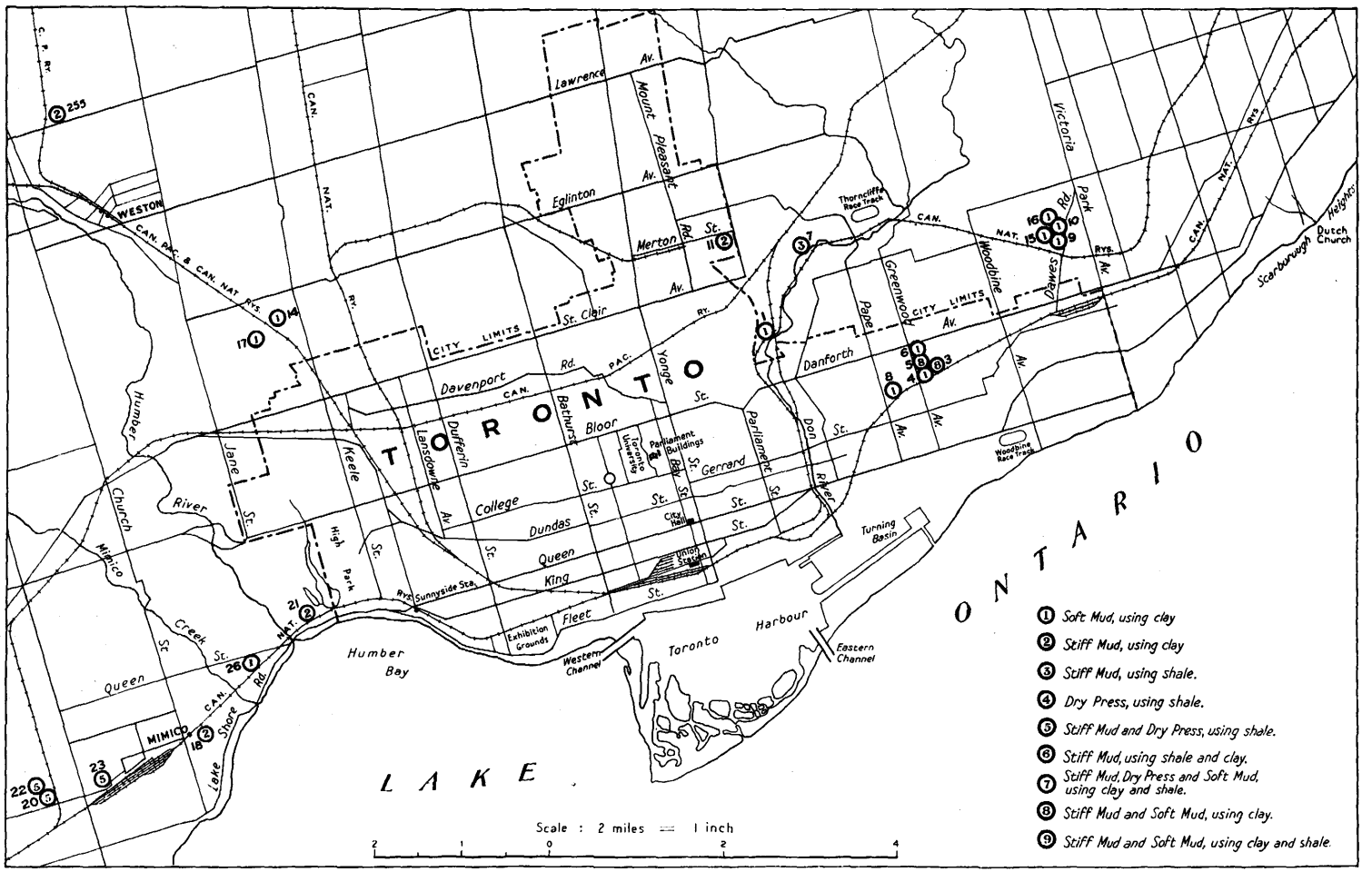
Until three of four years ago dry-press brick only were made, but the change in demand necessitated the introduction of the stiff-mud process and flashing instead of the normal clear burning. For making dry-press brick there is a 9-foot Stevenson dry pan, perforated plate screen, Berg dry press with a capacity of 22,000 brick per day, and cars direct to the kilns. A 50 h.p. electric motor is required. For making stiff-mud brick there is a Stevenson 9-foot dry pan, E. M. Freese and Company auger machine and cut-off, using a 100 h.p. electric motor and having a capacity of 50,000 brick per day. The actual production is one-half of the capacity, or 25,000 brick a day. Cars take the brick to an 8-tunnel radiation-flue dryer, burning coke as fuel, and then to the 10 round down-draft kilns. The kilns, which are 38 feet inside diameter with 14 dead-bottom fire boxes for burning coal, have a capacity of 145,000 brick. When flashing, only 130,000 are set in a kiln to give a better distribution of gases. There is a 60-foot stack for each two kilns. Pyrometers are used for burning control. A depressed track allows easy loading for shipment. The plant is one of the simplest in operation for its capacity in Ontario.

W. H. Cooper (95), Paradise Road, Hamilton

The production of this plant is about 2,000,000 red soft-mud brick in a season of five months. The plant was built in 1910 on King Street and was moved in 1925 to this new location farther out of town. The clay deposit consists of 7 feet of red-burning clay, 8 feet of clay burning to a cream colour, and gravel below. The red-burning clay is used at present. It is harrowed and brought to the plant in a clay gatherer (see photograph on page 48), delivered to a Martin "A" soft-mud brick machine, which has a capacity of 24,000 brick per day, and is powered by a 40 h.p. electric motor. A cable conveyer takes the brick on pallets to 16 dry racks 190 feet long. The burning is done in three permanent wall scove kilns having a capacity of 550,000 brick each and in two other scove kilns used at times for extra production. The plant is a very good one of its type. Water-smoking is done with coke, and the burning with coal.

Richard Tope Estate (97), King Street West, Hamilton

The production is 1,000,000 red- and cream-coloured soft-mud brick in a season of five months. The plant was built in 1910 and has not changed ownership. The clay pit contains 8 to 12 feet of red-burning clay overlying 10 to 12 feet of cream-burning clay with gravel below. The red clay will only last a few years at the present rate of production. The clay is hand-loaded to wagons. The machinery consists of rolls, open-top pug mill, Martin soft-mud machine, 30 h.p. electric motor, a 13-rack dryer 135 feet long, and 4 permanent wall scove kilns with a capacity of 320,000 brick each.



KEY PLAN OF TORONTO AND VICINITY, SHOWING LOCATION OF CLAY- AND SHALE-WORKING PLANTS. NO. 11 IS A FLOWER-POT PLANT, AND NOS. 18 AND 21 ARE SEWER PIPE WORKS.

Ollman Brothers (98), 111 Macklin Street, Hamilton

This plant makes 4,000,000 red and cream-burning stiff-mud brick, both plain and rug, in a season of five months. The plant is forty years old and a son, R. F. Ollman, now operates it. The pit contains 7 feet of sandy red-burning clay and 12 feet of sandy cream-burning clay with gravel below. The clay is hand-loaded to wagons and delivered to rolls, Fate combination pug mill and auger machine with an automatic cut-off. A cable conveyer takes the brick to 20 dry racks 105 feet long. Three scove kilns of 250,000 brick capacity burn the brick. Delivery is made by truck. The gravel below the clay is screened, and cement block are made as well as brick.

Canadian Pressed Brick Company (99), Bartonville

The production for a season of ten months is 3,000,000 dry-press brick, red, buff, and flashed, made from Queenston shale. The plant, which is seventeen years old, was bought by the present company in 1923 and is operated by J. C. Wright. The shale face is 50 to 60 feet high and has several layers of buff-burning shale running through it which are sorted out and used separately after mixing with cream-burning surface clay. There is not enough buff-burning shale to meet the plant requirements. The shale is hand-loaded to dump carts, ground in a Berg dry pan, elevated and screened through a perforated plate screen, and pressed in a Berg dry-press machine. The capacity is 18,000 brick per day. There are three rectangular down-draft kilns, 14 feet 6 inches by 51 feet inside, with a capacity of 100,000 brick each. For the three kilns, there are 2 stacks, 60 feet high and 9 feet square outside. The buildings are of brick and wood construction. There are 2 pyrometers in the crown of each kiln.

York County

PLANTS: Sixteen—four of group No. 1, nine of group No. 2, one of group No. 3, and two of group No. 4.
CLAYS: Glacial and interglacial clay and Lorraine shale.
PROCESS: Soft-mud brick, dry-press brick, and stiff-mud brick, and hollow building-block are made.

In 1906, there were thirty-one plants listed, but there have been many changes. The plants making rug brick from Queenston and Lorraine shale in Peel county have taken much of the soft-mud brick business, and only those plants favourably located as to size of deposit and quality and colour of product still operate. The local surface clays have been used up in some sections, as along Weston Road.

There are many old buildings in Toronto erected about 100 years ago, but very few have authentic dates easily obtained. Such buildings are being torn down rapidly, not because the brick are failing but because the buildings no longer have a commercial value. Most buildings in a growing city become obsolete in thirty-five to forty years because of changes in style and equipment. Churches and houses have a longer useful life than office or factory buildings and apartment houses. Among the older churches of Toronto is St. George (Anglican) Church, 197 John Street, which is shown in the photograph on page 163. It was built in 1844 of cream-coloured soft-mud brick and has stood the test of time. Old St. Pauls church on Dundas Street was built in 1834 of hand-made red slop brick, and Holy Trinity church in Trinity Square was completed in 1847.

Don Valley Brick Works (1), Todmorden

This plant is owned by the Toronto Brick Company. The normal production of this plant is 25,000,000 brick in a 12 months' season and includes red, buff, cream, and flashed soft-mud brick, dry-press brick, stiff-mud brick,

and enamelled dry-press brick. Wm. Burgess is superintendent. This plant is one of the best known in Ontario and was built in 1889 by Taylor Brothers. The name was changed to the Don Valley Brick Works in 1909 and was purchased by the present owners in 1929. The pit is an unusual one and is made up approximately as follows:—

	Feet
Iroquois clay, largely buff-burning but with some red-burning on top	25
Glacial drift, largely gravel	2
Interglacial clay, of buff- and red-burning clay mixed	65
Sand, used in soft-mud brick and for sand ng moulds	21
Lorraine shale containing 20 to 30 per cent. stone in bands	75
Shale below.	

There are three steam shovels, with capacities of three-quarter, seven-eighths, and one and three-quarter yards, used to load the raw materials on three different levels. For the manufacture of soft-mud brick the top Iroquois clay is loaded to cars and sent down an incline to the plant by gravity. The interglacial clay is also used for soft-mud brick or may be mixed with shale to make stiff-mud brick. Sand is delivered through a disc feeder to mix with the clay, which goes to an open-top pug mill, rolls, and a Hercules soft-mud brick machine. The brick are sent through an 8-track waste-heat dryer 128 feet long. Steam coils give extra heat as required. A 10 h.p. plate fan controls the circulation.

The stiff-mud brick are made by mixing Lorraine shale with clay in the various proportions required to control plasticity and colour (see photographs on pages 38 and 41). The clay goes through a granulator and is then mixed and ground with the shale in 8-foot dry pans, 4 of which have been in use since 1895. Each pan requires about 30 h.p. The ground material is screened through 8 perforated plate screens, 4 by 16 feet, and then sent to storage or to the machines, which consist of two open-top pug mills in series and a Chambers auger machine and cut-off. Barium carbonate is added at the pug mill to prevent scum. The daily production of this equipment is 60,000 brick. The brick go by car to a 50-track waste-heat dryer 80 feet long. A 25 h.p. motor fan controls the waste-heat circulation, which is taken from the kiln crowns through an overhead pipe, 5 to 6 feet in diameter.

The dry-press brick are made from shale ground in the dry pans and formed in 4 dry presses, two Boyd and two Berg machines, each taking about 8 h.p. The average plant production from the three departments is 83,000 brick a day. Selected burned dry-press brick are enamelled with a lead glaze by dipping and firing in 4 small muffle kilns. The brick are burned in 14 rectangular down-draft kilns and a 20-chamber continuous kiln. The rectangular down-draft kilns are 16 feet 6 inches by 82 feet inside and have a capacity of 125,000 brick each. Wood fuel is used to water-smoke and then coal, using horizontal grates. There are three stacks: One is 175 feet high, with a 4- by 4-foot cross-section, and is connected with a 15 h.p. fan to increase the draft; the second stack is 120 feet high and 5 feet square inside; and the third stack is 105 feet high and 3 feet square inside. The plant is located in a valley, and high stacks are necessary. Some of the kilns are as far as 160 feet from the stacks, and the draft is not always the best. Pyrometers are used in each kiln crown.

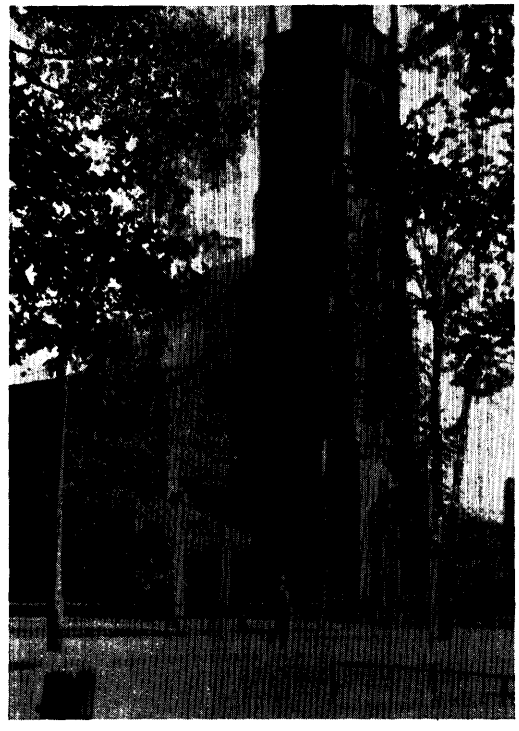
The continuous-chamber kiln has 20 chambers, in two rows. Each chamber is 14 feet 6 inches by 47 feet long. Producer gas is used as fuel, requiring 5 producers with 4 in use at a time.

Toronto Brick Company (3), John Price Plant, Greenwood Avenue, Toronto

The production is 11,000,000 red soft-mud and stiff-mud face brick a year. The plant was started in 1912 by John Price, who moved from an older location on Queen Street where he had been making brick since 1883.

The brick from this plant and from the others on the same street are still in demand for face purposes because of their pleasing rich dark-red colour.

The pit consists of 70 feet of blue-grey lower interglacial clay[1] and is worked in two benches of 30 feet each. A Bay City 25 h.p. electric-power shovel is used for stripping 20 feet of sand overburden, but the clay is hand-loaded to cars, which are pulled up an incline to the plant. For making soft-mud brick there are two units, each composed of rolls, open-top pug mill, and Martin soft-mud machine. Each unit requires 40 h.p. and makes



St. George Church, Toronto, built in 1844.

3,000 brick an hour. For the manufacture of stiff-mud brick there is a 4-shaft disintegrator, open-top pug mill, E. M. Freese and Company combined pug mill and auger machine, with an automatic cut-off, requiring 100 h.p. and having a capacity of 60,000 brick per day. The actual production is about 20,000 stiff-mud brick per day. The brick go on cars to a 23-track waste-heat tunnel dryer 110 feet long. A 50 h.p. fan controls the waste-heat circulation. The air goes to the dryer at 135° to 140° F. and comes out at 80° F. There are 8 round down-draft kilns, 30 feet inside diameter, having a capacity of 85,000 brick each. Coal is burned on horizontal grates using forced draft and fan exhaust instead of a stack, being a modified Minter system of burning. Rapid burning with good colour, with no time lost during the water-smoking period, is the result. There are also 3 rectangular chamber kilns obtained by modifying an old continuous-chamber kiln. These are 15 by 35 feet inside dimensions and increase the burning capacity of the plant. Pyrometers are used in the kiln crowns. A railway siding allows easy shipping, but most of the delivery is by truck direct from the kilns. The stock carried is very small.

[1] J. Keele, op. cit., p. 106.

A. H. Wagstaff (4), Greenwood Avenue, Toronto

This plant makes 4,500,000 red soft-mud brick in a season of ten to twelve months. The plant was built in 1905 and rebuilt after a fire in 1915. There has been no change in ownership . The pit has a 40- to 50-foot face of blue-grey inter-glacial clay with sandy seams in it. Sand is blended with the clay as it is hand-loaded to cars, which are hauled to the foot of the incline by horse. The equipment includes rolls, open-top pug mill, and Martin soft-mud brick machine equipped with a 50 h.p. electric motor. Cars take the brick to an 11-track waste-heat dryer 85 feet long. A 25 h.p. fan pulls the heat from the cooling kilns. There is some recirculation of air at the hot end of the dryer. There is also a 5-track open-air dryer for use in summer, each track holding 18 cars. The 5 kilns are of the rectangular down-draft type, 17 feet 6 inches by 48 feet inside dimension, having a capacity of 120,000 brick each. There is one 55-foot stack 4 feet square inside for 4 of the kilns. The fifth kiln is an older one and has three stacks built in the kiln walls.

Price and Smith (5), Greenwood Avenue, Toronto

This plant produces about 4,500,000 red soft-mud and stiff-mud brick in a season of eight to nine months. The plant was started in 1888 by Isaac Price, father of Fred. S. Price who now operates the plant. Some of the first brick from this plant were used in sewer construction at King and Yonge Streets, Toronto, and Mr. Price says that they are still in place and as good as ever after 40 years of service.

The clay pit contains 1 to 2 feet of stripping, 4 feet of sand, 15 feet of sandy clay, and 50 feet of good plastic clay. It is an interglacial deposit. The clay is hand-loaded to cars and hauled by horse to the incline at the plant. For making soft-mud brick there is an open-top pug mill, rolls, and a Lancaster Iron Works vertical automatic soft-mud brick machine. This machine requires 35 h.p. and is hand-operated to get brick of a better quality than was found to be possible when using the automatic equipment. For manufacturing stiff-mud brick there are rolls, Fate combination pug mill and auger machine and cut-off, requiring 80 h.p. and having a capacity of 40,000 brick per day. The brick are taken by cars to a 14-track waste-heat tunnel dryer 94 feet long. A 15 h.p. Keith fan controls the waste-heat circulation. Additional heat may be obtained from steam coils if needed. There are 4 rectangular down-draft kilns and one round down-draft kiln. The rectangular kilns are 12 by 58 feet inside dimensions with a capacity of 100,000 brick each. The round down-draft kiln is 32 feet inside diameter and has a capacity of 85,000 brick. It has a Vogt flue system in the bottom, which gives good heat distribution. Forced draft allows good control of the burning, especially during the first part of the burn. There are 2 stacks for the 4 rectangular kilns. One is 100 feet high and 5 feet square inside, and the other is 60 feet high and 4 feet square inside. The round kiln has a 40-foot stack 4 feet square inside.

Standard Brick Company (6), Greenwood Avenue, Toronto

The production is 4,300,000 red soft-mud brick in a season of seven to eight months. The plant was built in 1908 and there has been no change in ownership. The Granite Club on St. Clair Avenue, Toronto, was built with brick from this plant in 1927 and is a good example of the modern use of soft-mud brick. The clay is the same as at the other plants on this street. The equipment consists of rolls, Doig open-top pug mill, and Martin soft-mud machine requiring a 40 h.p. electric motor. The pair of rolls consists of a 12-inch smooth roll, travelling at 700 r.p.m., and an 18-inch roll with knives running at 100 r.p.m. A cable conveyer takes the brick to

a steam rack dry shed, 24 by 105 feet in size. There are also natural-air dryer racks in an area of 285 by 110 feet. There are 3 rectangular down-draft kilns, 16 feet 6 inches by 68 feet inside dimension, with a capacity of 185,000 brick each. A pyrometer is used in each crown. Forced draft for burning the fuel is supplied to each fire box by a 10 h.p. Keith blower with a 20-inch outlet. A 2 h.p. Sheldon fan on a portable truck aids in cooling the kilns. There are two 35-foot stacks, 4 feet square inside, for each kiln.

Sun Brick Company (7), Todmorden

This plant produces 20,000 tons of hollow building-block in a season of ten to eleven months. The plant, which was built in 1911, was bought by the present company in 1919 and is operated by H. Bevens as superintendent. A 40-foot face of red-burning Lorraine shale gives an unlimited supply of raw material. About 20 feet of overburden must be removed. After blasting, the shale is hand-loaded to cars, which are pulled up an incline to the plant by a five-eighths-inch cable and a 20 h.p. electric motor. The cars dump automatically to a hopper, which feeds a single-roll crusher, which is considered to be better for shale than a 2-roll crusher. A conveyer takes the material to the dry pans or storage. There are three 9-foot International dry pans, requiring 25 h.p. each, and 3 perforated plate screens. A new type of vibrating screen that can be adjusted for angle is being installed. The screened shale goes to a 10-foot Raymond open-top pug mill and an International auger machine and hand cut-off. The hollow-ware dies are made in the machine shop at the plant. Dryer cars take the ware to a 20-tunnel radiation-flue track dryer 95 feet long. The burning is done in an 18-chamber Youngren type of continuous kiln. Each chamber is 14 feet 6 inches by 41 feet in size and is burned once every ten days, with the fire on for 27 hours. Producer gas is used as fuel. There is a depressed siding for loading railway cars for shipment.

Russell Brick Company (8), Blake Avenue, Toronto

The production is 4,500,000 red soft-mud brick in a season of ten months. In 1906, Mr. Baker states that this was one of the largest plants and made 10,000,000 brick a season. Its present production has fallen to less than half that figure, and the plant has not been kept up to date or in good repair. It was started in 1897 by the Simpson Brick Company, was owned by Abe Orpen in 1904, and later bought by Joseph Russell, who is now dead. At present it is operated by Thomas J. Russell. The Russell family have made brick for years. John Russell, father of Joseph Russell, started making brick on Queen Street about 1860. At this plant, a 20-foot face of clay is hand-loaded to dump carts and hauled to the plant. The clay is elevated from a hopper at the ground level to rolls, open-top pug mill, and Martin soft-mud machine run by a 50 h.p. steam engine. There is a 10-track tunnel-car dryer, 85 feet long, with a 32 h.p. fan ventilation and recirculation of the air. Steam coils under the hot end of the dryer furnish heat for drying. There are 3 rectangular kilns of an old and unusual type, having a capacity of 140,000 brick each. The inside dimensions are 18 by 61 feet, and the flues are in the side walls and go horizontally along the top of the kiln to the stack.

Phippen and Field (9), Dawes Road, Toronto

This plant makes 4,000,000 cream-coloured soft-mud brick a season of nine months. Brick have been made here since 1885, but the present plant was built in 1918 by Phippen and Field. The pit consists of 2 feet of red-burning clay, 13 feet of sandy cream-burning clay with stony clay below. It is hand-loaded to cars, taken up an incline to the plant, and delivered to

an open-top pug mill and a Martin "A" soft-mud brick machine. There is a 5-track car-tunnel dryer 90 feet long, which is used in cool weather, but most of the brick are dried on 10 open-air racks 265 feet long. The burning is done in 3 round down-draft kilns and one rectangular kiln. The round kilns are 31 feet inside diameter and have two stacks each. The rectangular kiln was an old type and was not measured. A pyrometer is used in each crown.

J. E. De Laplante and Company (10), Dawes Road, Toronto

The production is 2,500,000 cream-coloured soft-mud brick per season of five months. The present plant was started in 1900 by the Chapman Brick Company and was purchased by the present owner in 1910. There is a 10-foot face of surface clay, consisting of 2 feet of red-burning clay, 8 feet of sandy cream-burning clay, with a sand bed below. The clay is hand-loaded to cars and delivered by an incline to the plant. The equipment consists of an open-top pug mill, Martin soft-mud brick machine, 21 dry racks 230 feet long, and 4 round down-draft kilns. The kilns are 29 feet inside diameter, have a capacity of 96,000 brick each, and burn coal on horizontal grates. There is one stack 40 feet high and 5 feet square inside.

Geo. Piggott and Company (14), Mount Dennis

Red and cream-coloured soft-mud brick are made every other year. Selling is done from the kilns. Brick were made by hand at this location as early as 1855 by Mr. Porter. The present plant was started in 1912, and there has been no change in ownership. The clay is hand-loaded, brought to the plant in dump carts, and formed in a Doig Hercules soft-mud machine, using a 20 h.p. electric motor for power. There is a hack yard with pivot shed roofs and scove kilns.

Chapman Brick Company (15), Dawes Road, Toronto

The present production is about 2,000,000 red and cream-coloured soft-mud brick in a season of five months. The grandfather, John C. Chapman, started making brick in Toronto about 1850. The father is David C. Chapman, and the son is Charles. The Chapman family owned and operated the Phippen and Field plant for years and started the present plant in 1927. The pit consists of 4 feet of red-burning clay overlying 8 feet of sandy clay, which burns to a cream colour. The clay is hand-loaded to a dump cart and delivered to an open-top auger machine and a Martin soft-mud machine. A 25 h.p. motor furnishes power. The average production is 17,000 brick per day. There are 10 dry racks 230 feet long, and a scove kiln burns the brick. Round down-draft kilns are being planned.

Walker Morley Brick Company (16), Dawes Road, Toronto

The production is about 1,500,000 red and cream-coloured soft-mud brick in a season of five months. John Morley, grandfather of A. Morley and father of Walker Morley, started making brick in 1834 on Davenport Road, Toronto. The family have manufactured brick ever since. This is a normal yard, using 3 to 4 feet of red-burning clay overlying 8 feet of sandy clay, which burns to a cream colour. There is an open-top pug mill, Martin soft-mud machine, 25 h.p. electric motor, 15 dry racks, 180 feet long, and 3 round down-draft kilns, 30 feet inside diameter. A 4-track tunnel dryer is being built.

Mount Dennis Brick Company (17), Bushey Avenue, Mount Dennis

The production is uncertain, and no brick were made in 1928. The clay is about used up, and the property will probably be sold as a factory

site. There is a Martin soft-mud machine, hack dry yard, and scove kilns for burning.

Booth Brick and Lumber Company (22), New Toronto

This plant produces 8,000,000 red, buff, and flashed dry-press and wire-cut brick, using Lorraine shale, and operates all year. Wm. Booth, father of Geo. W. Booth, the present owner, started making brick in North Toronto in 1878. Geo. Booth's sons are active in the operation of the present plant The first railway tunnel kiln to be successfully operated in Ontario was developed by Geo. Booth, and he deserves much credit as a pioneer in this field.[1] He has two such kilns at this plant and has constructed another at the Crang-Booth plant in Weston, as well as one in the United States near Buffalo. The replacement of the old type of kiln has been justified in the opinion of the owners. The Lorraine shale is worked to a depth of 25 to 30 feet. A 3-foot bed of sandy clay is found above the shale. The shale is hand-loaded from three points in the pit to get a satisfactory blend and is delivered to the plant by car up an incline. There are 2 dry pans requiring 25 h.p. each, 2 stationary inclined 7-mesh wire screens, and 2 Berg dry-press machines for making dry-press brick. For manufacturing stiff-mud brick, there is a Bechtel open-top pug mill, an International auger machine, and a Freese cut-off, requiring a 75 h.p. motor. Dryer cars take the brick to a waste-heat dryer, which is part of the tunnel kiln outfit. A 25 h.p. fan controls the waste-heat circulation. There are two tunnel kilns burning coal as fuel. One is 250 feet long and takes a car of 1,000 brick every $2\frac{1}{2}$ hours; the other is 335 feet long and takes a car every 2 hours. Both flashed and clear colours are obtained. The kiln temperatures are controlled by pyrometer. A 50 h.p. fan pulls the products of combustion through a recuperator and then to a 40-foot stack. The total kiln capacity is 25,000 brick per day, burning 340 days a year.

Richard Butwell (26), Humber Bay, Toronto

This plant makes red and cream-coloured soft-mud brick during the summer season. It was not in operation at the time of the writer's visit. A 20-foot face of sandy glacial clay is used. The equipment includes an open-top pug mill, a Martin soft-mud machine, a 30 h.p. motor, 9 dry racks, 185 feet long, and 2 round down-draft kilns, 30 feet in diameter, having one 35-foot stack. It is a normal summer yard.

Crang-Booth, Limited (255), Wilson Road, Weston

Geo. W. Booth, of the Booth Brick and Lumber Company, New Toronto, designed and built this new plant to make 60,000 stiff-mud brick per day from surface glacial clay. The plant is modern in design, being the first plant to place the waste-heat dryer above the tunnel kiln. The construction is completed, and it will start operation in the spring of 1930, running twelve months a year.

The clay pit, which will be about 25 feet deep, consists of 12 feet of red-burning clay overlying 13 feet of blue clay, which burns to a cream colour. The property comprises 100 acres. A half-yard electric-power shovel will load the clay to a car, which will deliver to an aerial bucket (see photograph on page 53) for delivery to the storage bin at the plant. The machinery includes a 9-foot open-top pug mill, rolls, a conveyer to the second floor, a combination pug and auger machine, and an automatic cut-off. The equipment is furnished by the International Clay Machinery Company. The pug mill and rolls require 40 h.p., and the auger machine 75 h.p. The total capacity is 100,000 brick a day, but the kiln will not burn more than 60,000 brick. Dryer cars take the brick through a 2-track

[1] *See* Canadian patent 198,889, April 6, 1920.

tunnel dryer over the top of the tunnel kiln. First, there is a 70-foot preheater with high humidity, receiving its heat from the flue gases by recuperation. Then there is the 400-foot main tunnel over the kiln. The dryer cars are lowered to the first floor by means of an automatic elevator, and the brick are set on the kiln cars, which are on a parallel track. The dryer cars return up an incline to the auger machine. The kiln cars go to the 400-foot Booth tunnel kiln for burning. The labour required to operate the plant has been reduced to a minimum. Fans, specially designed to give the minimum of friction, will control the circulation of the waste heat and flue gases. The stack is just high enough to clear the building. The operation of this plant will be watched with great interest, as it is unique in Ontario and may be the beginning of a movement to use more railway tunnel-kilns for the burning of clay products.

Ontario Brick and Tile Plant (23), Mimico

The products of this Ontario Government plant are brick, drain tile, floor tile, roofing tile, coping, hollow building-block, etc., using Lorraine shale. A small percentage of surface clay is used with the shale in the production of brick, drain tile, and hollow blocks. The plant was started in 1911, and the products are used in government construction. Only non-competitive products, such as floor and roofing tile, are sold to the public. There is no unusual equipment, and the stiff-mud process is being used. The drying is done in a 12-track tunnel dryer, and the burning in 6 round down-draft kilns, 30 feet inside diameter. Each kiln has 8 stacks and 8 fire boxes. Two rectangular down-draft kilns are being built for burning drain tile.

SEWER-PIPE PLANTS

There are four plants manufacturing sewer pipe or electrical conduits, and all are owned by the National Sewer Pipe Company, of Toronto. There is a plan to rebuild the brick plant owned by Price and Cumming on Salisbury Avenue, Humber Bay, Toronto, York county, and to manufacture sewer pipe from clay shipped in from a short distance.

National Sewer Pipe Company, Limited

In April, 1929, it was announced that Ryland H. New of the Hamilton and Toronto Sewer Pipe Company, Limited, of Hamilton, had consolidated under one management his plant with those of the Ontario Sewer Pipe and Clay Products, Limited, of Mimico, and the Dominion Sewer Pipe and Clay Industries, Limited, of Swansea and Aldershot. Andrew Dodds and Thomas Kennedy, long known as active men in the industry, retired. The products include salt-glazed vitrified clay pipe, 4 to 30 inches in diameter, vitrified clay pipe-fittings, flue linings, wall coping, etc. Plans are under way to expand production, and extensive improvements are being made at the Aldershot plant, including the installation of a dryer having automatic temperature and humidity control. Harold F. Dingledine, a ceramic engineer, is the production manager.

Hamilton Plant.—This plant produces 85 to 90 tons of ware per day, operating twelve months a year. It was started by the New family fifty years ago, but has been at this location only thirty years. The sewer-pipe clay, a surface clay composed of reworked weathered Queenston shale, comes from Aldershot in trucks or from Dundas by rail. The two clays are kept in separate storage bins, each holding 400 cars of clay, and are blended by shovelling to a conveyer, which feeds the dry pan. A Stevenson dry pan, requiring 125 horse-power grinds the clay through three-sixteenths-inch screen plates. No other screening is done. The ground clay goes to a storage

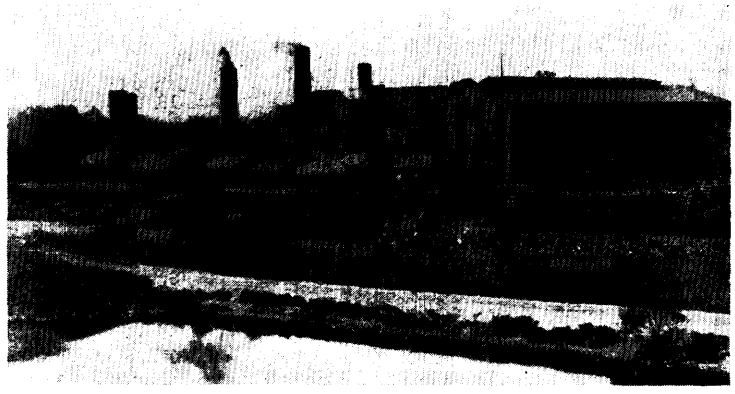
bin and then to 2 wet pans, requiring 75 horse-power each, where water and grog are added as required to prepare the clay for the sewer-pipe press. An elevator takes the clay to the two presses, one for large pipe and one for the smaller sizes. Drying is done on the usual slat floor, heated by steam pipes below. The burning is done in 10 round down-draft kilns, 34 to 36 feet inside diameter, burning coal in dead-bottom grates (see photograph on page 87). With one exception there are 2 kilns to a stack. The stacks are 40 to 45 feet high and 11 feet square outside at the bottom. The main building is three storeys high and about 120 by 185 feet. The storage and grinding building is 115 by 110 feet. The mechanical features of the plant are designed to reduce hand labour to a minimum. Steam power is used, and waste steam is available for drying. Pyrometer equipment is used in the kilns.

Mimico Plant (18).—The plant production is 60 to 70 tons per day for a 12 months' year. The plant was founded in 1892 by A. D. Harris. Thos. A. Kennedy was connected with it in the early days, and Andrew Dodds operated it before selling to the present owner. The clay is the same as is used at the other plants, except that it all comes from Aldershot by rail. When the clay is wet, it is unloaded on a hot floor and steam-heated from below, before going to the dry pans. The equipment consists of a 9-foot Stevenson and Company dry pan requiring 50 horse-power; a piano-wire screen, 3 by 8 feet; 2 Taplin Rice and Company (Akron, Ohio) wet pans, requiring 45 horse-power each; 2 Taplin Rice sewer-pipe presses, using 115 pounds steam pressure; three 150 h.p. boilers for steam power and heating; normal slat-floor drying rooms; and 8 round down-draft kilns, 34 feet inside diameter, having a capacity of 60 tons of ware each. There is a 50-foot stack, which is 40 inches square, inside dimensions, for each kiln, except in two cases where there are 2 kilns to one stack. It takes 10 days to turn over a kiln. The main building is 115 by 125 feet and four storeys high. The clay-storage building is 27 by 95 feet, with the railway track going under cover for unloading.

Aldershot Plant.—The Aldershot plant in Wentworth county produces drain tile from Queenston shale and conduits from the sewer-pipe surface clay, which is salt glazed. The production is about 65 tons per day for a season of nine months. The plant was built by the Dominion Sewer Pipe Company about 1904. A gasoline locomotive (see photograph on page 52) brings the clay a mile and a half to the plant, where it is loaded for shipment to the Mimico and Swansea plants by rail or used at this plant. The equipment consists of dry pan, wire screen, bin for storage, disc feeder to open-top pug mill, made by the American Clay Machine Company, combination auger and pug mill, dryer cars, 18-track tunnel dryer 90 feet long, and 10 round down-draft kilns of various sizes and styles of flues and stacks. The average kiln capacity is 65 tons. There is an addition that was designed to dry and store sewer-pipe clay for use in the Toronto plant but it was never put into operation. The entire plant is now being remodelled and improved.

Swansea Plant (21).—The production is about 20,000 tons per year of 11 months, with a one-month shut-down for repairs. The plant was started in 1905 and was operated by Thomas A. Kennedy up to the time it was purchased by the present owners. The clay came from Aldershot, 30 miles by rail. An overhead grab bucket unloads the clay and delivers it to storage or to dry pans. There are two Stevenson and Company (Wellsville, Ohio) dry pans, requiring 70 horse-power, which grind grog and clay. After screening through a piano-wire screen or a Tyler hummer screen, the clay goes to storage or to 2 Stevenson wet pans and then to 2 Stevenson sewer-

pipe presses. One press makes pipe 4 to 9 inches in size and the other makes pipe 10 to 30 inches in diameter. The drying is done on slat floors and takes from three days to two weeks, depending upon the size. The burning is done in 13 round down-draft kilns, 30 feet diameter inside the bag walls. The 5 stacks for the 13 kilns are 70 to 80 feet high, 9 by 9 feet outside at



National Sewer Pipe Company, Swansea plant.

the base, and contain 4 compartments where there are 4 kilns to a stack. The division wall in these stacks runs up 16 to 18 feet.

OTHER CERAMIC PLANTS

Refractories

The oldest plant manufacturing refractories in Ontario, known as Bailey and Company, was started about 1898 on Yonge Street, Toronto, and was moved to 321 Albany Avenue in 1912. In 1929, it was taken over by the National Refractories, Limited.

FIRE-CLAY BRICK AND SHAPES

National Refractories, Limited

Toronto Plant.— The plant manufactures stove-linings and special boiler shapes as its main product. George Bailey is superintendent. The flow sheet is as follows: pulverizer for grinding grog, mixing clay and grog, open-top pug mill, soaking pit for 24 hours, auger machine to increase plasticity, hand-moulding, drying on hot floor with steam heat or radiation flues below, burning in a rectangular down-draft kiln, 10 by 25 feet, with metal stack 30 feet high and 30 inches in diameter. The kiln capacity is about 45 tons. The main building is 30 by 140 feet and is one storey high.

Port Robinson Plant.—This plant makes about 125 tons of refractories a week, employing 35 men, and operates twelve months a year. Plastic and flint fire clay is imported from the United States to make a product of high quality. The slop-mud, hand-moulded method is used, employing experienced Scotch moulders. They make stove-linings, locomotive tile, and some 9-inch straight brick. The clay comes in by rail and is stored in bins. After crushing in a jaw crusher and grinding in a dry pan, it is screened to 30 mesh. Each clay is ground separately and then proportioned by volume, mixed in a concrete mixer of the revolving-

drum type, ground with water in a wet pan, and delivered to the hand-moulders. After drying 48 hours or more on hot floors, it is burned in 4 down-draft kilns. There are three rectangular kilns of 80 tons capacity, 12 by 15 feet inside the bag walls, and one 20-foot round kiln of larger capacity.

Northern Ontario China Corporation

This company was organized by Wm. Douglas and C. M. McCarthy to utilize the fire clays on the Mattagami river north of Cochrane in the Moose River valley. It is planned to start operations as soon as some means of transportation is available. A preliminary lot of 3,000 fire brick have been made.

Canada Potteries, Limited, Hamilton

This plant, located at 100 Lock Street, Hamilton, has a department making stove-linings and a few special shapes. Hand moulding, slop-method, is used, the equipment being the same as for making saggers.

Ontario Refractories Company, Bridgeburg

This is a new company with a plant at Bridgeburg, in Welland county. Fire-clay brick and shapes are listed as the products. The plant was not visited, and details of equipment are not available.

Dominion Glass Company, Wallaceburg

This plant at Wallaceburg in Kent county has a department making refractories for their own use; it employs 12 men, making tank blocks, furnace parts, etc. The hand-moulding method is used.

Bell Fire Brick Company, Toronto

W. G. Bell has been operating this plant, which is located at 1347 Dufferin Street, Toronto, for about ten years, making stove linings and special refractory shapes from fire clays imported from Ohio and Pennsylvania. The clay is received in the ground condition, and the grog is crushed in a hammer mill. The mix is pugged and hand-pressed in moulds. After drying on a hot floor, the ware is burned to 2000° F. in a rectangular down-draft kiln, burning coal. Twelve men are employed.

SILICA BRICK

Algoma Steel Corporation, Sault Ste. Marie

The plant is at Sault Ste. Marie, Algoma district, and is the only one in Ontario making this product. The brick are used in their own plant. The production is 1,500,000 silica brick per year, operating twelve months a year. The mix consists of 98 per cent. crushed silica rock, which comes from about 20 miles north of the plant, and 2 per cent. calcium oxide obtained by burning limestone in their own plant in a rotary kiln. An analysis of the rock is as follows:—

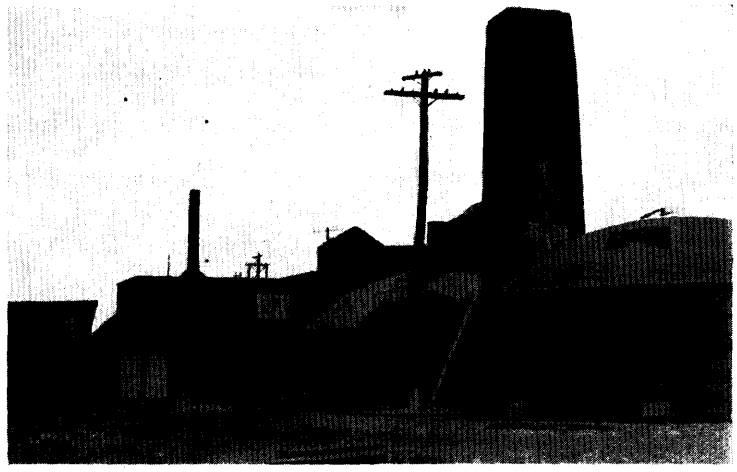
	Per cent.
Silica	96.55
Ferric oxide	1.5-2.5
Alumina	.61
Calcium oxide	.45

The equipment consists of a 50 h.p. jaw crusher, an 8-foot Clearfield dry pan, requiring 85 horse-power, which grinds the lime and the silica rock together, steel moulds for hand-moulding, a 2-track tunnel dryer

100 feet long, and 2 round down-draft kilns 32 feet in diameter, having a capacity of 90,000 brick each. Coal is used as fuel. The photograph below shows a view of the kilns with the plant in the background.

ELECTRIC FURNACE PRODUCTS

Several plants make artificial refractory products in electric furnaces in the Niagara Falls area. Some of these products are also used as abrasives. The Exolon Company, Incorporated, Thorold, Welland county, specializes in the making of silicon carbide, fused magnesite, alumina, and



Kilns for burning silica brick, Algoma Steel Corporation, Sault Ste. Marie

mullite. The Norton Company of Canada, Limited, makes silicon carbide at Chippawa, along with other products.

SPECIAL CEMENTS

G. F. Sterne and Sons, Brantford

This company is well known as consulting chemists and manufacturers of special refractory cements. The plant, which is in Brantford, Brant county, was started in 1898 by G. F. Sterne making a furnace cement of china clay, silicate of soda, and asbestos. Since 1920, special attention has been given to this subject, and now both general and special purpose cements are made.

Pottery

FLOWER-POTS

Two plants make flower-pots in Ontario. Both are old, being started about 1880.

Foster Pottery Company, Hamilton

This plant, which is at West Main Street, Hamilton, Wentworth county, has been operated by the Foster family for fifty years and is now in charge of S. Foster. They make 20,000 flower-pots a day, using a surface clay. The flow sheet is as follows: open-top pug, plastic storage from 3 to 6 weeks, open-top pug, Baird auger machine to make blanks for the 4 semi-automatic presses. The pots are dried on steam racks or above the kilns on the second floor and are burned in 4 round down-draft kilns,

18 feet inside diameter. The building is 165 by 100 feet and has two floors. Twenty-five men are employed.

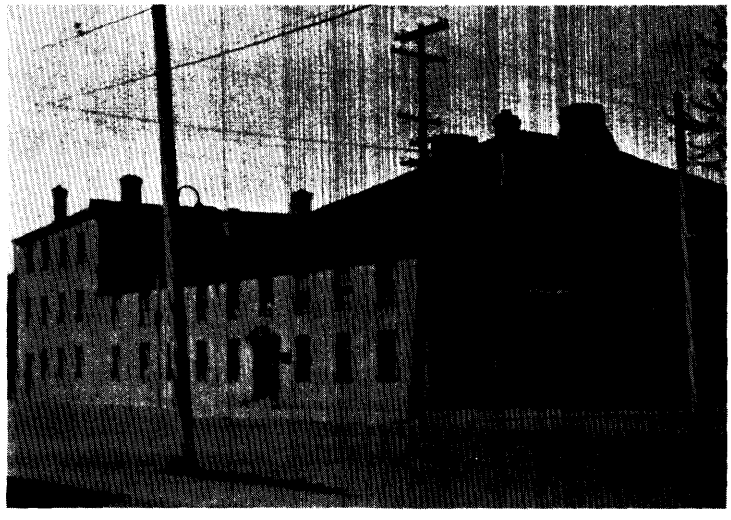
John Davis and Son, Toronto

The plant, which is at 601 Merton Street, Toronto, is also about fifty years old, but was sold by the Davis family in 1928. It is operated by Chas. Kerr under the same firm name. Surface clay is blunged, screened, and filter-pressed to obtain a uniform clay free from lime pebbles. The burning is done in two rectangular down-draft kilns, 12 by 11 feet inside. The other operations are about the same as at the Foster plant. This plant is known as the Davisville Potteries.

ROCKINGHAM WARE

Canada Potteries, Limited, Hamilton

This is the only plant in Ontario making ware of this type, which includes teapots, yellow ware, kitchen bowls, etc. The plant, which is at



Canada Potteries, Limited, Hamilton, established in 1852 by the Campbell family.

100 Lock Street, Hamilton, was established in 1852 by the Campbell family and was known as R. Campbell's Sons up to 1928, when it was sold. The clay used is imported and includes pottery, sagger, and wad clay from New Jersey, as well as fire clay from Pennsylvania. The burning temperature is 2400° F. Stove linings and saggers are made from a mix of fire clay and grog, which is crushed, pugged, aged, and hand-pressed to shape. The pottery is made from a blend of clays which is blunged, filter-pressed, pugged, and hand-pressed or jiggered in plaster moulds to the desired shape. After drying on steam racks the pieces are given a first burn at a low temperature. The ware is then glazed and reburned to the maturing temperature of the body and glaze. There are two up-draft potter's kilns, 12 feet inside diameter. Coke is used as fuel. The upper part of the kiln is a separate chamber in which the bisque or first burn is made. The temperature here is less than that of the lower chamber. The photograph above shows a general view of the building.

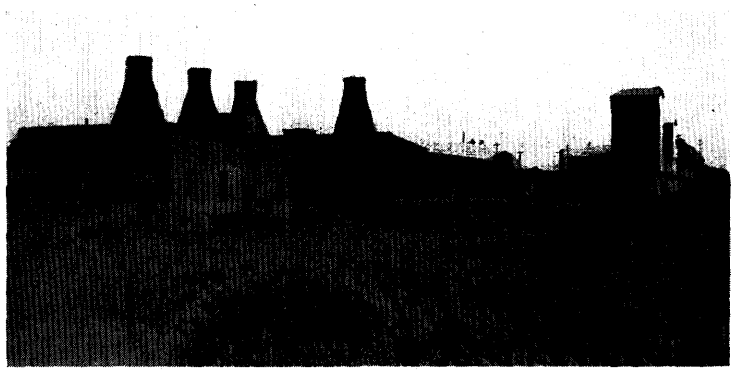
ART POTTERY

Smith Potteries, Oshawa

H. Smith started this plant at Oshawa, Ontario county, in 1924, making "Velta Art Pottery," which consists largely of lamp-stands, small vases, and novelties. He uses English, Kentucky, and Saskatchewan clay and burns to cone 5. The equipment allows casting and jiggering of the ware. The burning is done in a rectangular kiln, 6 by 4 feet inside, using oil fuel. An addition is being built to the plant to take care of increased business.

Ecanada Art Pottery

George Emery is starting to manufacture art pottery in Hamilton, Wentworth county, on a semi-commercial scale. He served an apprenticeship at the Wedgewood plant in England and is a competent potter of artistic



Frontenac Floor and Wall Tile Company, Kingston Junction.

ability. His pieces include the well-known white figures in relief on a blue background, and they equal the English importations in quality.

Training in clay modelling and decoration is being given in the Ontario College of Art and the Central Technical School, of Toronto, and the Technical High School, of Hamilton. There is latent talent in Ontario which has not been used.

Shale Floor Tile

Canadian Fireclay Products, Limited (20), New Toronto

This plant at New Toronto makes about 350,000 square feet of floor or quarry tile a year, using Lorraine shale as the raw material. The shale is ground in a dry pan and screened to 30 or 40 mesh. It then goes to an open-top pug mill and auger machine where it is formed into blanks. When partly dry, the tile are repressed to give square edges and corners. The burning is done in three small rectangular down-draft kilns holding from four to five thousand square feet of tile each. Pyrometers are used to measure temperature.

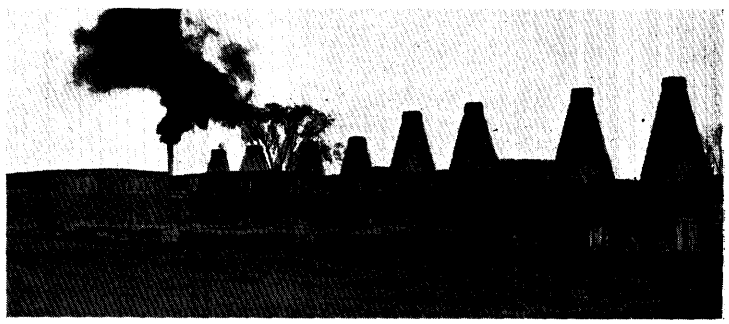
Ontario Brick and Tile Plant (23), Mimico

This plant at Mimico manufactures brick and other products as well as floor tile. The tile are made by the stiff-mud process and re-pressed when partly dry. The plant is discussed in more detail on page 168.

Porcelain Floor and Wall Tile

Frontenac Floor and Wall Tile Company, Kingston Junction

This plant was started in 1912 at Kingston Junction, Frontenac county, and was reorganized in 1920 and is operated by E. Townsend. They make white and coloured floor and wall tile by the dry-press method. The clay is imported, but they grind their own feldspar, which is mined near Verona. The process consists of weighing out the batch, blunging, screening to 120-mesh screen, agitating to keep the materials in suspension, filter-pressing, drying, disintegrating to a powder ready for pressing, dry-pressing, setting in saggers, burning to cone 8 to 12 depending upon the colour, sorting, inspecting, mounting on paper, and shipping. There are 4 power presses and 3 hand presses for forming the tile. The burning is done in 4 up-draft potter's kilns 12 feet in inside diameter. Saggers for setting the ware are made in a separate department, and feldspar is ground for the market as



Canadian Porcelain Company, Hamilton

well as for their own use. The feldspar is first crushed in a burr mill, then fine-ground in a ball mill, and graded in an air separator. The photograph opposite shows a general view, with the spar-grinding department on the right.

Electrical Porcelain, Plastic and Dry-Press Method

Canadian General Electric Company, Peterborough

The porcelain department of the company is in charge of E. Rigby, an English-trained ceramist. At the plant in Peterborough they make from five to six million pieces per year of twelve months. The products include dry-press electrical porcelain, high-tension electrical porcelain by the plastic process, and refractory supports for electric heating plates. The plant is thirty years old and employs 70 to 80 people. Clay and flint are imported from England and the United States. Feldspar is Canadian-ground. The clay mixture is weighed, blunged, agitated, screened to 120 mesh, and filter-pressed. For the dry-press process it is dried to 17 per cent. moisture, pulverized in a dust mill, and sent to 26 hand presses. For the plastic process it is run out in blanks after filter-pressing, partly dried, turned to shape on lathes when leather hard, and finally dried on steam racks. After drying the ware is cleaned, glazed by dipping or spraying, and fired in 3 potter's kilns to cone 11 or about 1300° C. The kilns are of the Laughton up-draft, down-draft type and give very good results. The moulds used in this industry are largely made of steel and are very expensive. The machine shop is one of the more important departments. The building is 2 storeys high and is about 125 by 200 feet. Saggers are made for their own use.

Canadian Porcelain Company, Hamilton

This plant uses the plastic and casting processes to manufacture high-tension electric insulators. They employ about 200 men and make 3,000 standard suspension-type insulators per day in addition to specialties. The plant, which is in Hamilton, was started in 1913. The raw materials are imported except for the feldspar, which is ground at Kingston. The process consists of blunging in 2 ball mills, agitating the slop, screening to 120 mesh, filter-pressing in 4 presses, aging in a damp cellar, pugging and forming in plaster moulds on the centre or pull-down machine. Ware is also cast in plaster moulds. After drying in special rooms, the ware is glazed, set in saggers which are made in another department, and burned in 8 up-draft



Smith and Stone porcelain plant, Georgetown.

kilns to 2400° F. After testing and mounting, the insulators are ready to ship. The photograph on page 175 is a general view of the kiln house and part of the plant.

Smith and Stone, Limited, Georgetown

Dry-press electrical porcelain refractory heater supports for electric stoves, insulation pads for electric stoves, and specialties are made in this plant, at Georgetown, Halton county. They assemble the brass with the porcelain for complete electric fixtures. The production is about 1,500,000 pieces a month during twelve months of the year. The plant was started in 1919, and the manufacture of porcelain was introduced in 1923. The clays are imported, but the flint, spar, and talc are Canadian. The usual dry-press process is used. The equipment consists mainly of weigh-car, blunger, screen, magnetic separator, agitator, filter presses, storage, pulverizer to prepare the clay for the dry presses, 29 hand and 2 power presses, steam rack dryer with fan circulation. The ware is then cleaned, glazed, placed in saggers, fired to cone 9 to 12 depending upon the ware, inspected, assembled with brass fittings, and packed. There is a sagger-making department and a machine shop. The dry-press dies are of steel, and the larger ones may cost up to $700 a piece to make. The photograph above is a view of this plant.

Canadian Ohio Brass Company, Niagara Falls

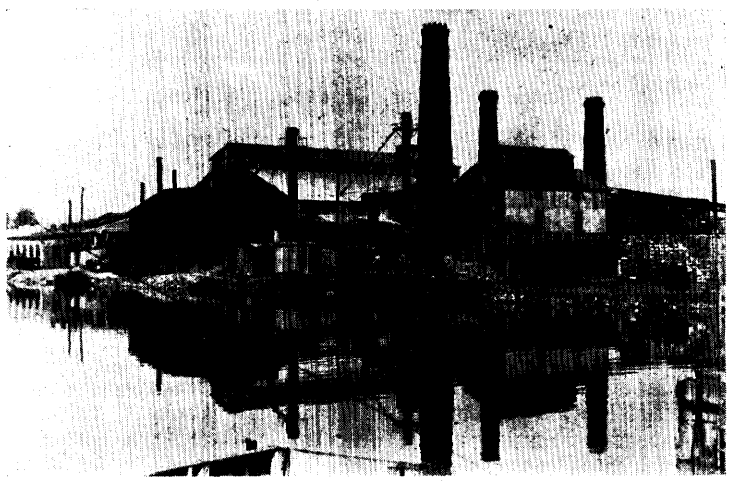
This plant at Niagara Falls is the Canadian branch of the Ohio Brass Company and makes high-tension insulators. They employ 70 to 80 men

and operate all year. The plant was started in 1923 and is housed in a modern brick-and-steel one-storey building, which gives a straight-line movement of ware through the plant from raw material to shipping. The raw materials are imported. The usual plastic process is used in manufacture, and the burning is done in 2 potter's kilns. The well-kept property and the lawn in front of the plant give a very pleasing appearance.

Glass Plants

Dominion Glass Company

Wallaceburg Plant (Kent County).—This plant, which is thirty-five years old and employs over 700 men, produces glass containers, such as bottles,



Plant of the Dominion Glass Company, Wallaceburg.

jars, etc., lamp chimneys, illuminating ware, globes, tumblers, and pressed tableware. In one department grinding, sand-blasting, acid-etching, and silvering is done. Most of the fire clay refractories used in the various plants of the company are made here, using imported refractory clays. The glass sand is imported from Ottawa, Ill. Most of the other chemicals come from Canada. The plant is modern and equipped with glass tanks and automatic machinery for forming the ware and with efficient lehrs of the latest design. The photograph above shows a view of part of the plant.

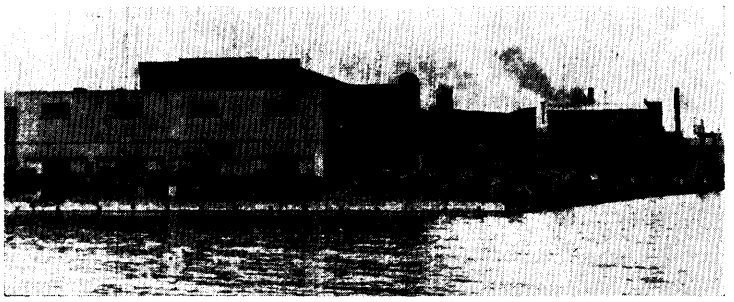
Hamilton Plant.—This plant is not very old, and is modern in all respects, with automatic machines and lehrs of the latest design for bottle manufacturers. The Dominion Glass Company has other plants at Montreal, Que., and at Redcliff, Alta.

Feldspar Glass Company, Oshawa

The company was organized in 1921 and has its plant at Oshawa, Ontario county. They have been experimenting on the melting of glass in an electric furnace. The glass batch is unusual, consisting of a high percentage of potash feldspar, using spar from their own deposit near Perth, Lanark county. A batch composed of 80 per cent. feldspar and 20 per cent. soda ash has been reported as giving a satisfactory glass for bottle manufacture. The electric furnace experiments are still in progress.

Enamelled Iron

In January, 1929, there were eleven plants manufacturing enamelled iron in Ontario, which include both cast iron and sheet steel. The business is growing rapidly, and interest is increasing in this industry. General Steel



Port Hope Sanitary Company, Port Hope.

Wares, Limited, is said to be the largest company of its kind in the British Empire. The list of plants follows:—

1—Beach Foundry, Limited, Ottawa.
2—General Steel Wares, Limited, Toronto.
3—Canadian General Electric Company, Limited, Toronto.
4—Moffats Limited, Toronto.
5—Guelph Stove Company, Guelph.
6—Stamped and Enamelled Ware, Hespeler.
7—Empire Stove and Furnace Company, Owen Sound.
8—Canadian Toledo Scale Company, Windsor.
9—Port Hope Sanitary Company, Port Hope.
10—Standard Sanitary Manufacturing Company, Limited, Toronto.
11—Findlay Brothers Company, Limited, Carleton Place.



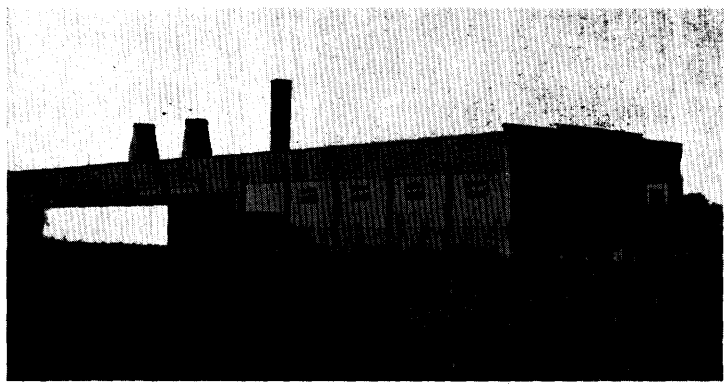
Moffats, Limited, Weston.

With two exceptions these companies buy their enamels prepared and do not manufacture them from the raw material. The two accompanying photographs are of typical plants.

Abrasives

Abrasive wheels come under the head of ceramic material, and the mix of abrasive material and clay binder is burned in kilns to about cone 11 or 12 (1300° C.). There are nine or ten plants in Ontario, some of which are quite active and important. The photograph below shows a view of the Lion Grinding Wheel Company at Brockville and is one of the better plants. The process as carried out in this plant is briefly described as follows:—

The bond clays, fire clays, and feldspar are imported from the United States. Silicate of soda, and shellac are used as well as the clay. The abrasive wheels made with a clay bond are formed plastic in moulds, dried,



Lion Grinding Wheel Company, Brockville.

and burned after setting in saggers in two potter's kilns. Uniformity of composition and temperature of burn is very important to get the hardness and grit desired.

Feldspar

This raw material is found in important amounts in Ontario. The output in 1929 in Ontario was 21,413 tons worth $208,607. There are eleven companies mining feldspar in Lanark, Frontenac, Sudbury, Renfrew, Hastings, and Nipissing counties or districts. Feldspar is ground and used in the manufacture of porcelain and to a limited extent in glass. Most of the Ontario material is exported to the United States for grinding, but some is ground by the Frontenac Floor and Wall Tile Company, of Kingston. An open-pit mine in Monteagle township, Hastings county, near Hybla, owned by the Genesee Feldspar Company, is one of the important producers.

The photograph on page 180 shows the pit of the Genesee Feldspar Company, 7 miles from Verona, Frontenac county. The derrick shown lifts the rock to the surface, where it is loaded to wagons and drawn two miles to the railway.

Cements, Limes, and Plasters

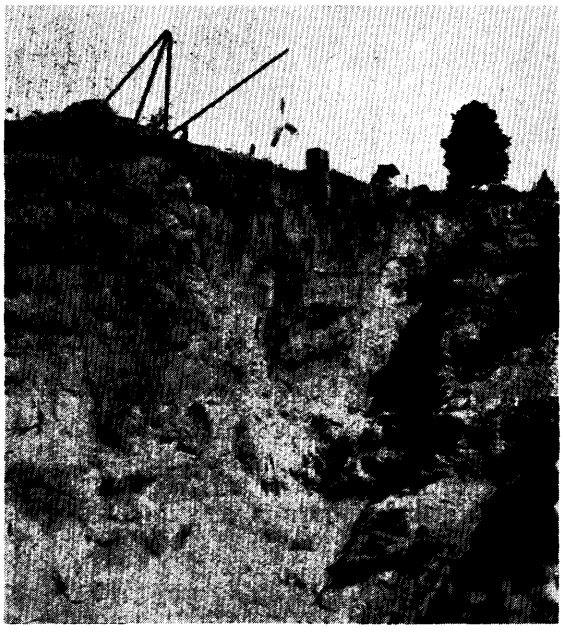
These industries come under the general head of ceramics but were not covered in this survey.

STANDARDS AND SIMPLIFIED PRACTICE

In modern business service is being emphasized, and it is found that commercial success depends largely upon the product meeting the needs of the user. It is recognized that products, therefore, can be classified accord-

ing to use, and the properties of the product may be determined so the manufacturer will know if he is keeping to the required standard. Such standards are based upon the needs of the user, modified by the limitations of the raw material available. The manufacturer's ability to produce at a reasonable profit must be considered, and it is here that real competition should come. Executive ability, employment of modern equipment, application of technical knowledge, and the obtaining of new fundamental information are the tools used to ensure success.

Standards are being established for almost everything, from automobile headlights to the size of eggs and oranges. About three years ago an effort



Richardson feldspar mine near Verona, Frontenac county.

was made to standardize the size of brick manufactured in Ontario.[1] The sizes were as follows:—

	Inches
Common brick	8 by $2\frac{1}{4}$ by $3\frac{3}{4}$
Rough-face brick	8 by $2\frac{1}{4}$ by $3\frac{3}{4}$
Smooth-face brick	8 by $2\frac{1}{4}$ by $3\frac{7}{8}$

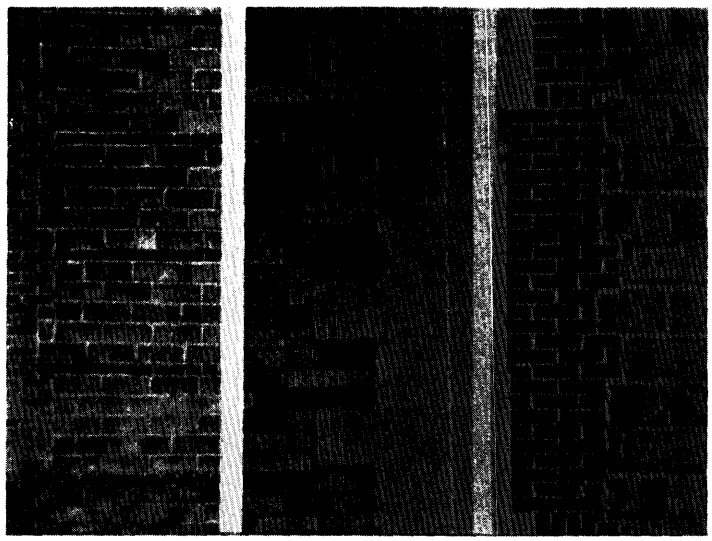
For some reason or other many manufacturers have stopped conforming to this standard, and on this survey the writer found that only a very few plants, mostly the small ones, are adhering to the size they had agreed upon. It is quite evident that the brick manufacturers are not acting to their best interests as long as they do not study the problem and endeavour to solve it. Co-operation seems to be lacking between the manufacturer, the bricklayer, the architect, and the authorities responsible for the building codes of the cities.

Exact brick size is difficult to obtain because of variation in drying and burning shrinkage of the various clays from different pits or from different sections of the same pit. Frequent change of die-size or proper blending of clay is necessary. Nevertheless, if it is recognized that the product is made

[1]26th Ann. Rept., Can. Nat. Clay Products Assoc., Executive Report of 1928.

primarily to satisfy the need of the user, the average requirements for that need should be determined and met. The same problem is being faced in the United States. A recent paper by Fred. T. Heath[1] gives examples of poor structural strength and unsightly patching at corners, and the photograph below is one of the illustrations. Such construction increases the cost of laying walls and advertises to the public the lack of co-operation in the industry.

A Canadian Research and Standards Bureau is being established at Ottawa, and the new Ontario Research Foundation in our own province will aid and advise the manufacturers in their efforts to establish standards for the clay industry and to advance the technical side of the industry.



Poor masonry construction.[2]

The Ontario Department of Mines, and the Department of Mines at Ottawa, have both aided the industry in the past and will continue to do so.

Considerable work has been done on standards in the United States, and we are able to profit by this experience and consider their standards in adopting Canadian ones. Such standards deal mainly with the properties of products and methods of testing. The standards of the American Society for Testing Materials[3] are generally accepted. All the technical organizations are represented in this society, including the American Ceramic Society. Some of the standards apply to the heavy clay products industry. Others apply to glass, refractories, whiteware, enamelled iron, etc. The following heavy clay products are covered: (1) clay sewer brick, (2) clay sewer pipe, (3) drain tile, and (4) hollow burned clay, load-bearing wall tile. The testing of these products includes water absorption, freezing and thawing tests, crushing strength, kind of raw material, etc.

Simplified practice has been introduced by the United States Department of Commerce with a definite saving to industry where it has been adopted. This has to do with a reduction in the number of sizes, shapes, styles, and designs. The result means interchangeable parts, less machinery,

[1]A Standard Unit of Dimension for Masonry, Jour. Amer. Cer. Soc., Vol. 12, p. 605.
[2]Jour. Amer. Cer. Soc., Vol. 12, 1929, p. 605.
[3]Published from 1315 Spruce Street, Philadelphia, Pa.

faster turnover, smaller stock, and large savings to the manufacturer and jobber, with better product and service to the consumer. The idea is also called "elimination of waste" of time, labour, and material. Recommendations have been made to cover some of the ceramic products. To make any proposal effective it must be approved by at least 80 per cent. of the industry. Common brick, face brick, sand-lime brick, hollow building-block, etc., are included in the list.

Standards and simplified practice have a bearing on costs, and when the principles are properly applied, savings should result. This implies that a satisfactory system has been installed and that accurate figures are obtained. Cost figures arrived at once a year often come too late to be of value in directing the business. A recent survey by the Common Brick Manufacturers Association of America (2121 Guarantee Title Building, Cleveland, Ohio), to which a number of Ontario manufacturers belong, showed that selling prices were often based on what others would sell for and not on the cost of production. Very few manufacturers knew their costs at the end of each month, and none knew them from day to day or week to week. This association has worked up a simple cost system which gives the needed information but does not require the employment of expert accountants. The usual clerical help can easily take care of the system after it has been installed. It is a flexible loose-leaf system which can be adapted to large or small plants, making one or more clay products. The association is glad to give the details to either members or non-members on request.

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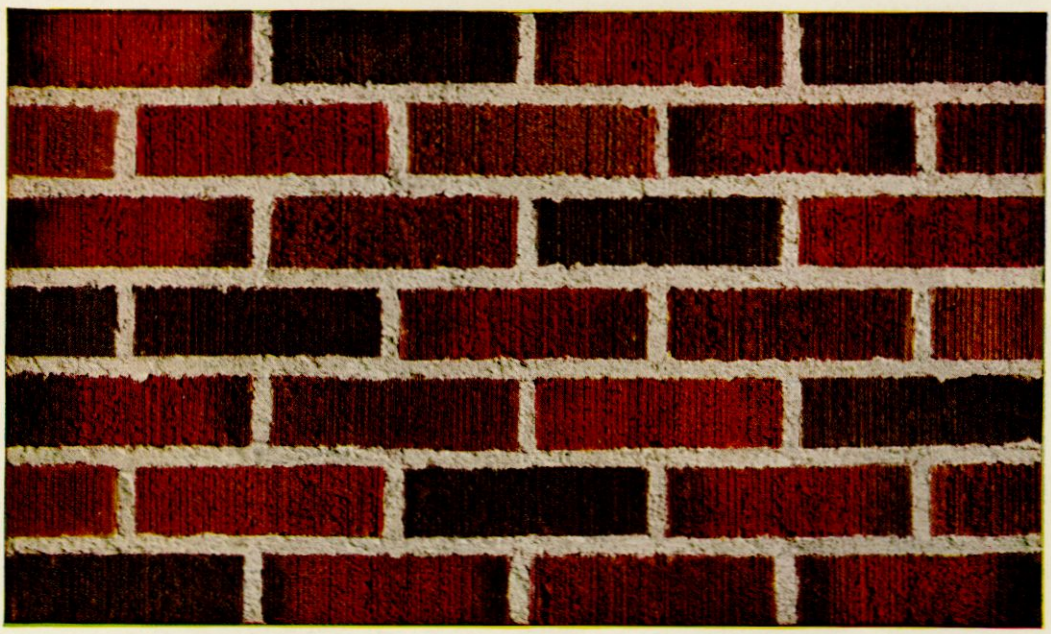
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COLOURS AND TEXTURES OBTAINED USING BUFF AND RED-BURNING QUEENSTON SHALE

(Stiff Mud Process)



Full range buff, including pinkish buff and light green shades. A grey or chocolate joint, either flush or set-back, is recommended.



Full range rug brick consisting of brown and red shades.

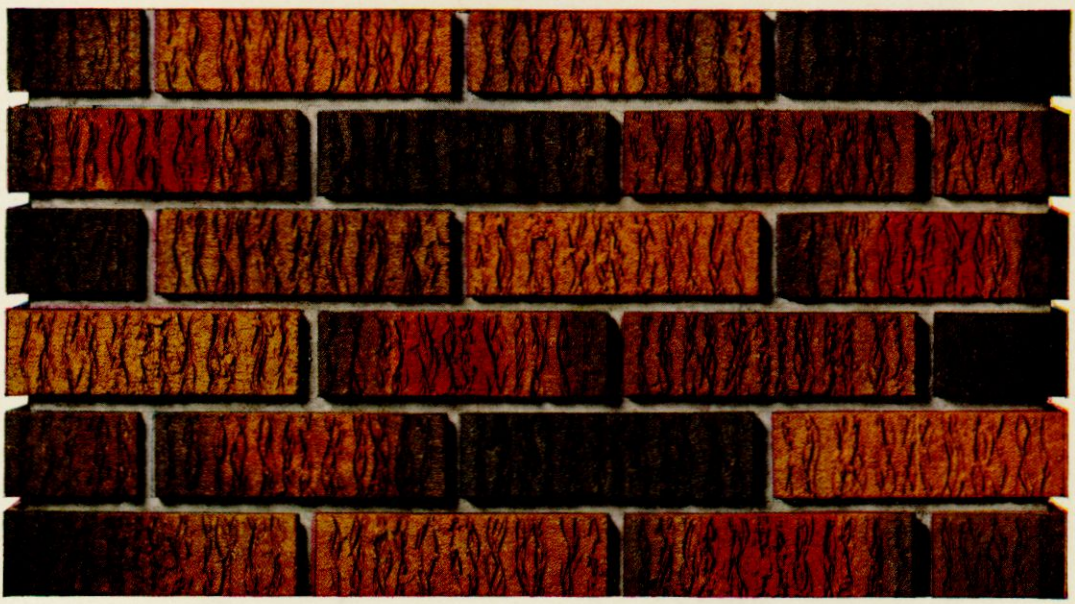
To accompany Report by R. J. Montgomery

COLOURS AND TEXTURES OBTAINED USING RED-BURNING LORRAINE SHALE

(Stiff Mud Process)

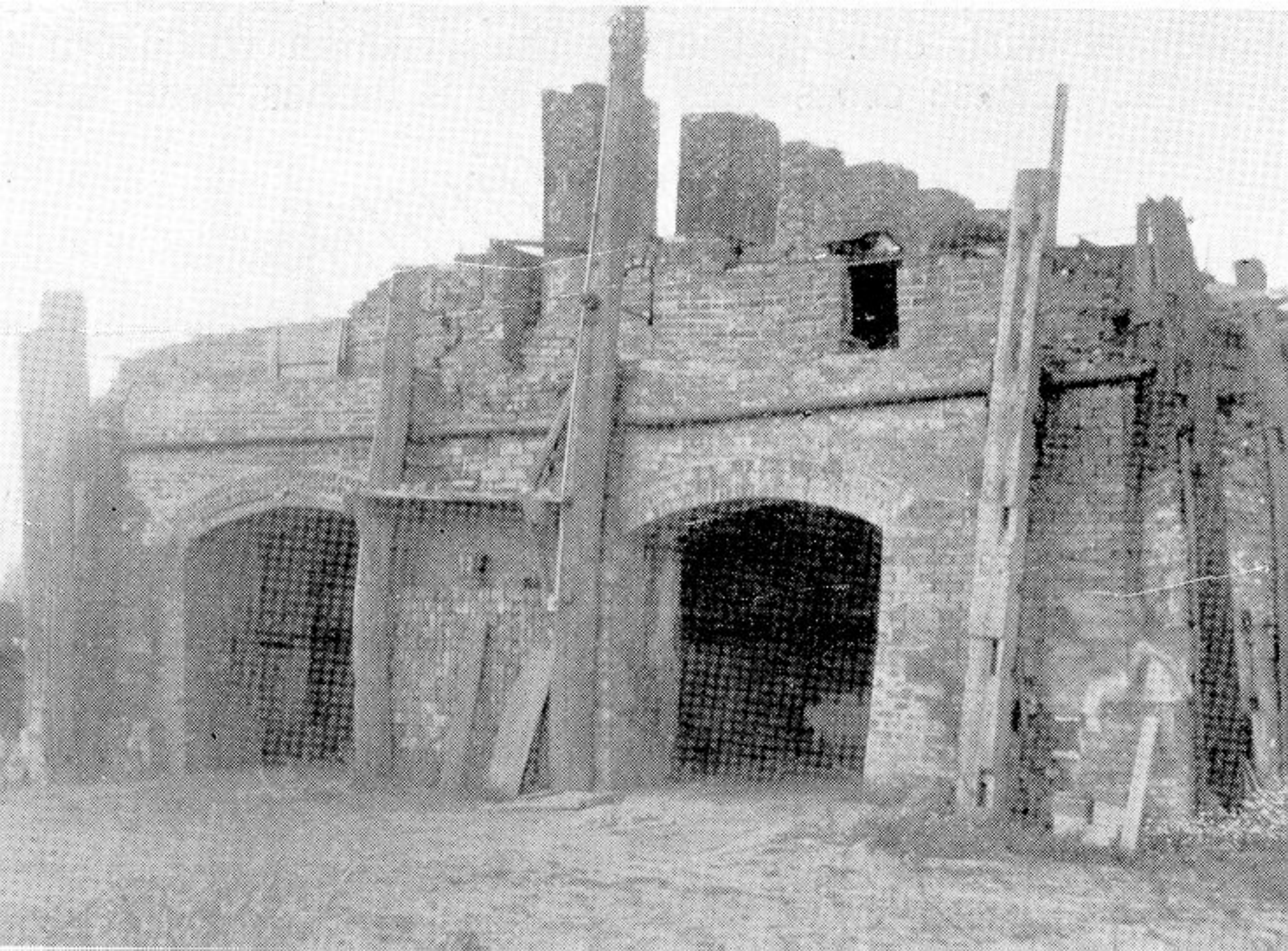


Corduroy texture with mingled shades including clear red, also flashed buff and brown colours.



Log texture and autumn colours obtained by flashing.

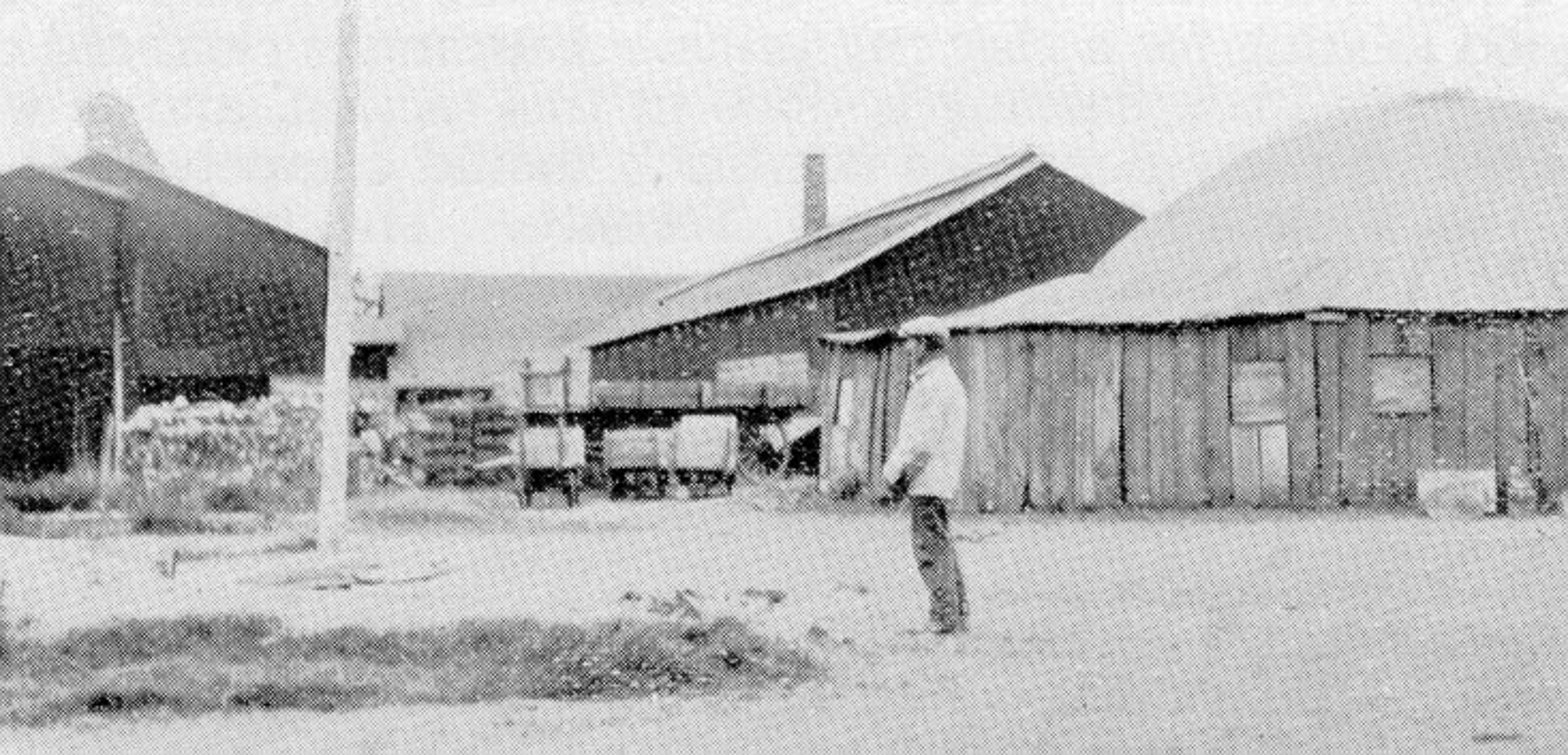
To accompany Report by R. J. Montgomery

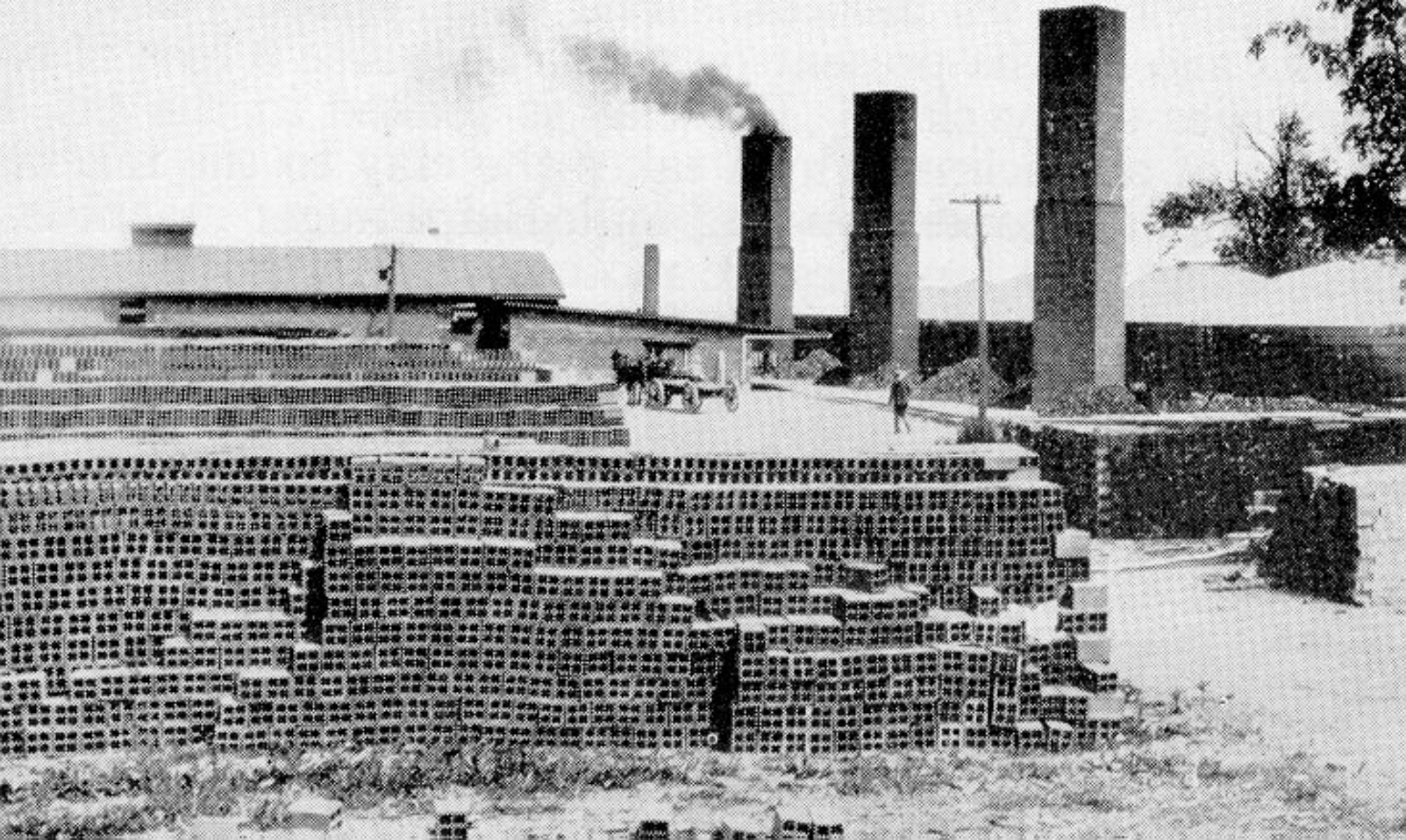






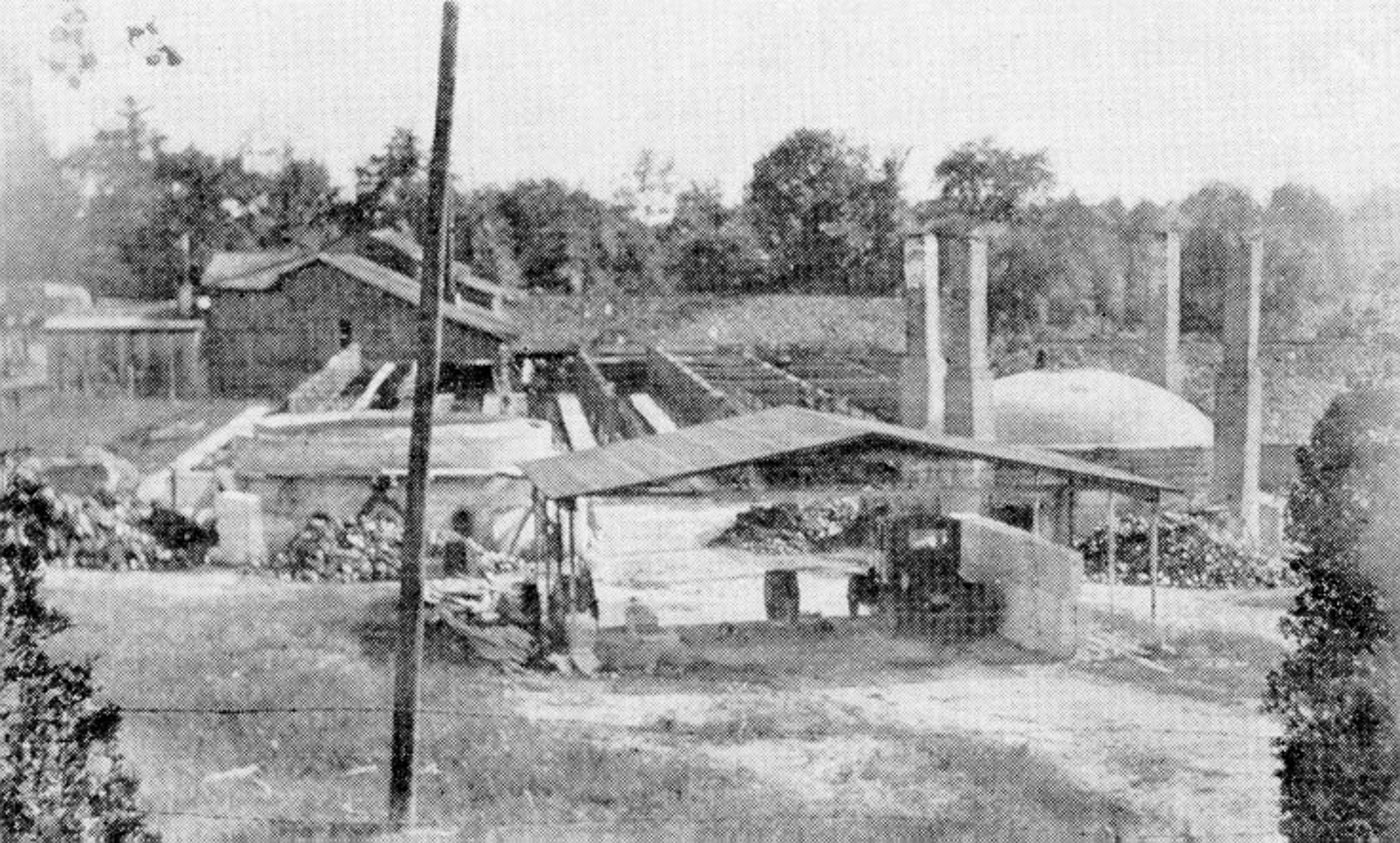








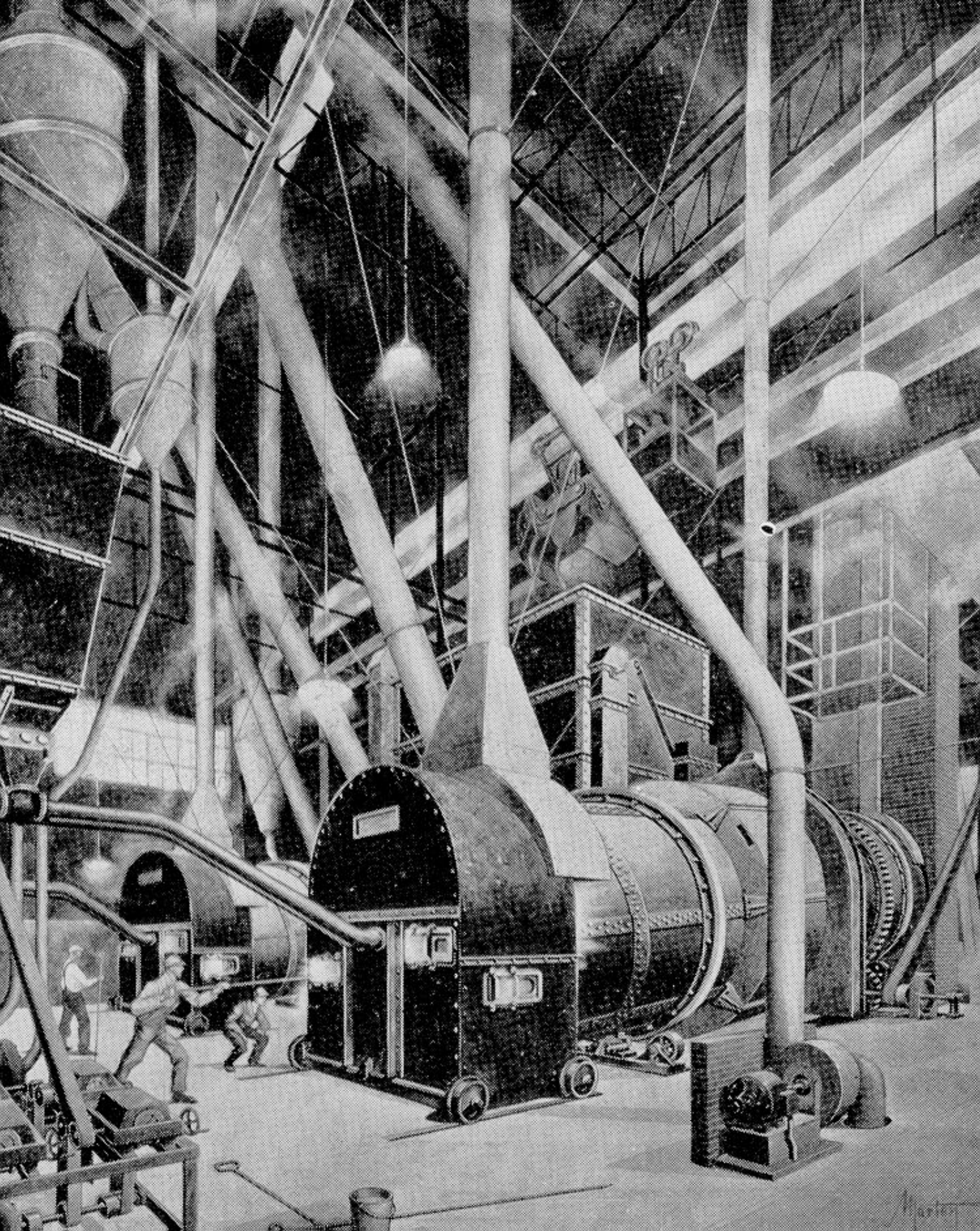








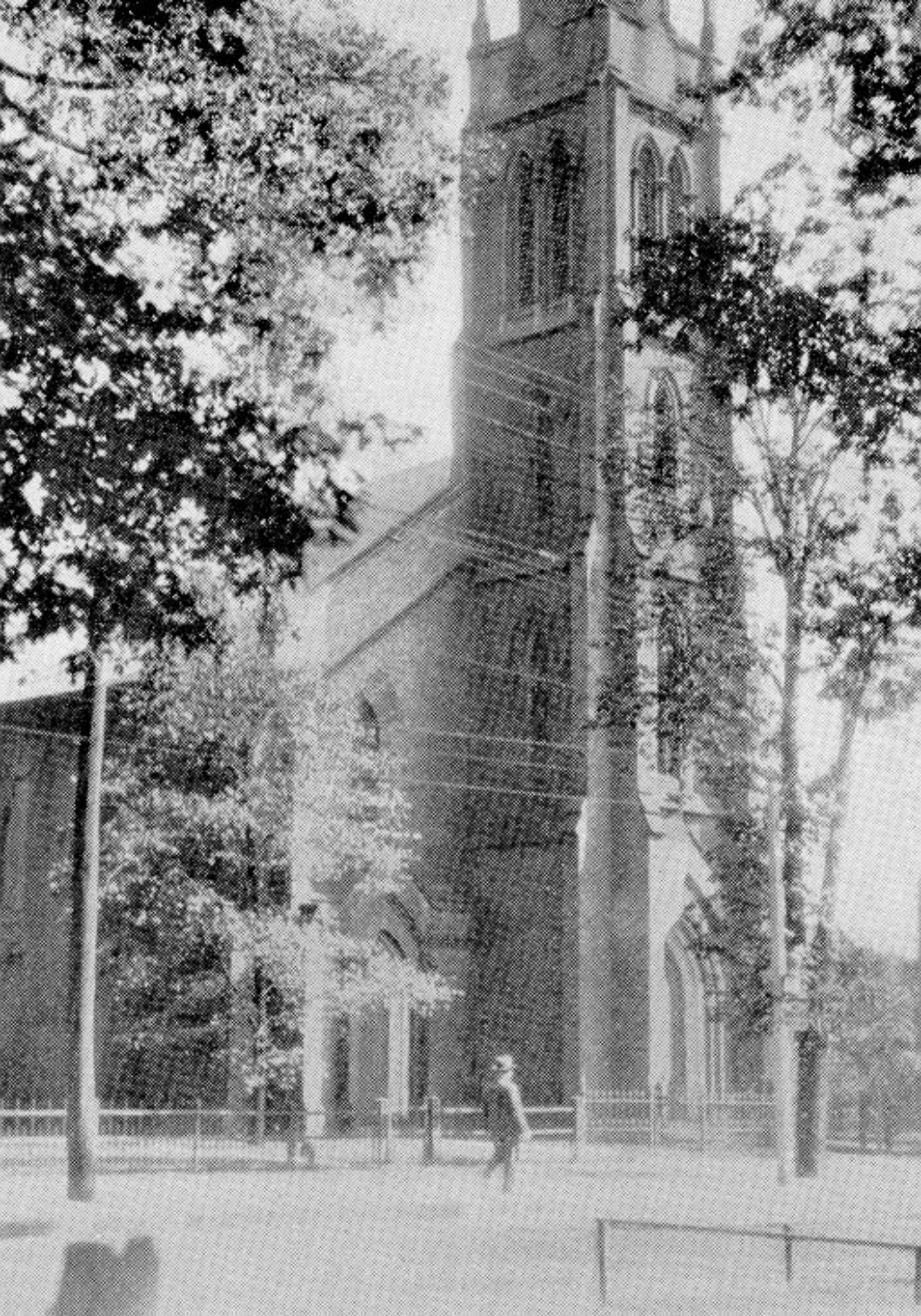


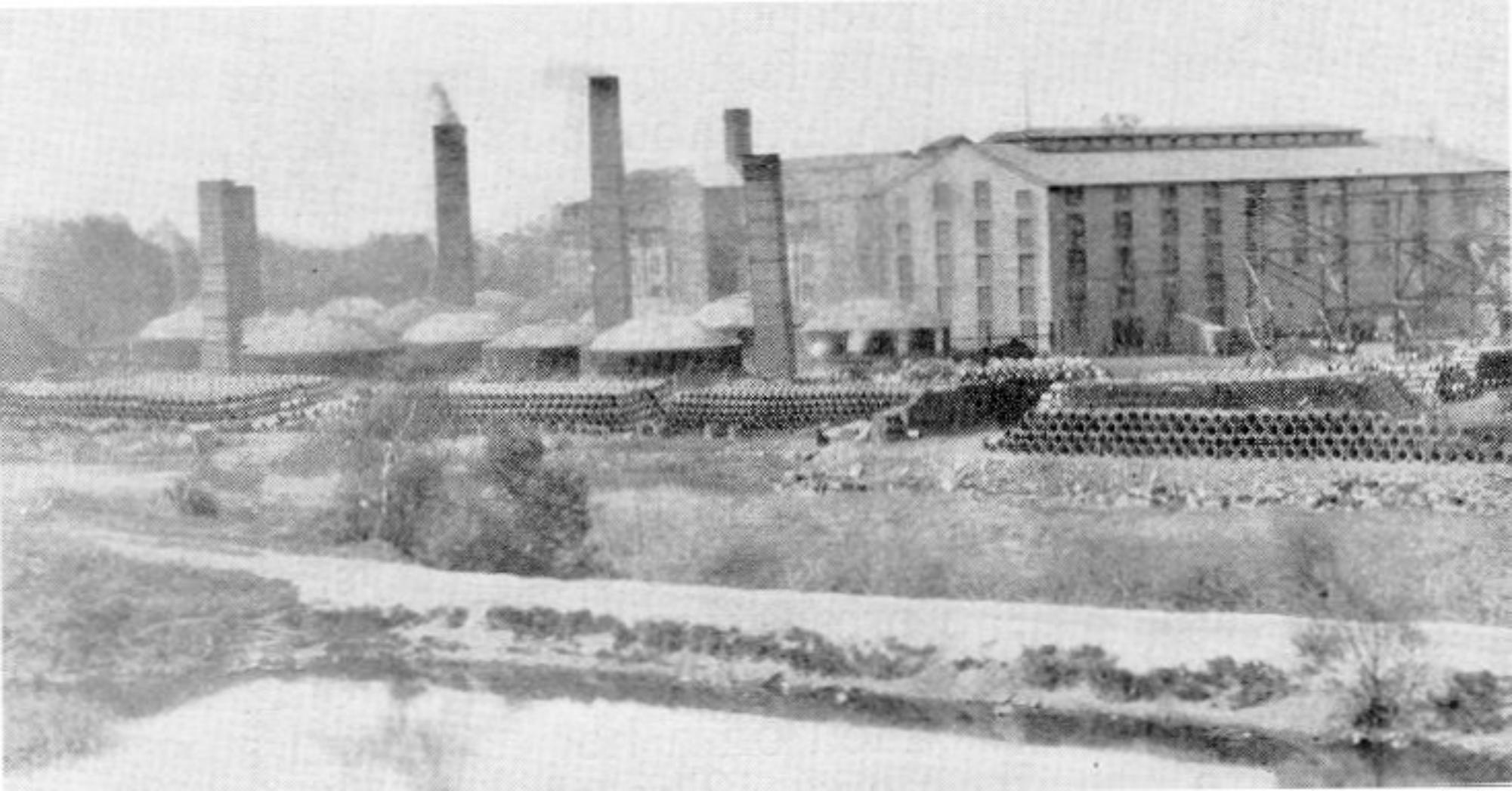








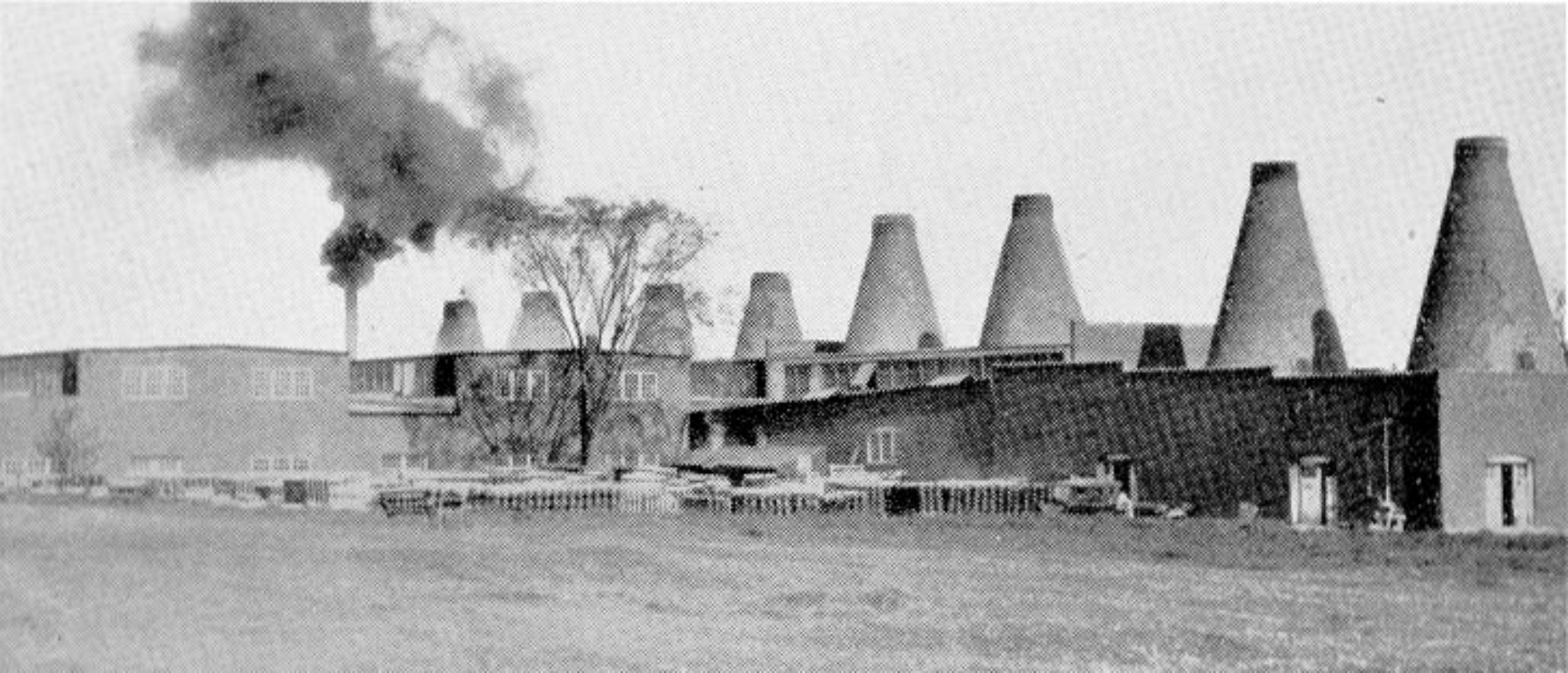


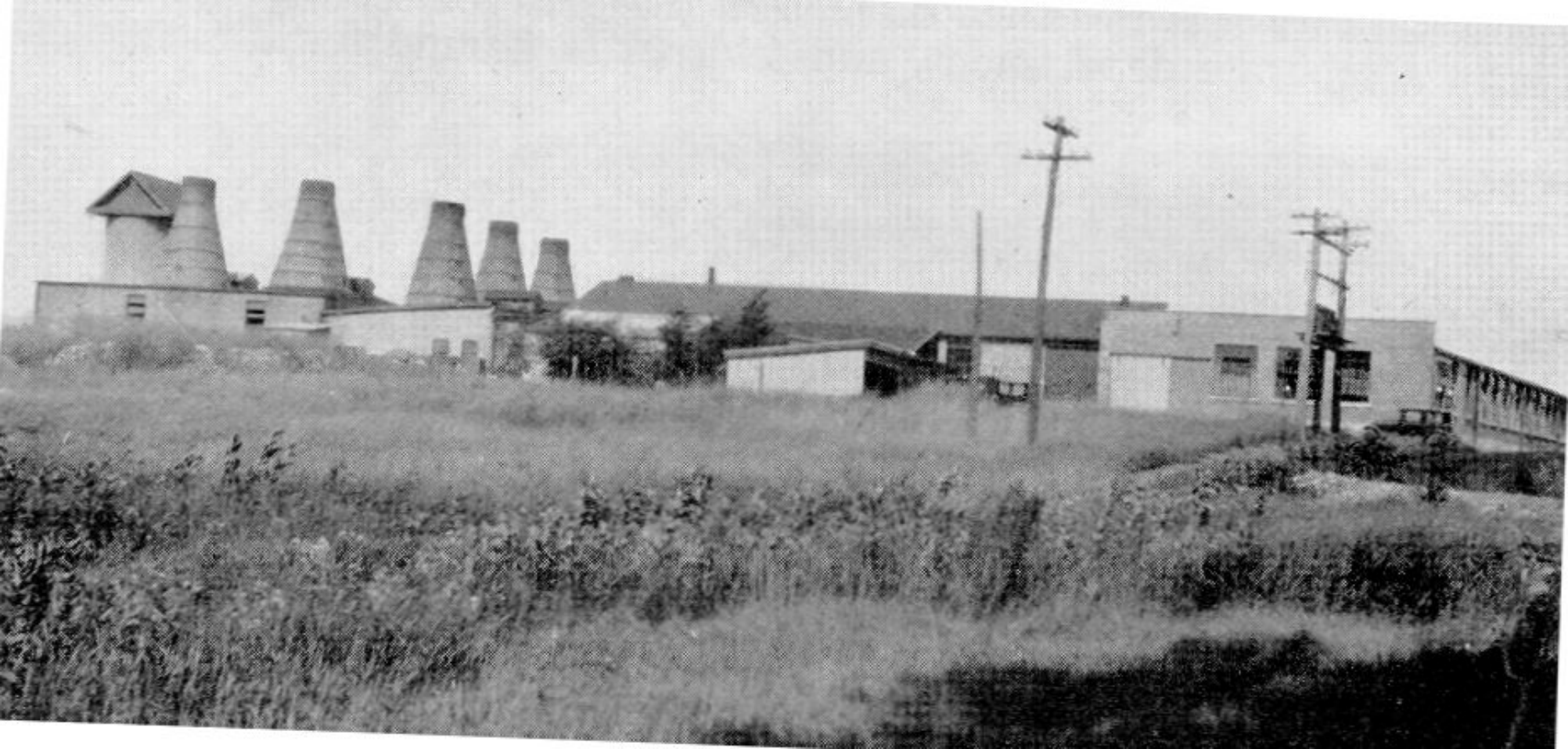


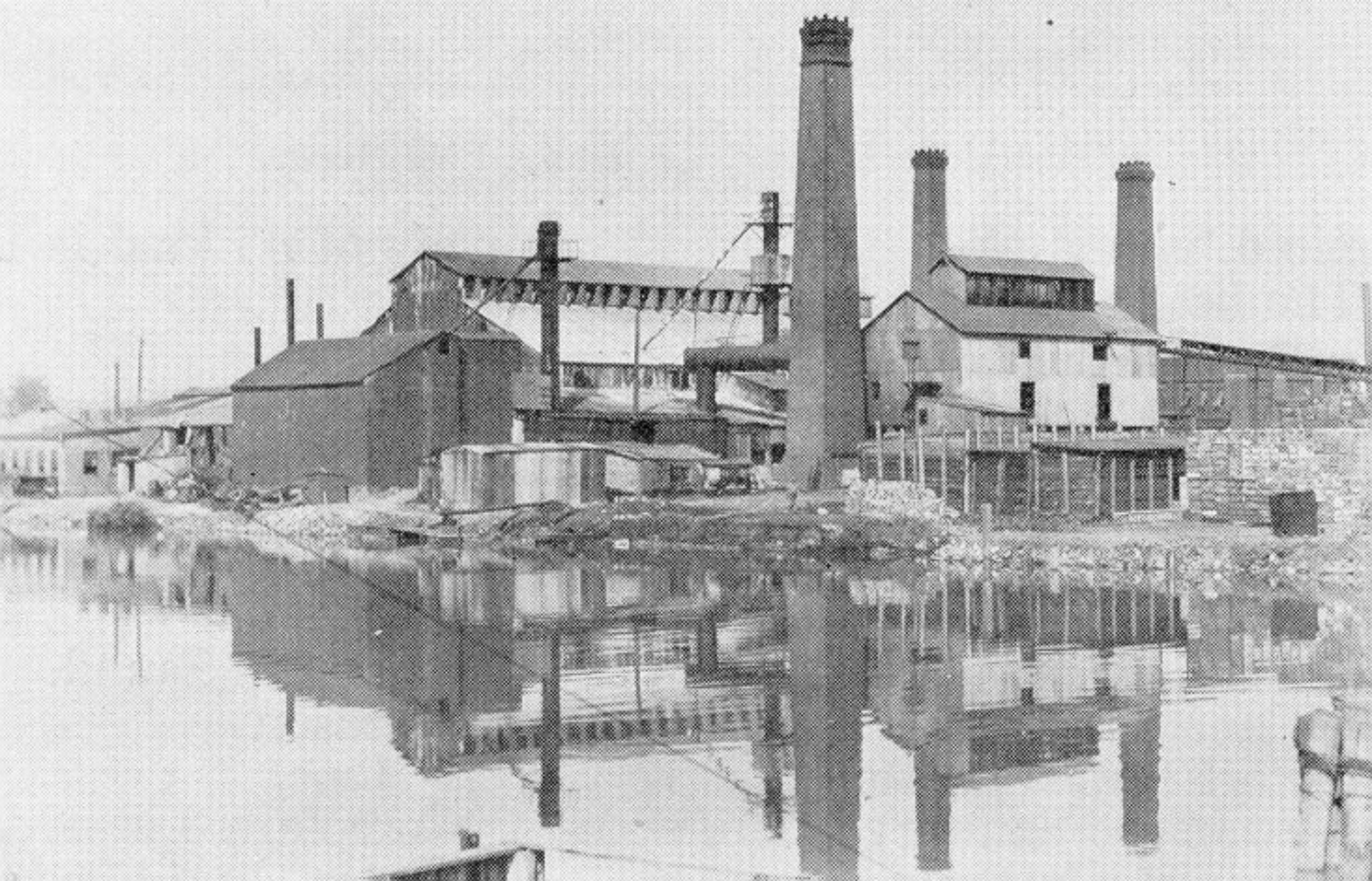


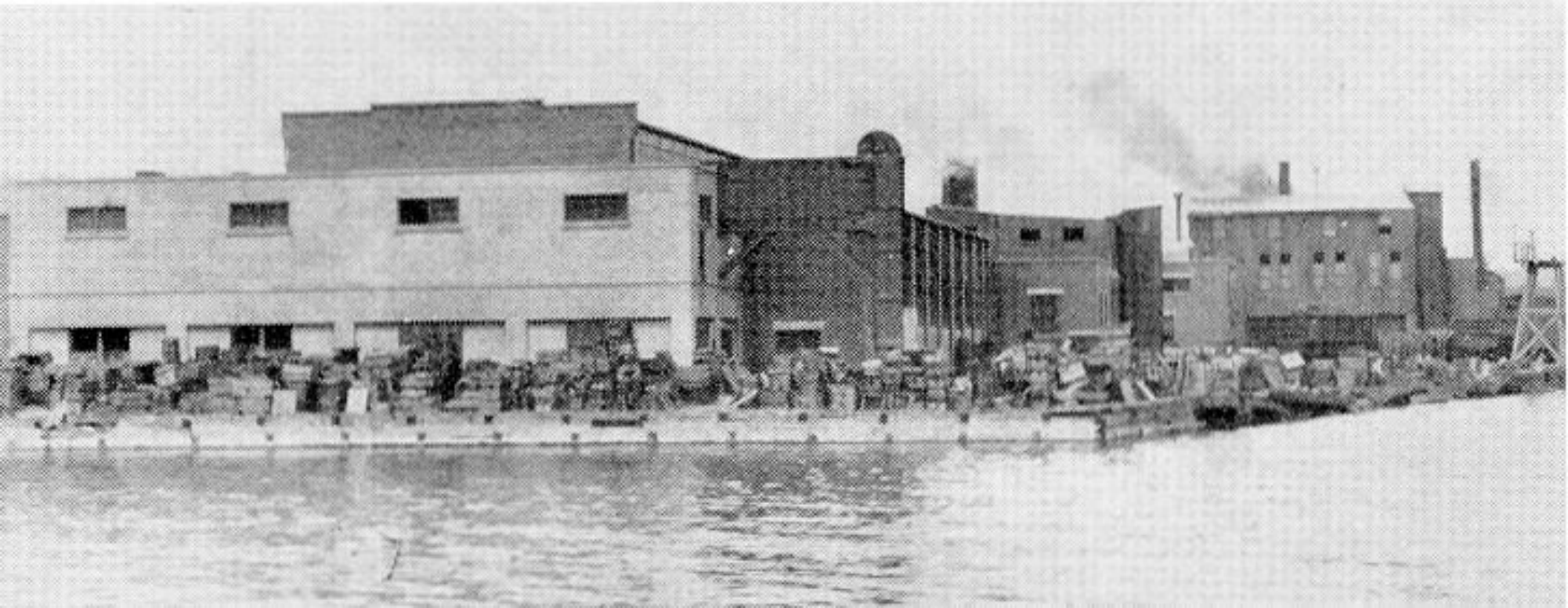




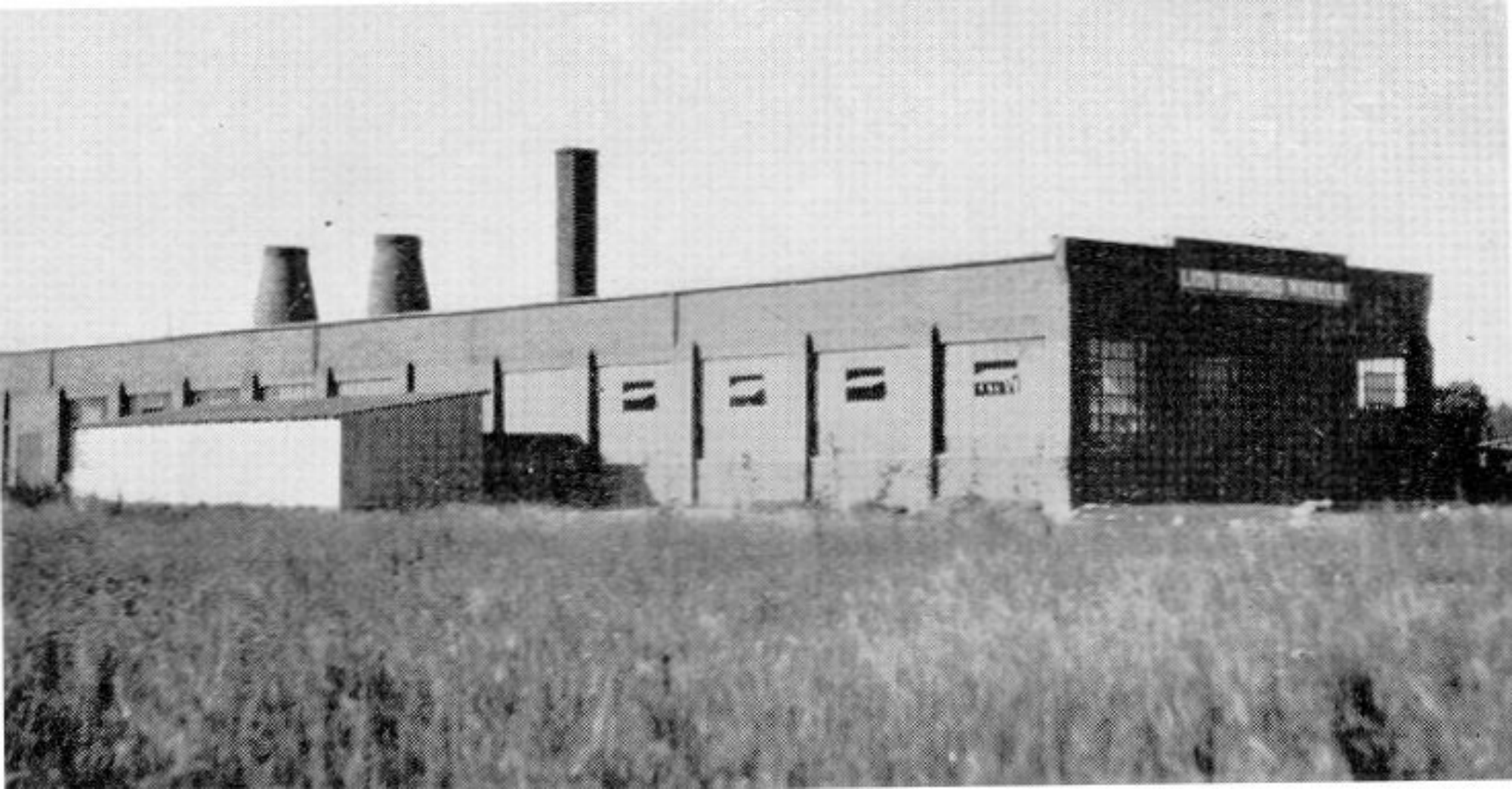


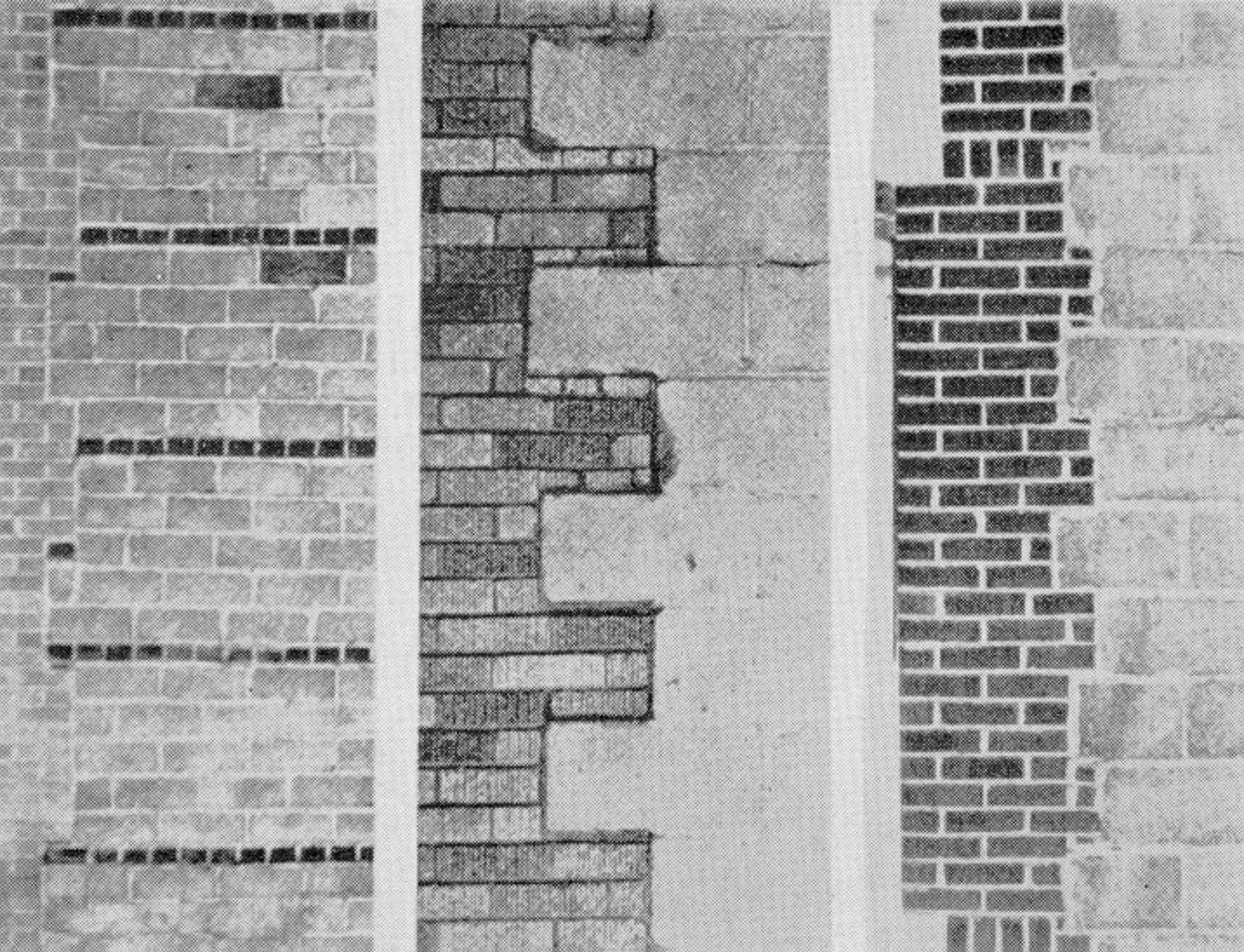






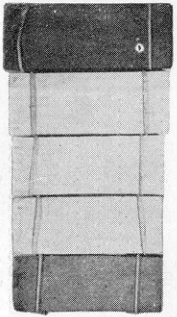






Nº 64-1

	% Porosity
Raw	
Cone 08 (1733°F.)	43·2
4 (2129°F.)	31·0
10 (2300°F.)	20·3
14 (2534°F.)	9·1

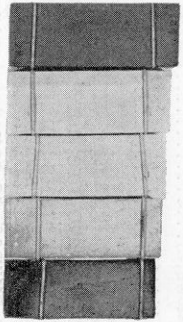


P.C.E.-Cone 33

(3173°F.)

Nº 64-2

	% Porosity
Raw	
Cone 08	38·1
4	31·4
10	24·9
14	15·5

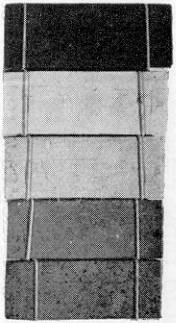


P.C.E.-Cone 32½

(3130°F.)

Nº 64-3

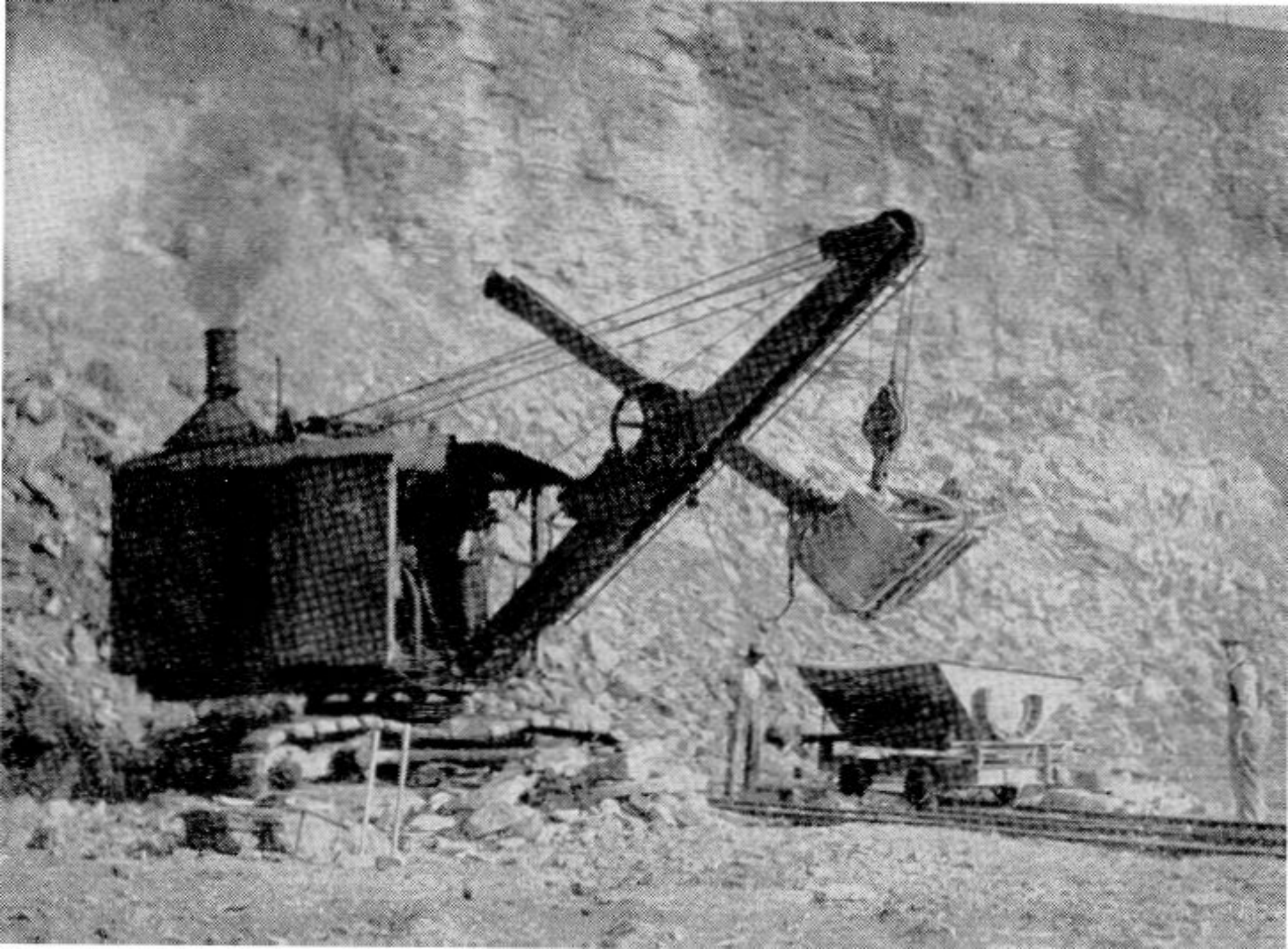
	% Porosity
Raw	
Cone 08	34·4
4	23·8
10	9·3
14	11·4



P.C.E.-Cone 23

(2876°F.)

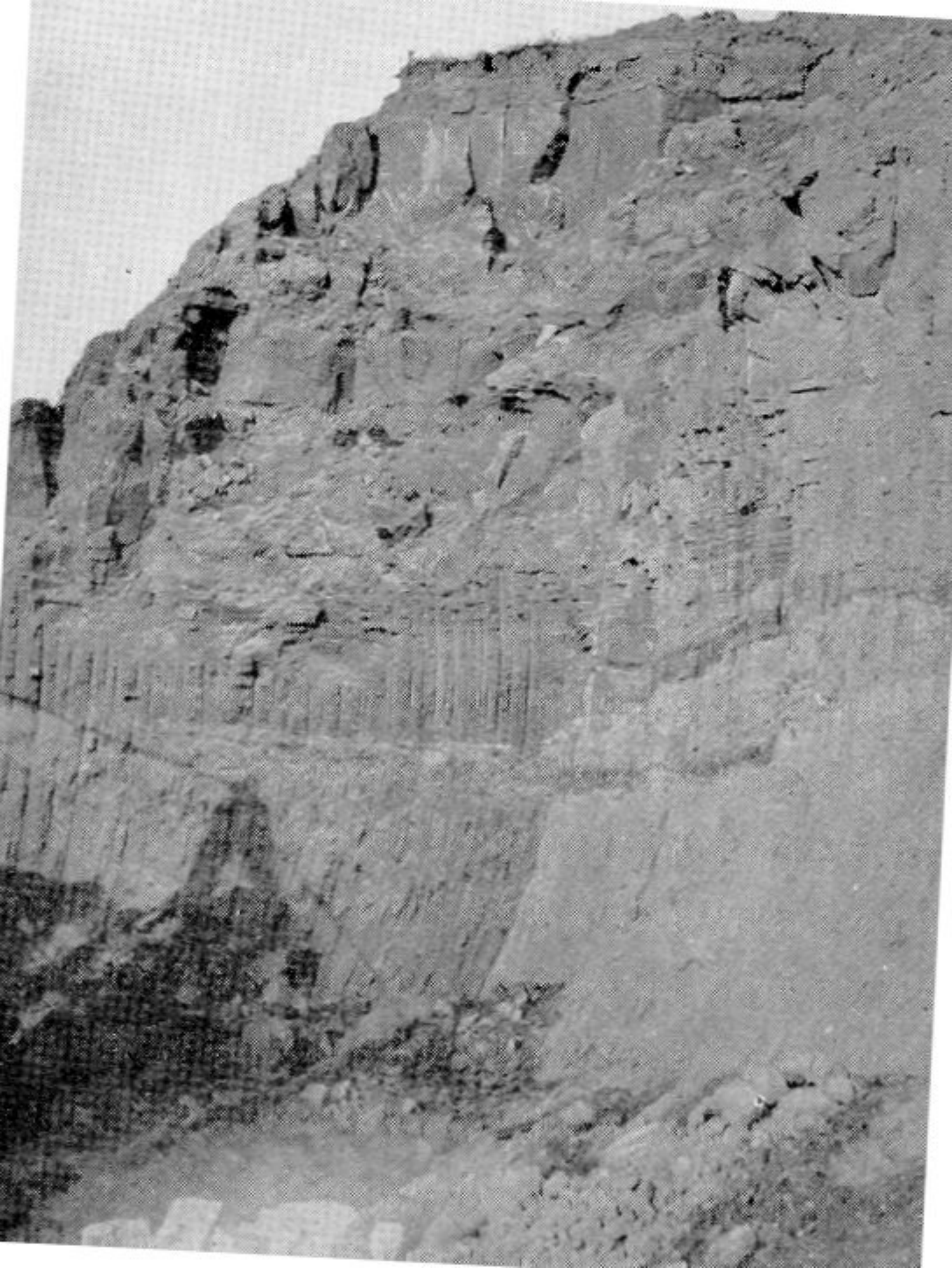


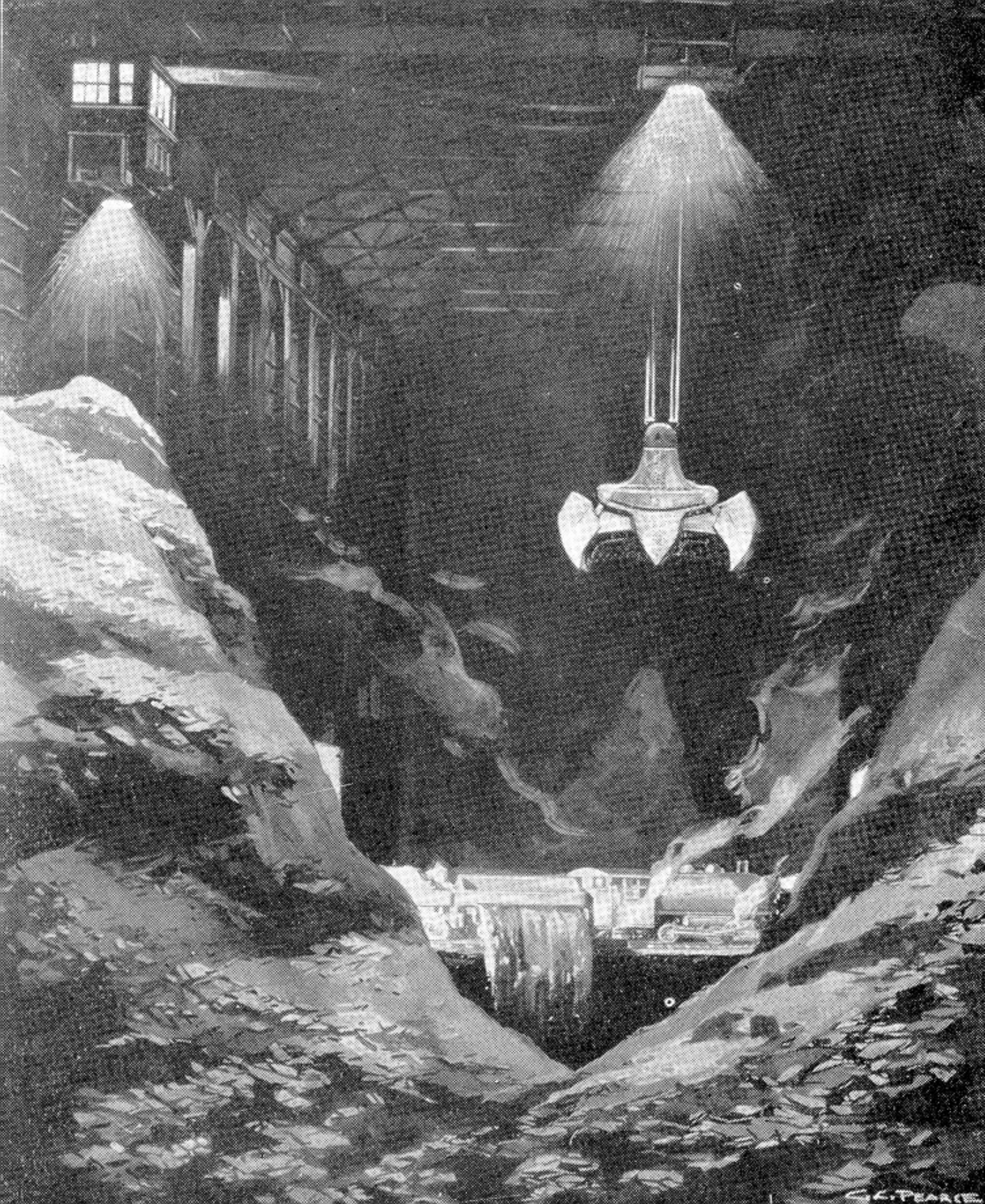


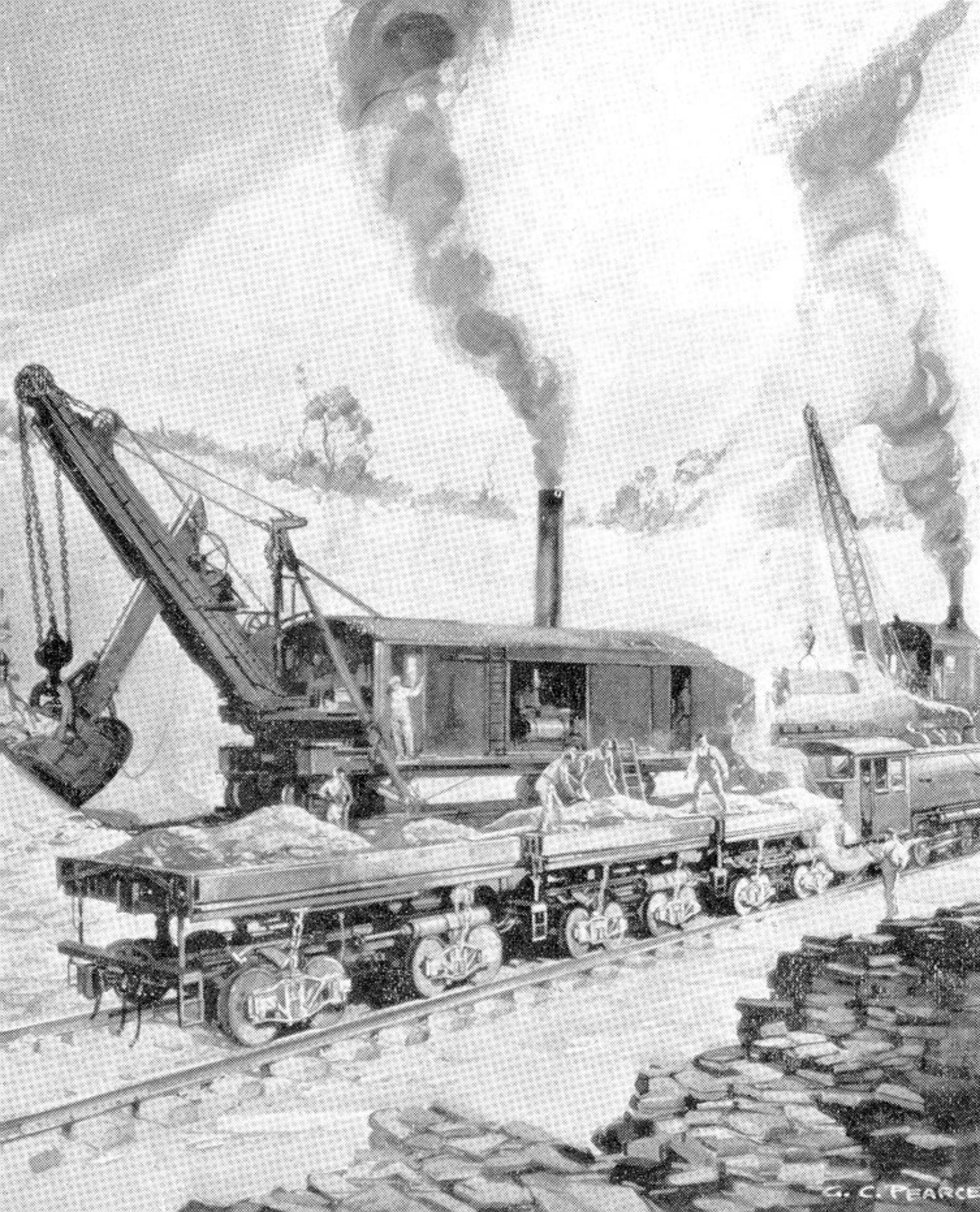


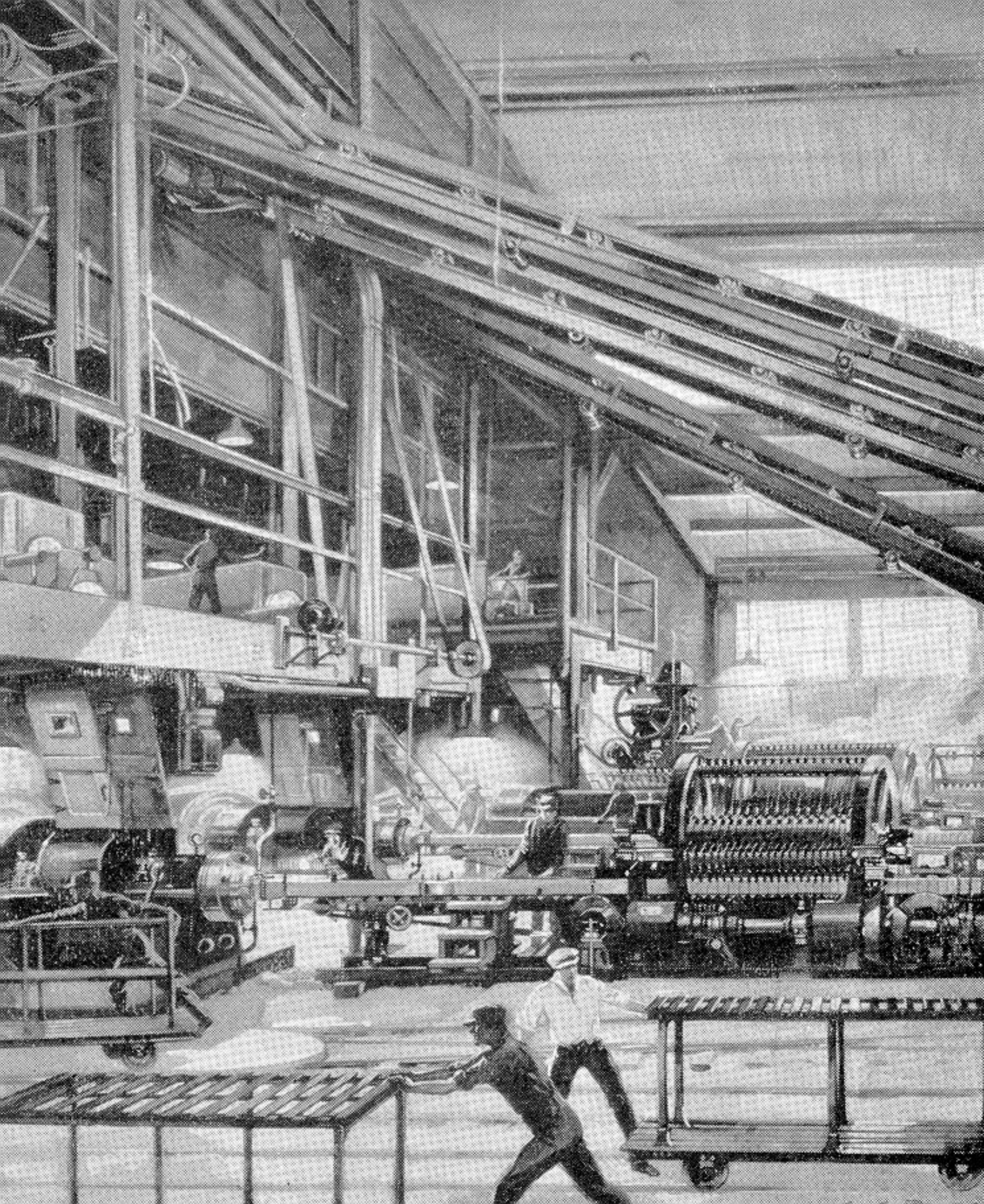


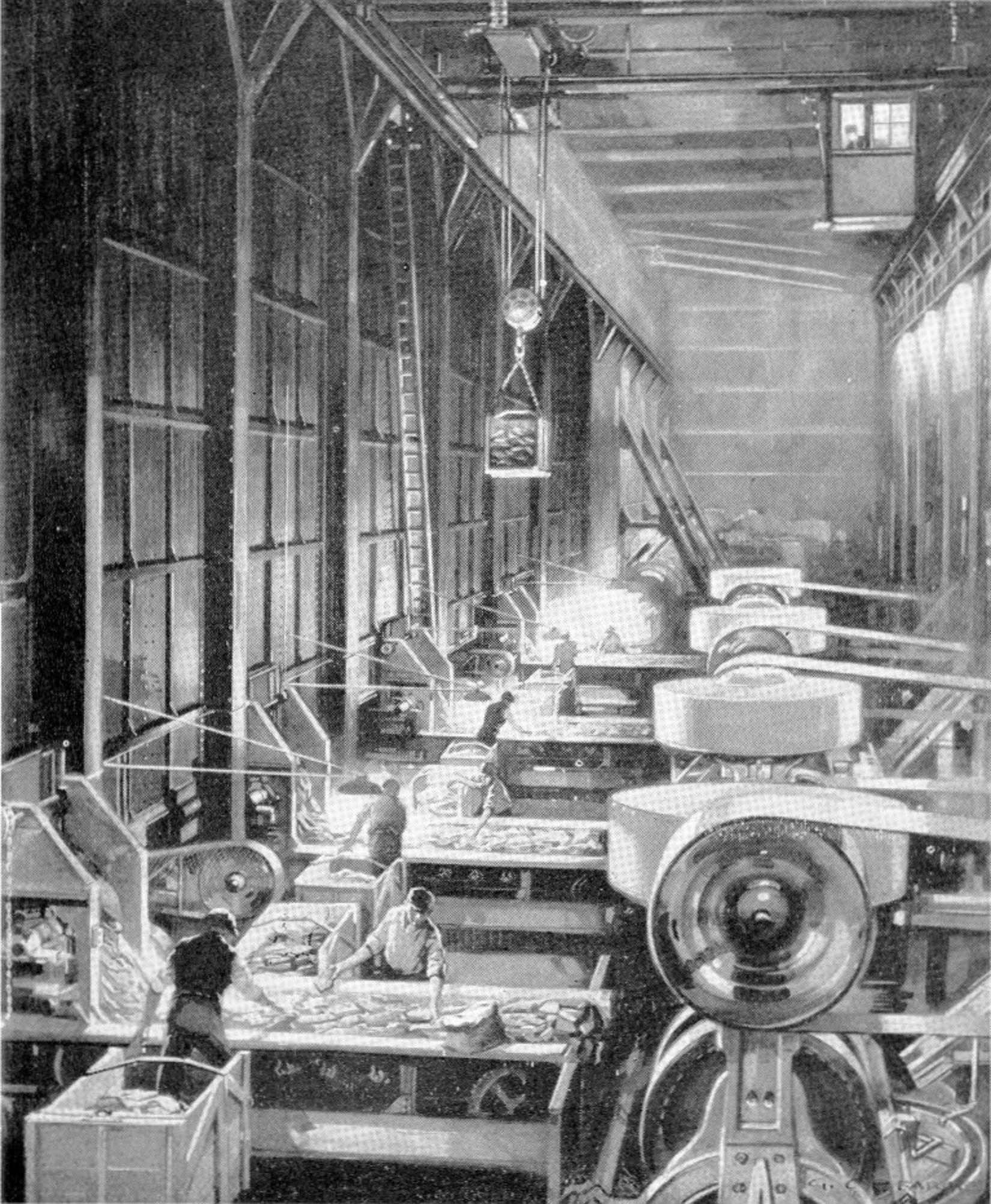


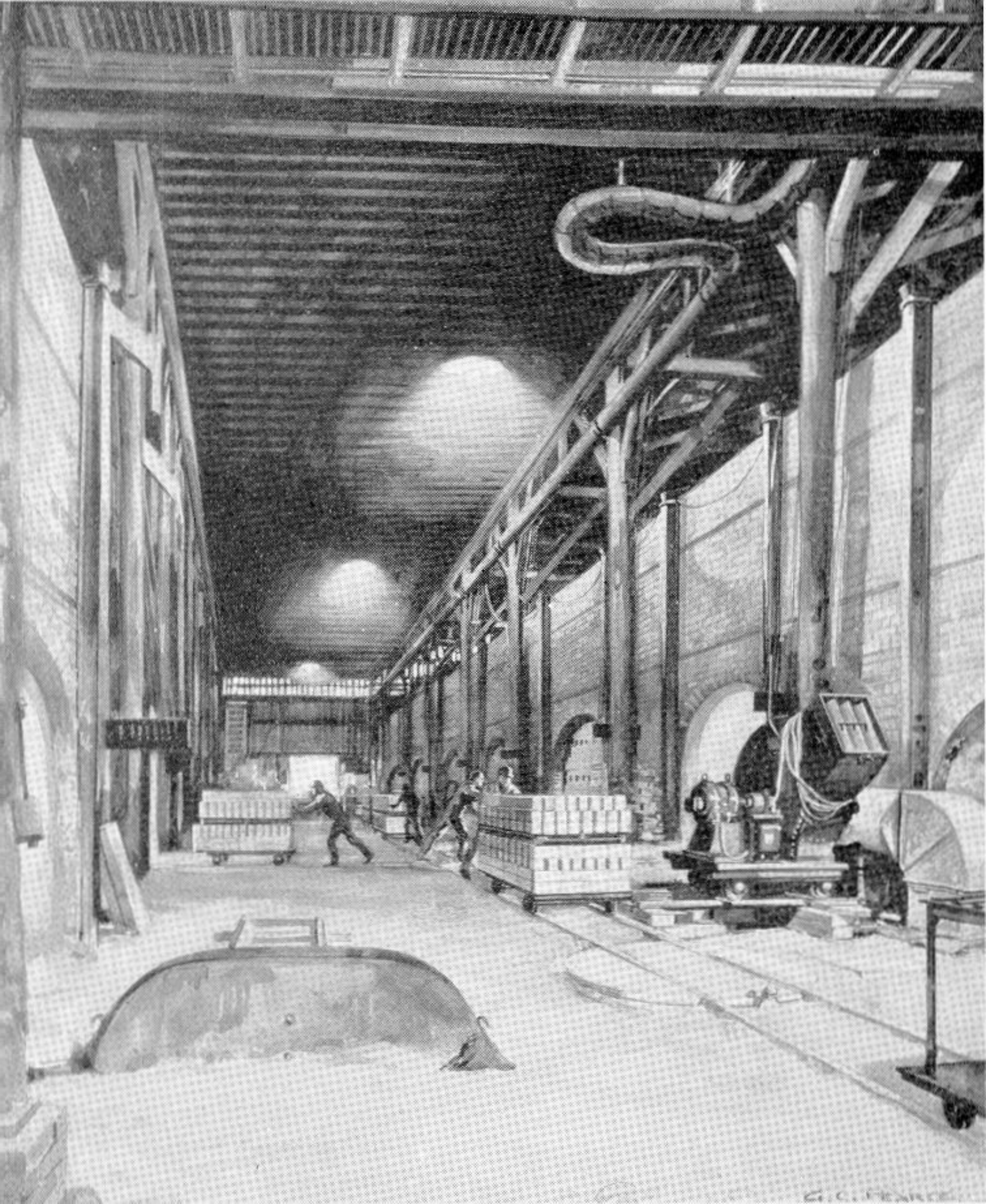


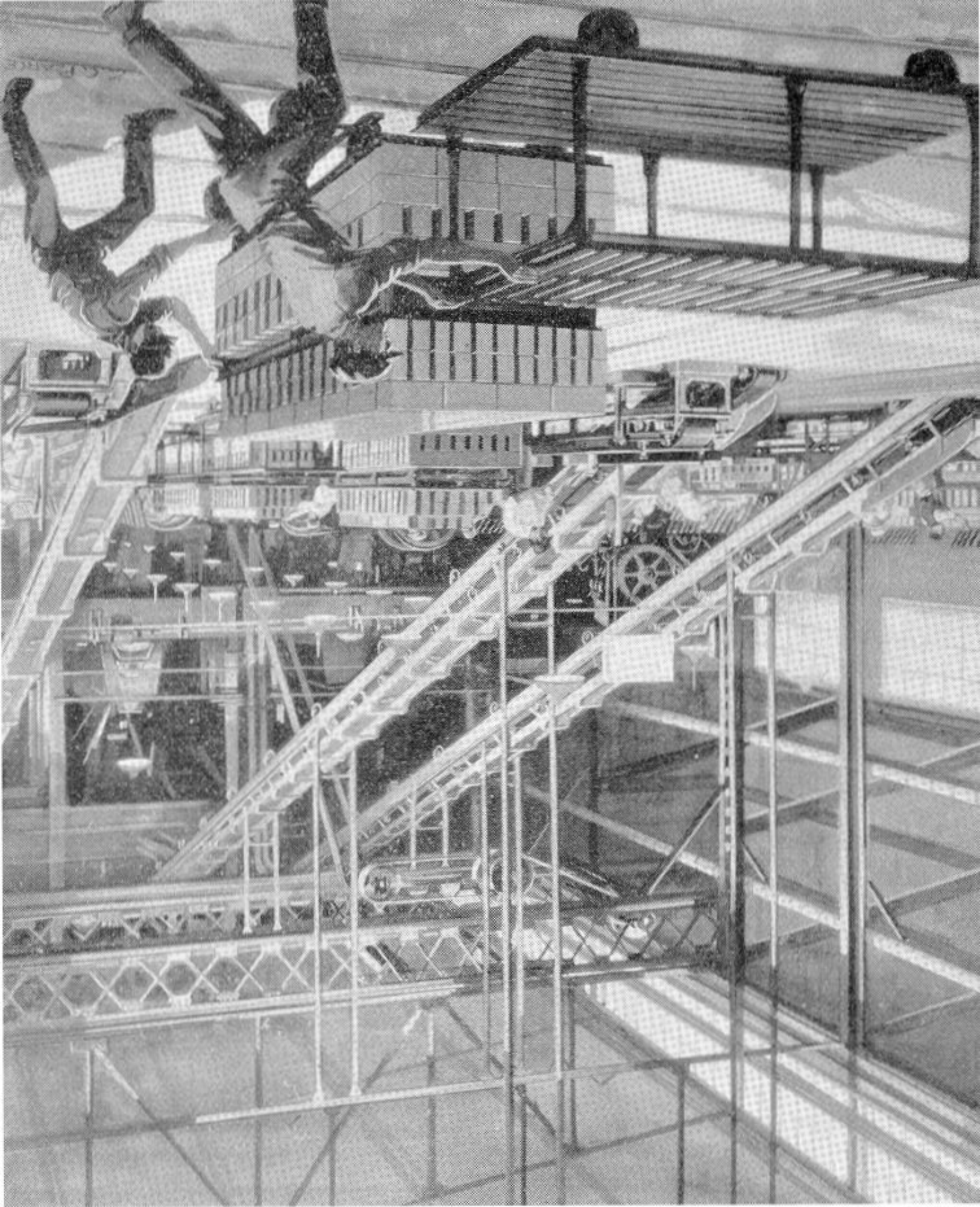



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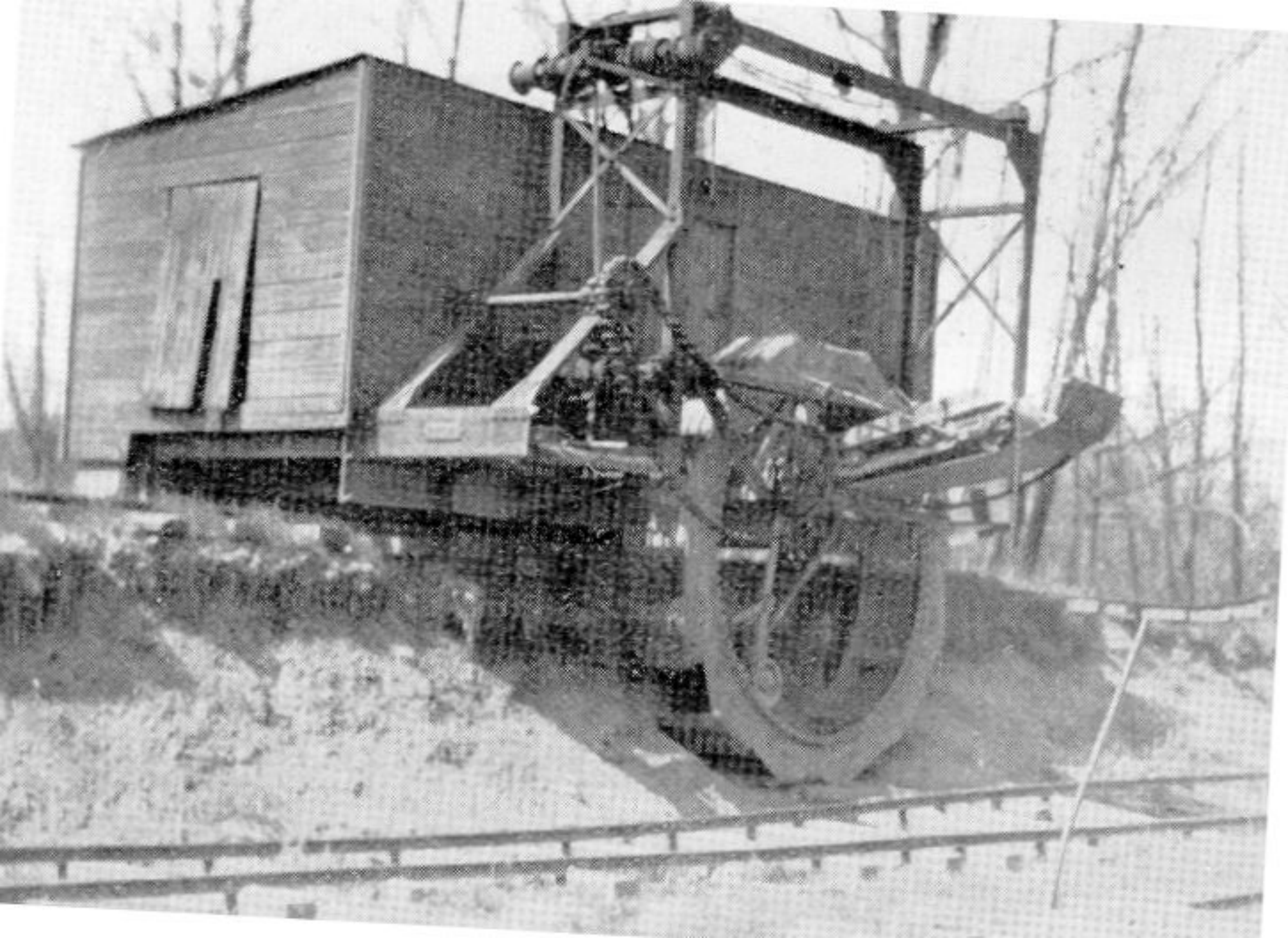


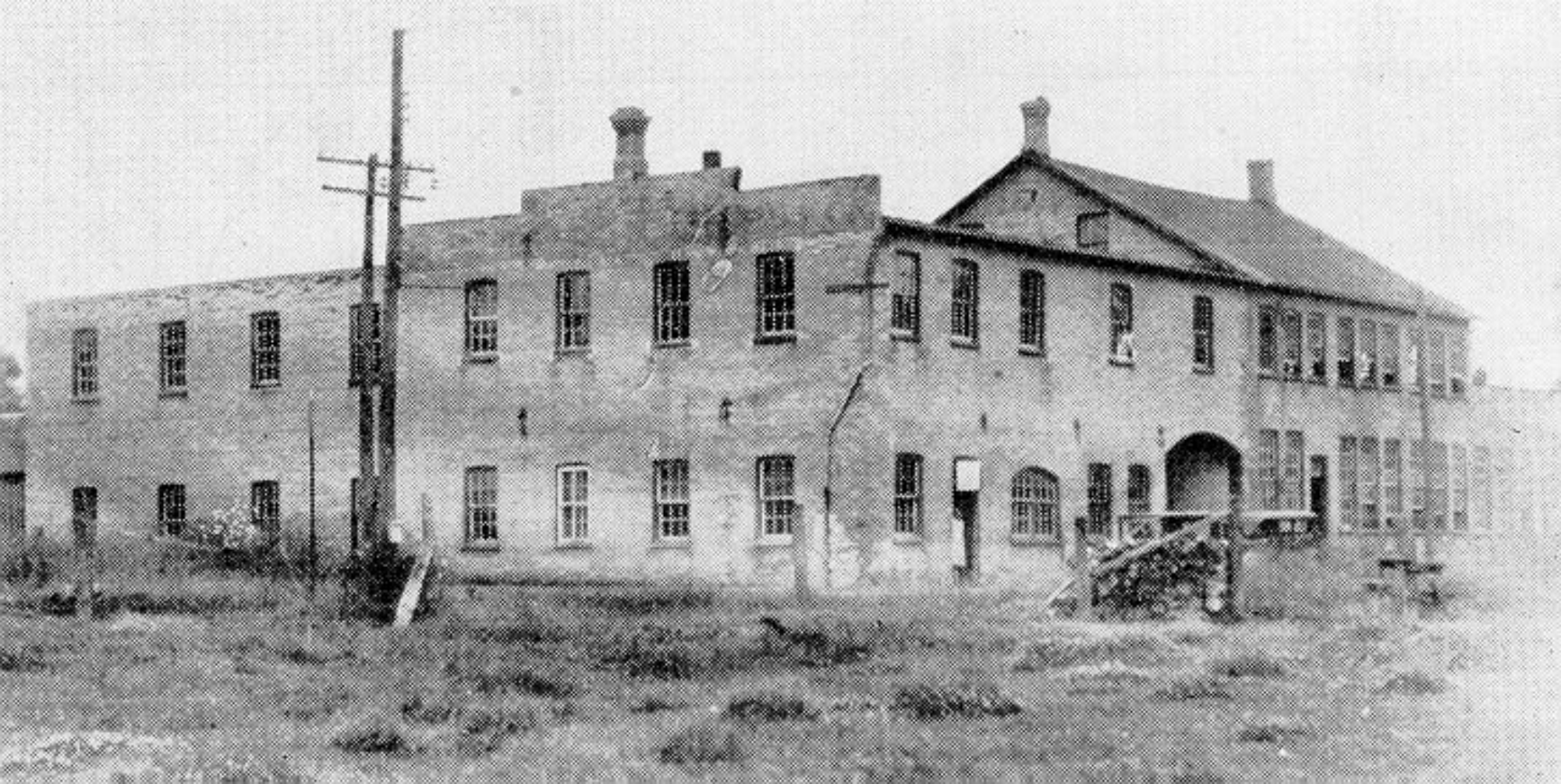






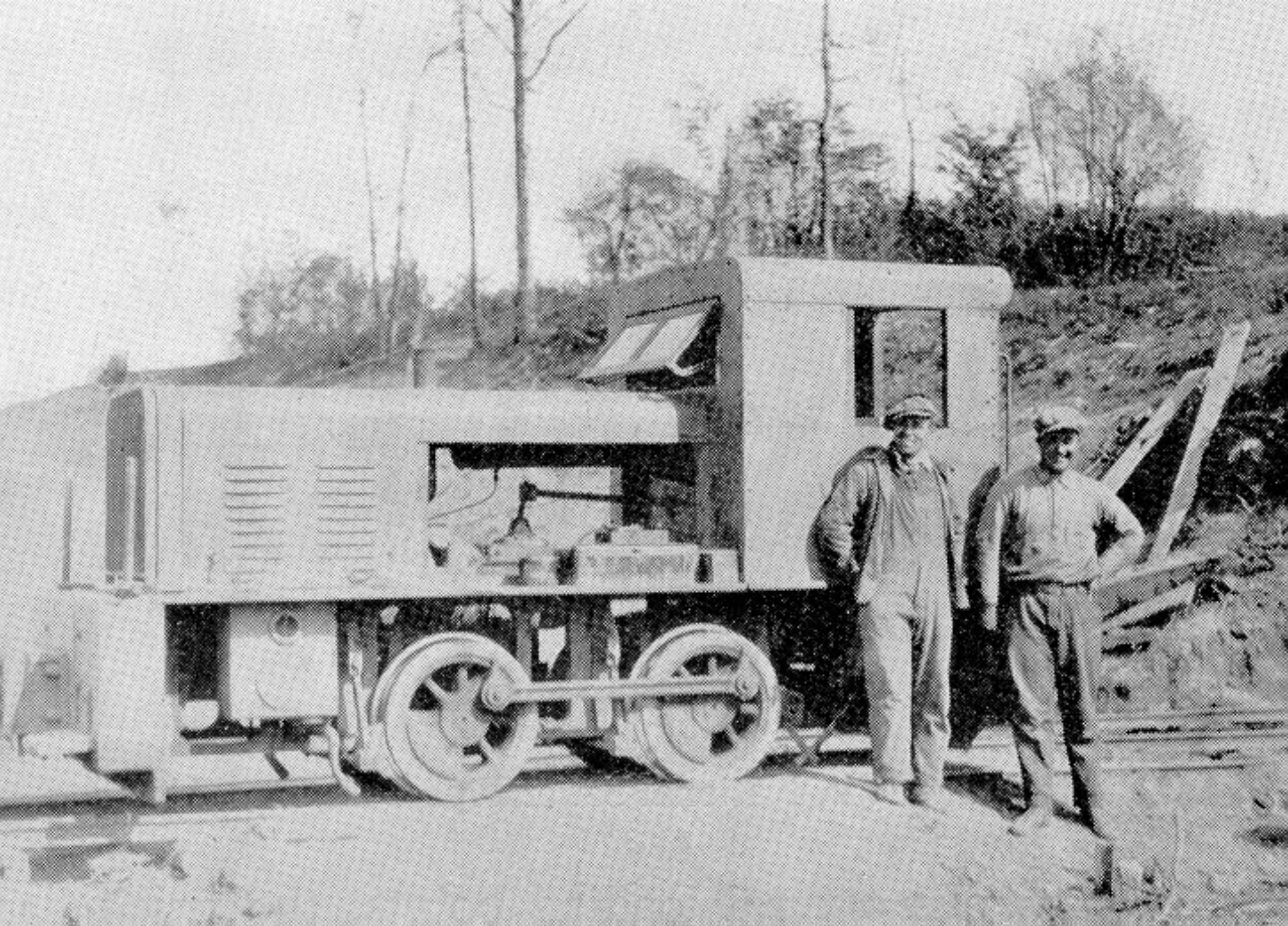


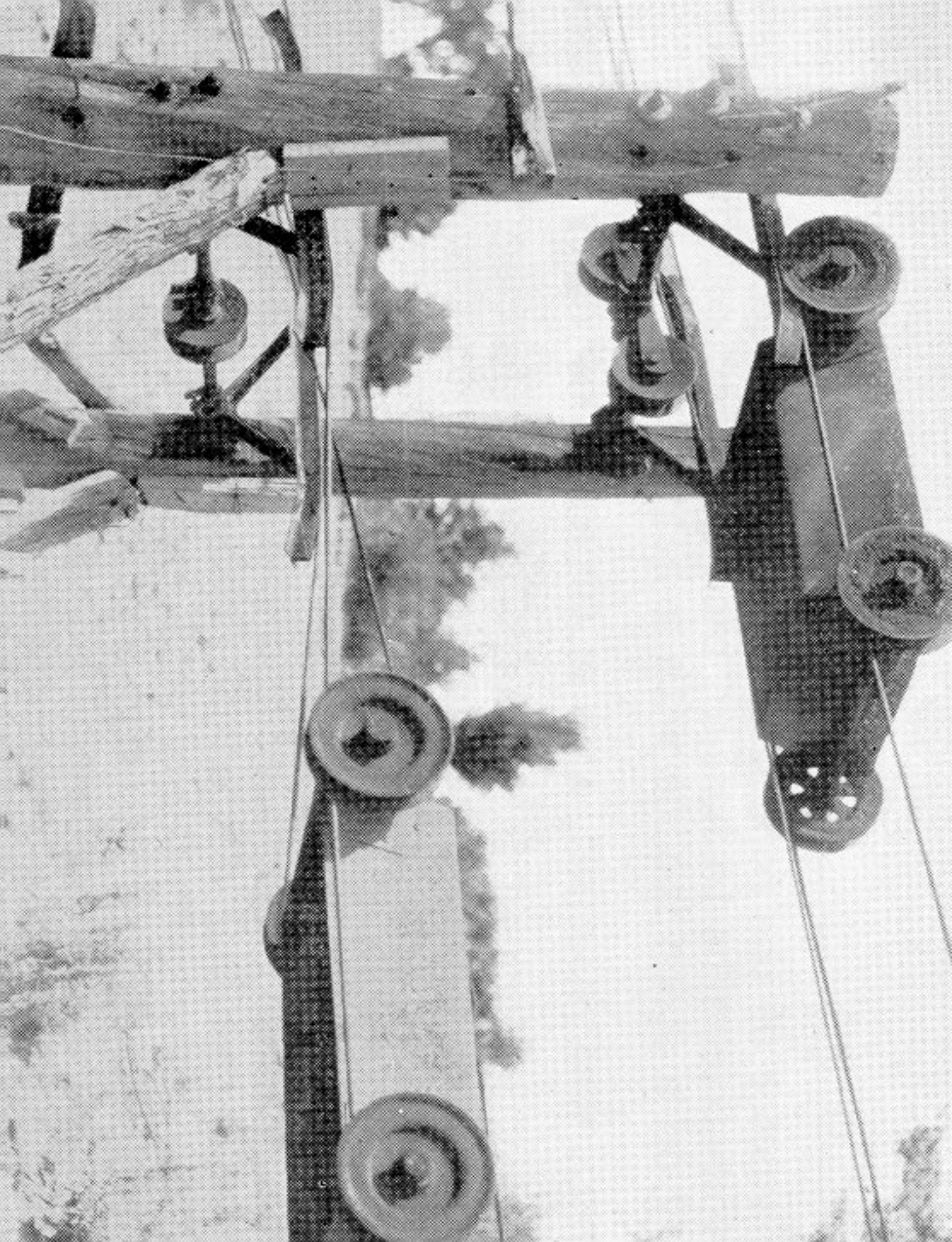


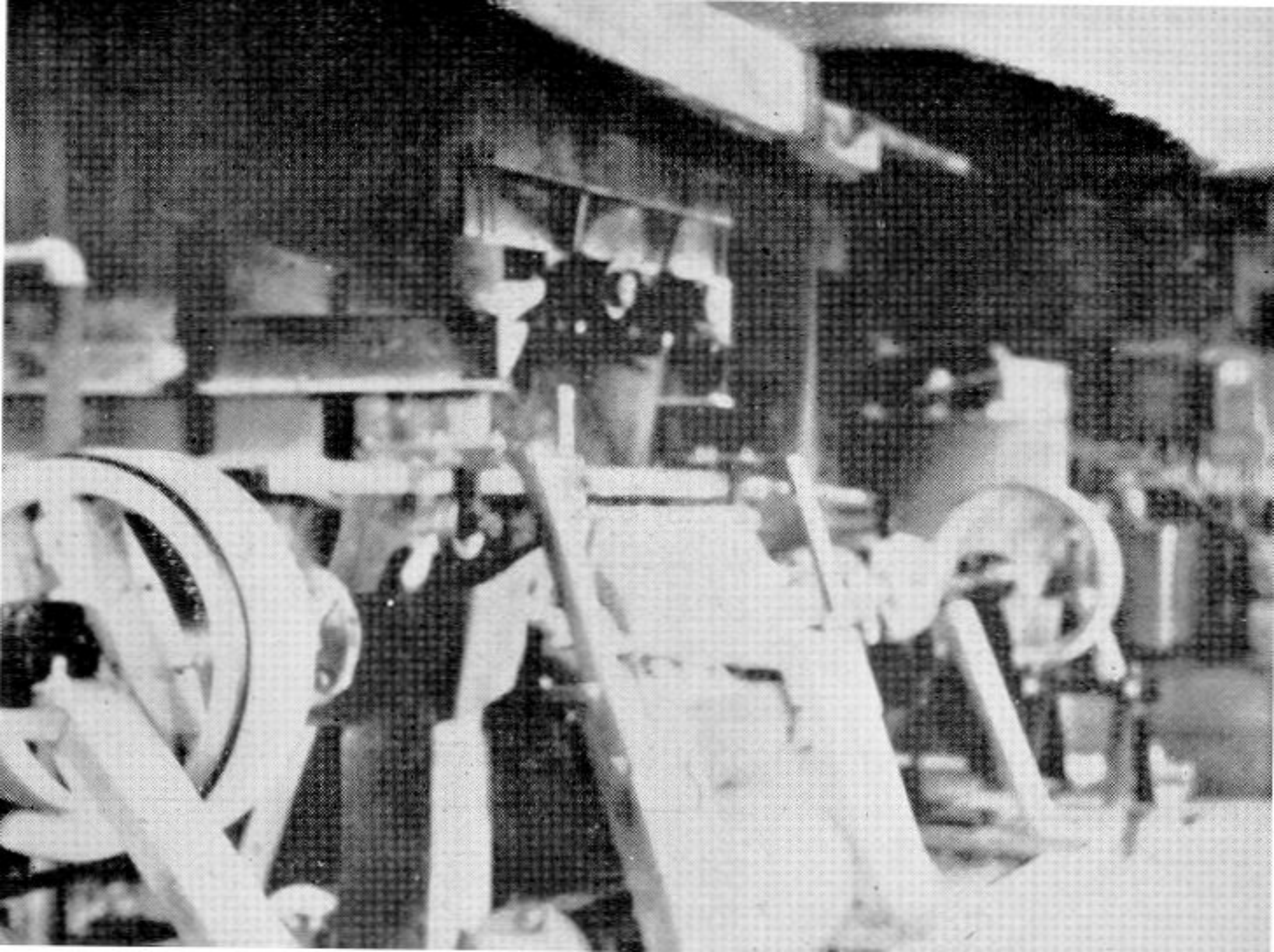


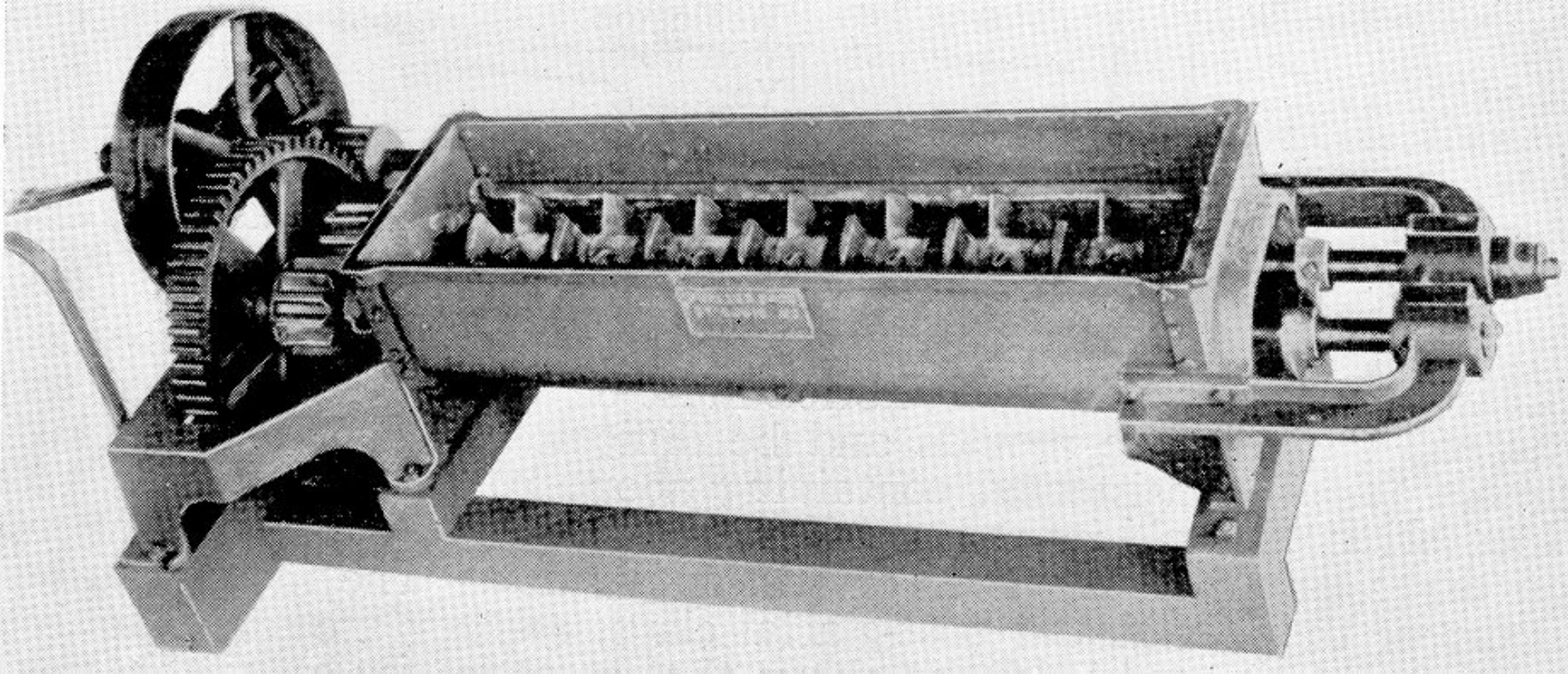


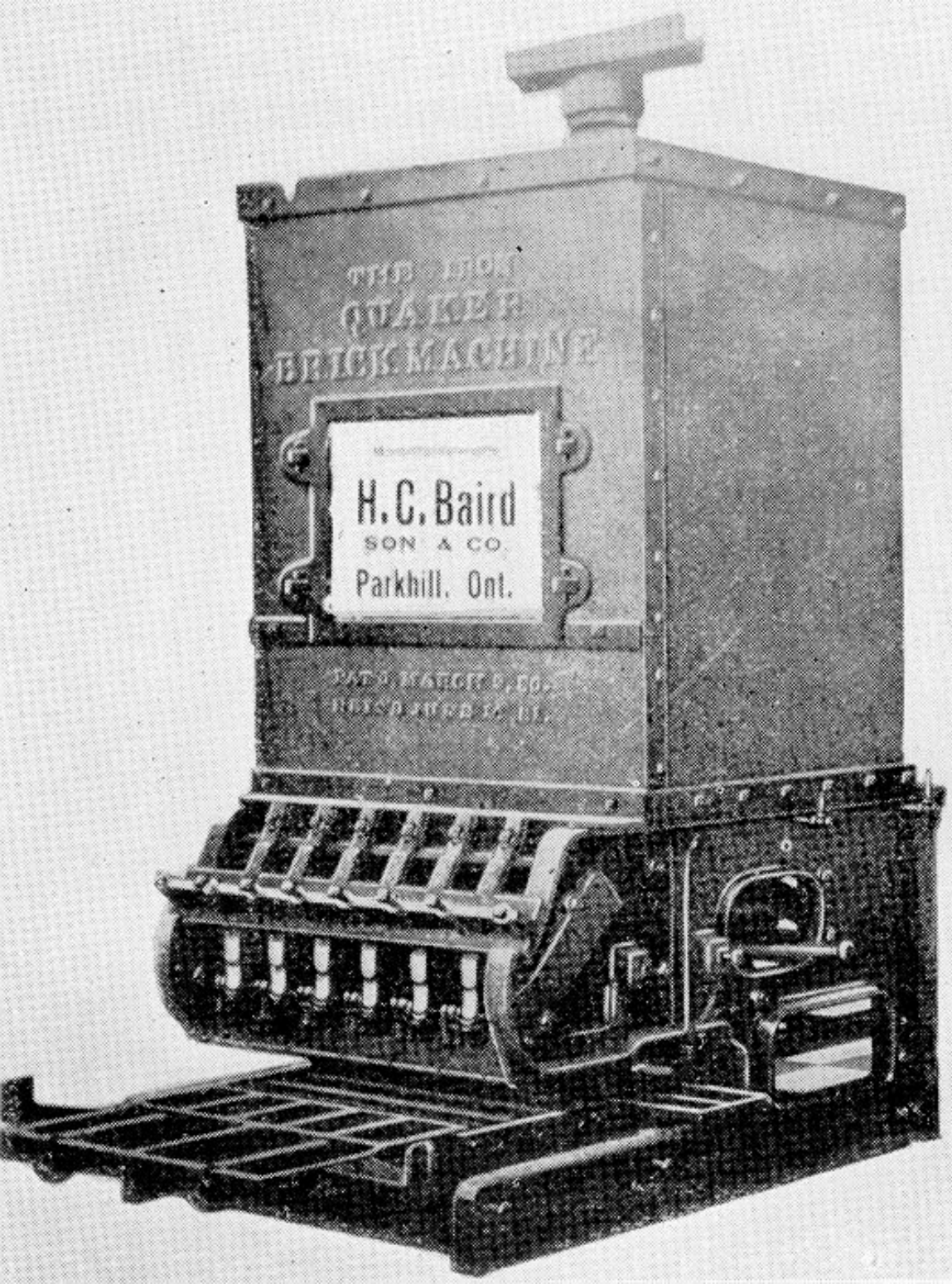


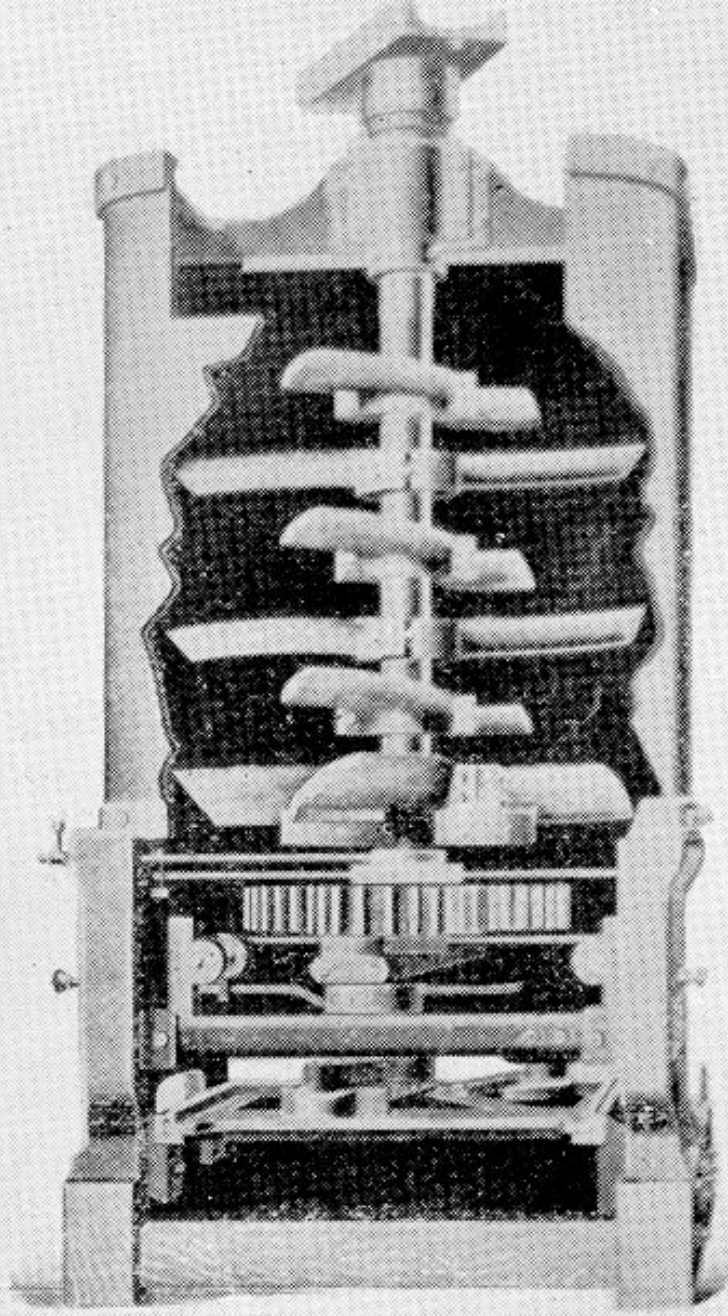


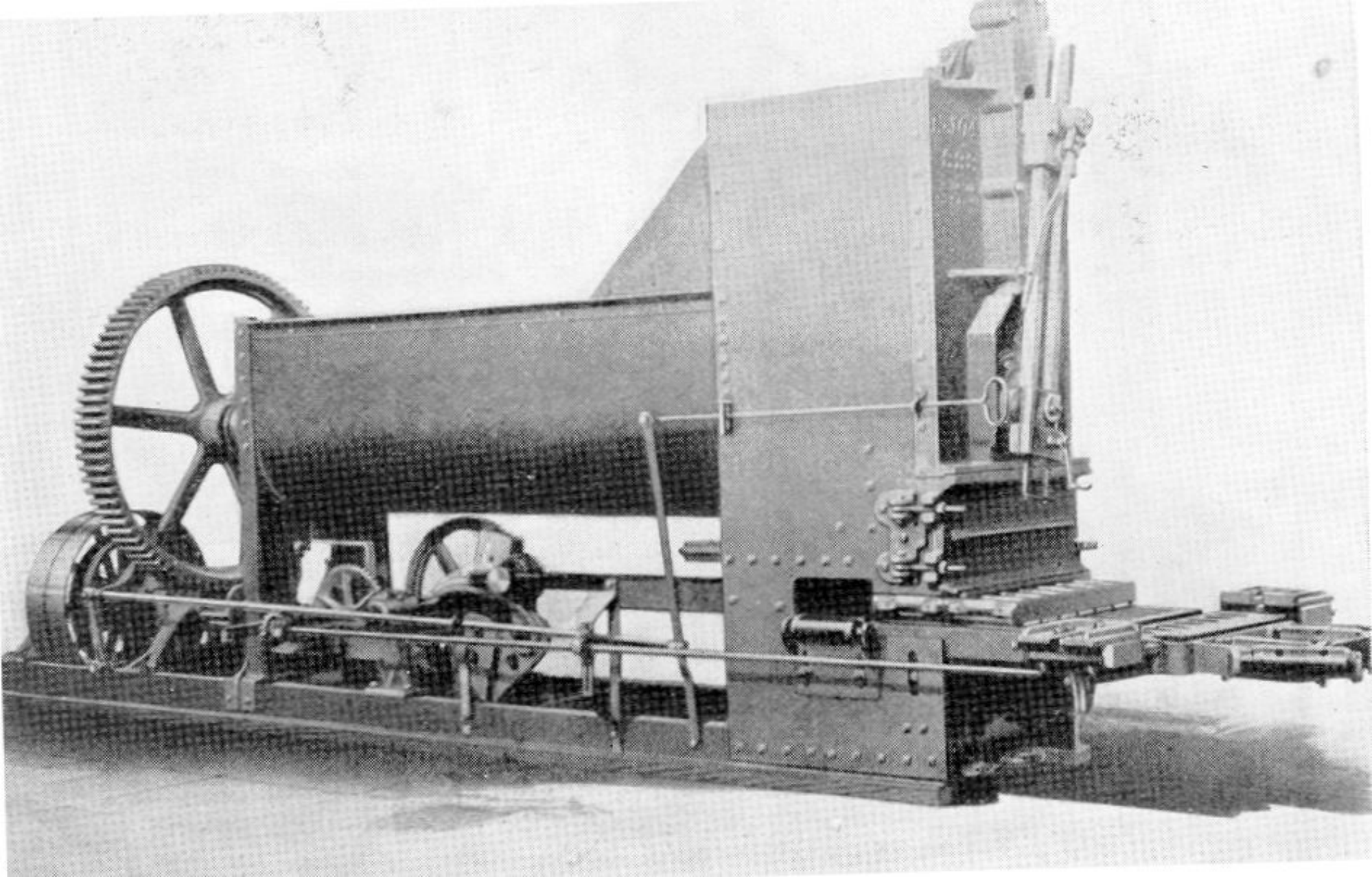


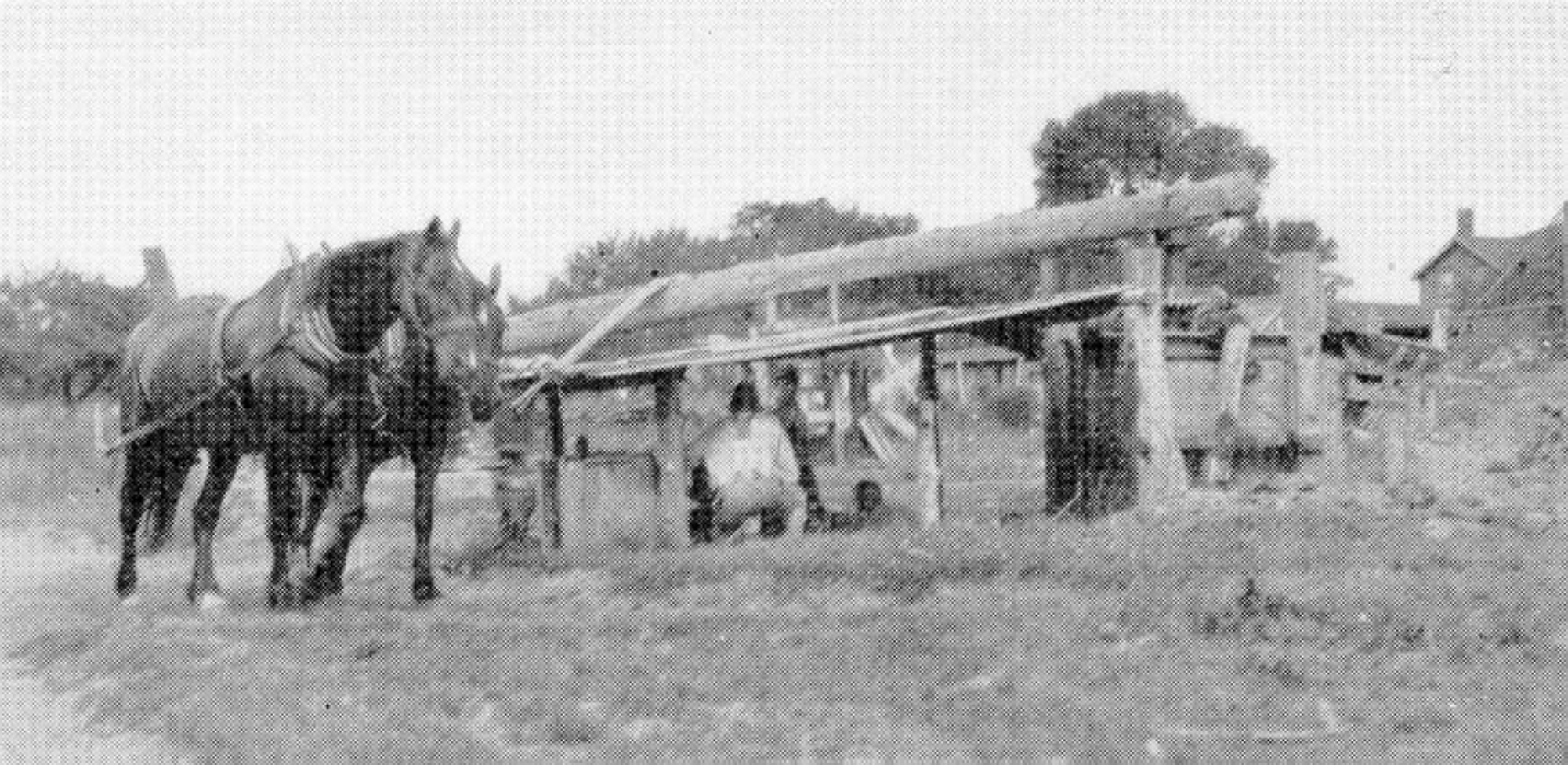




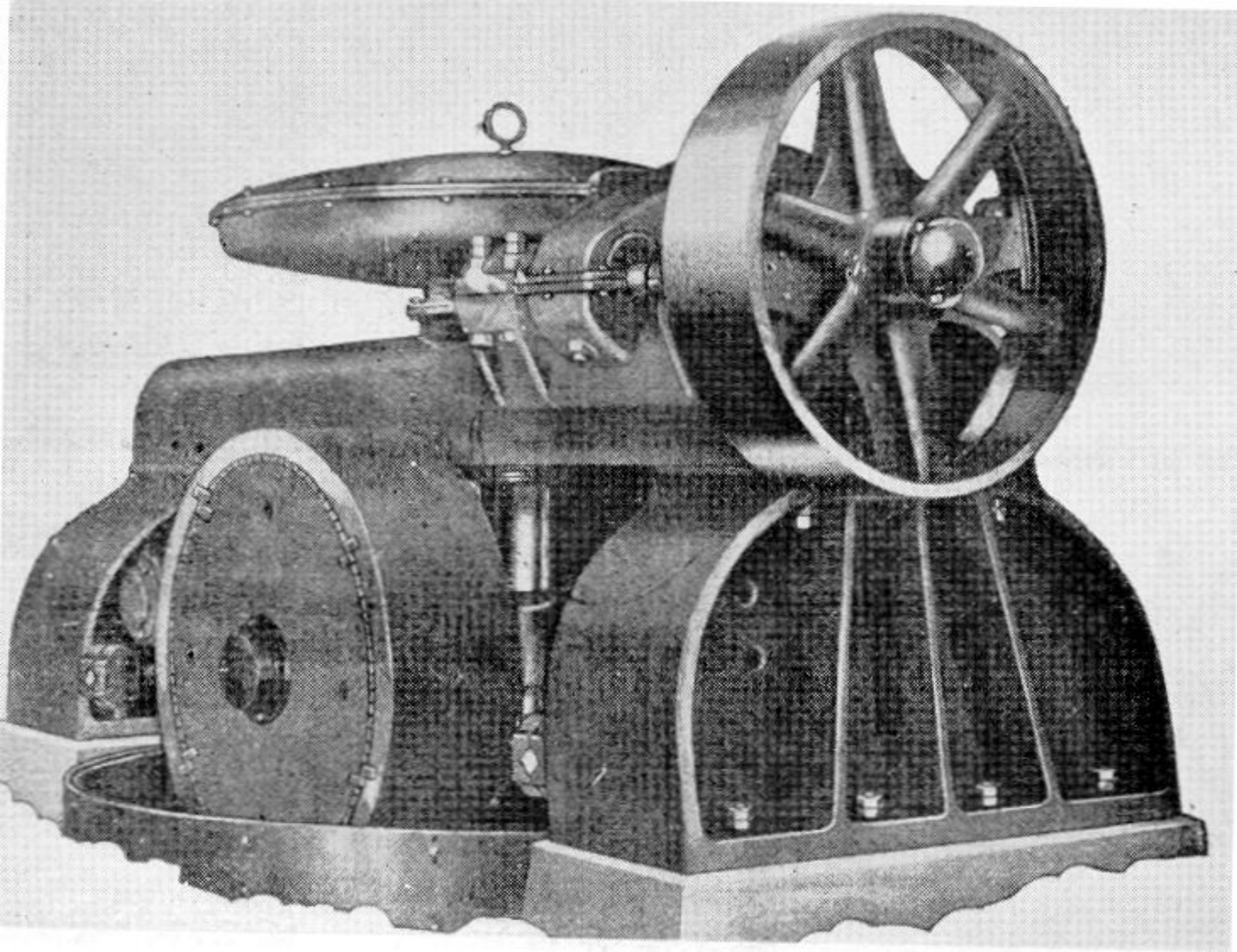

QUAKER
BRICK MACHINE
H. C. Baird
SON & CO.
Parkhill, Ont.

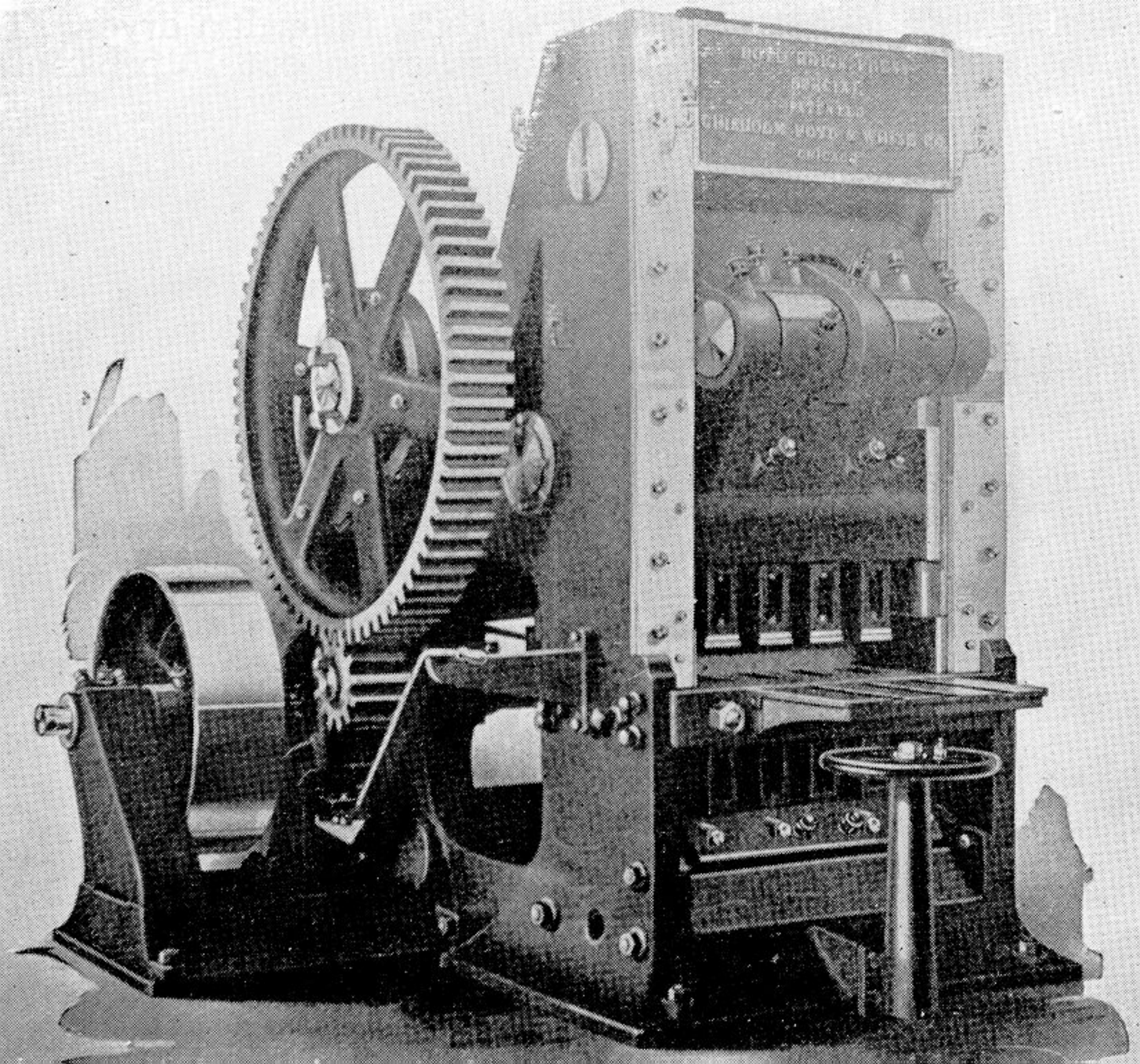


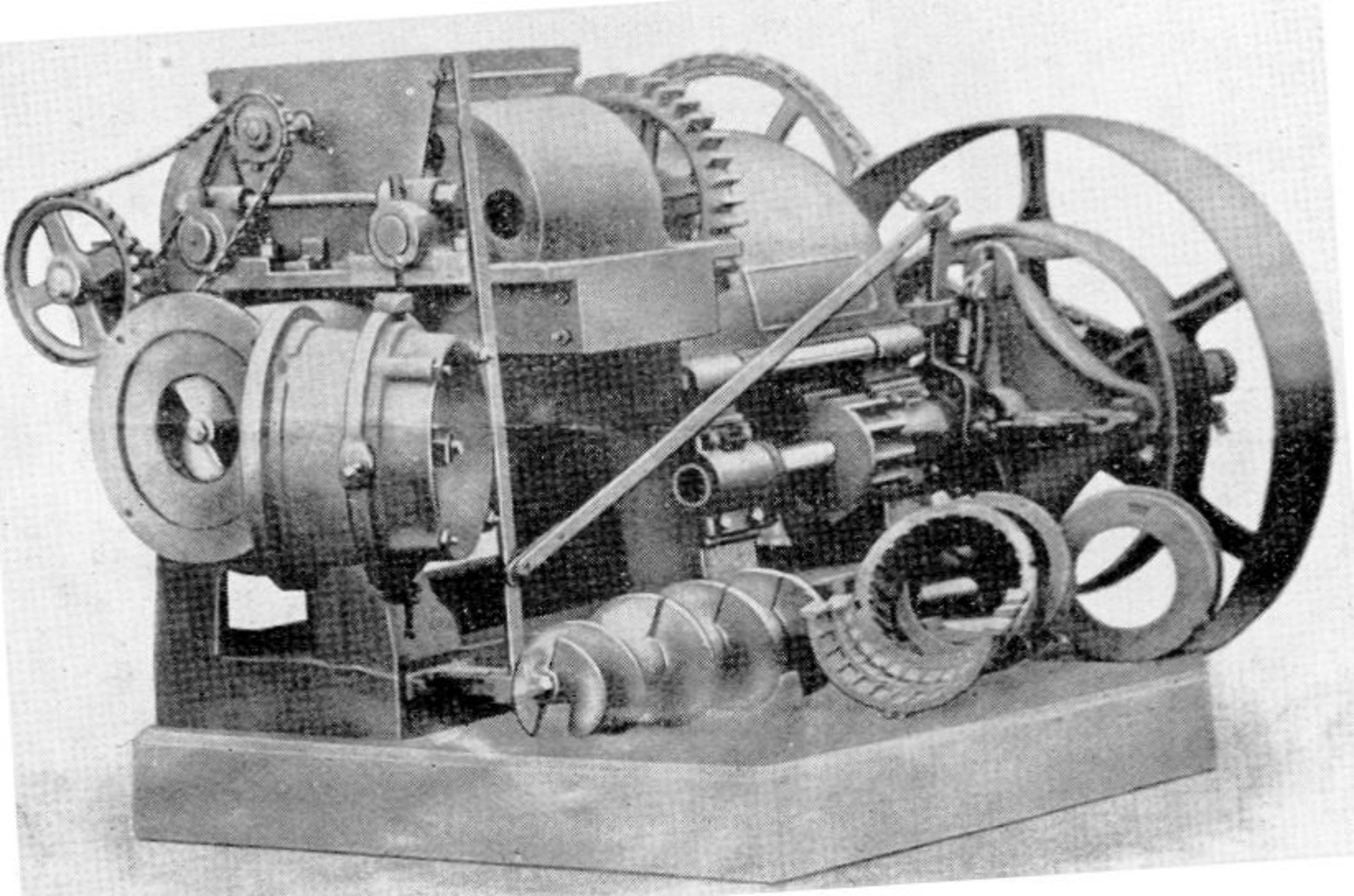






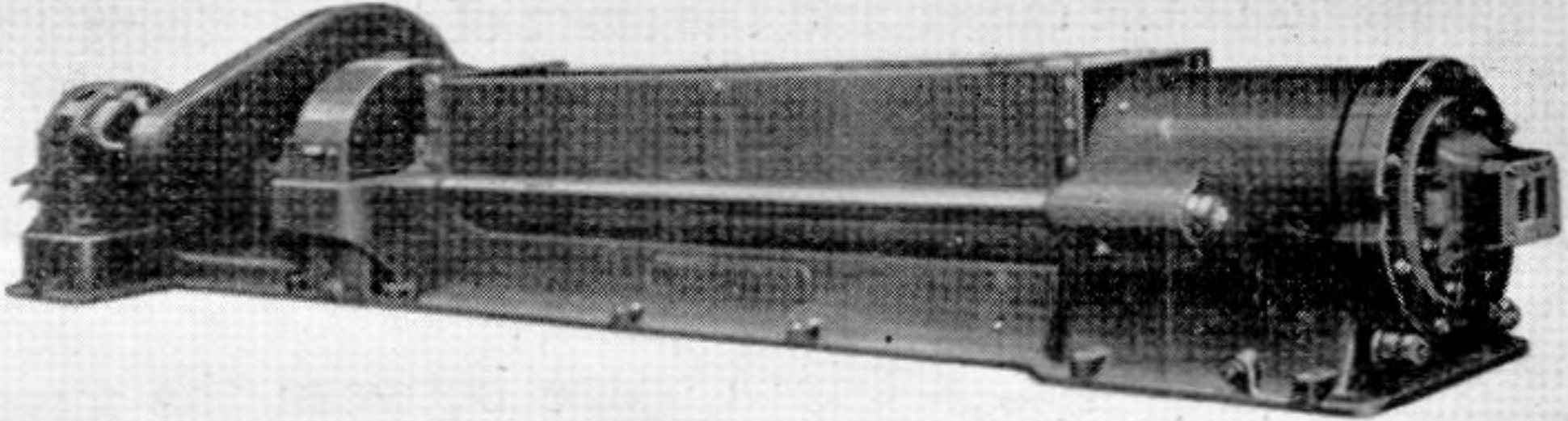


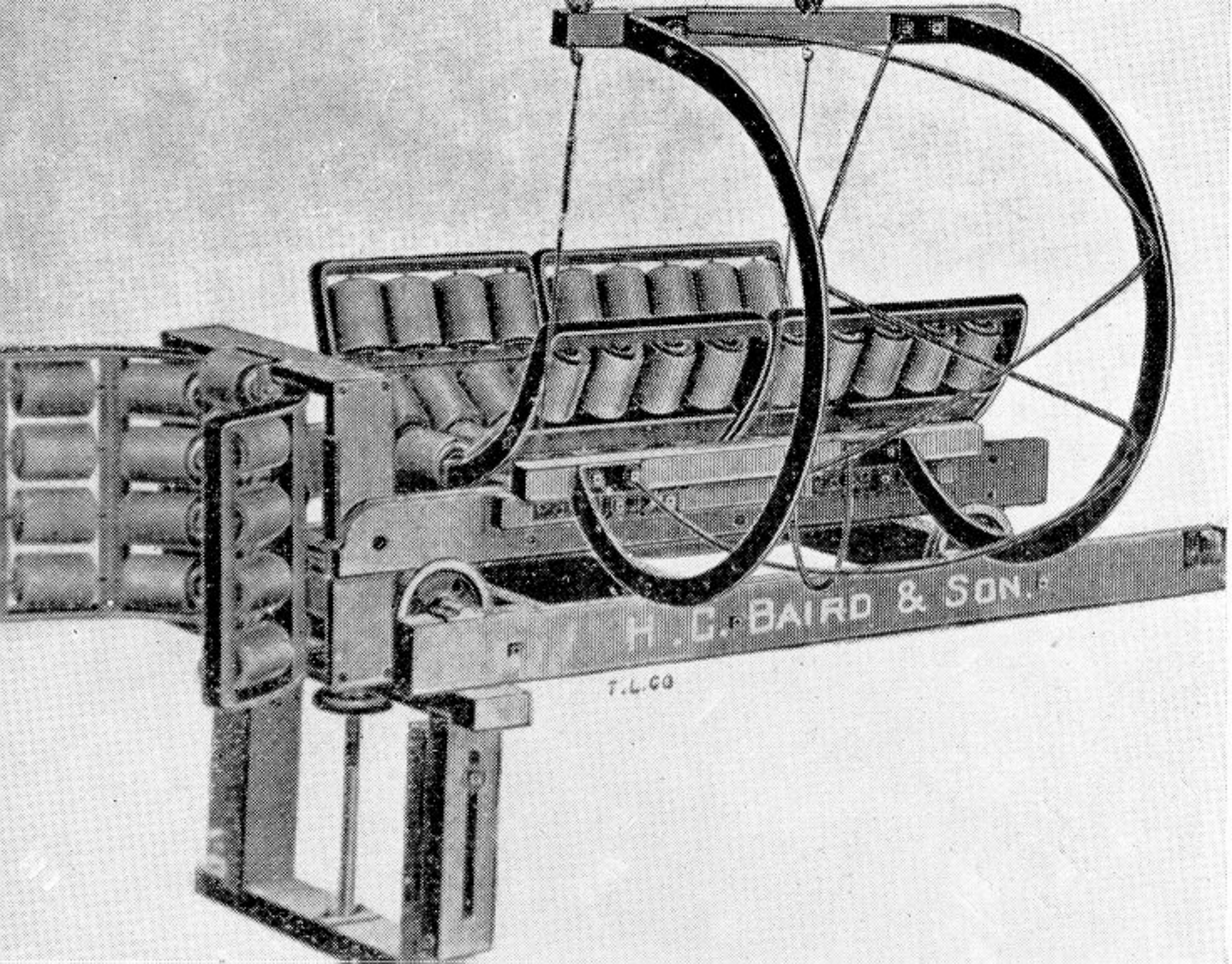


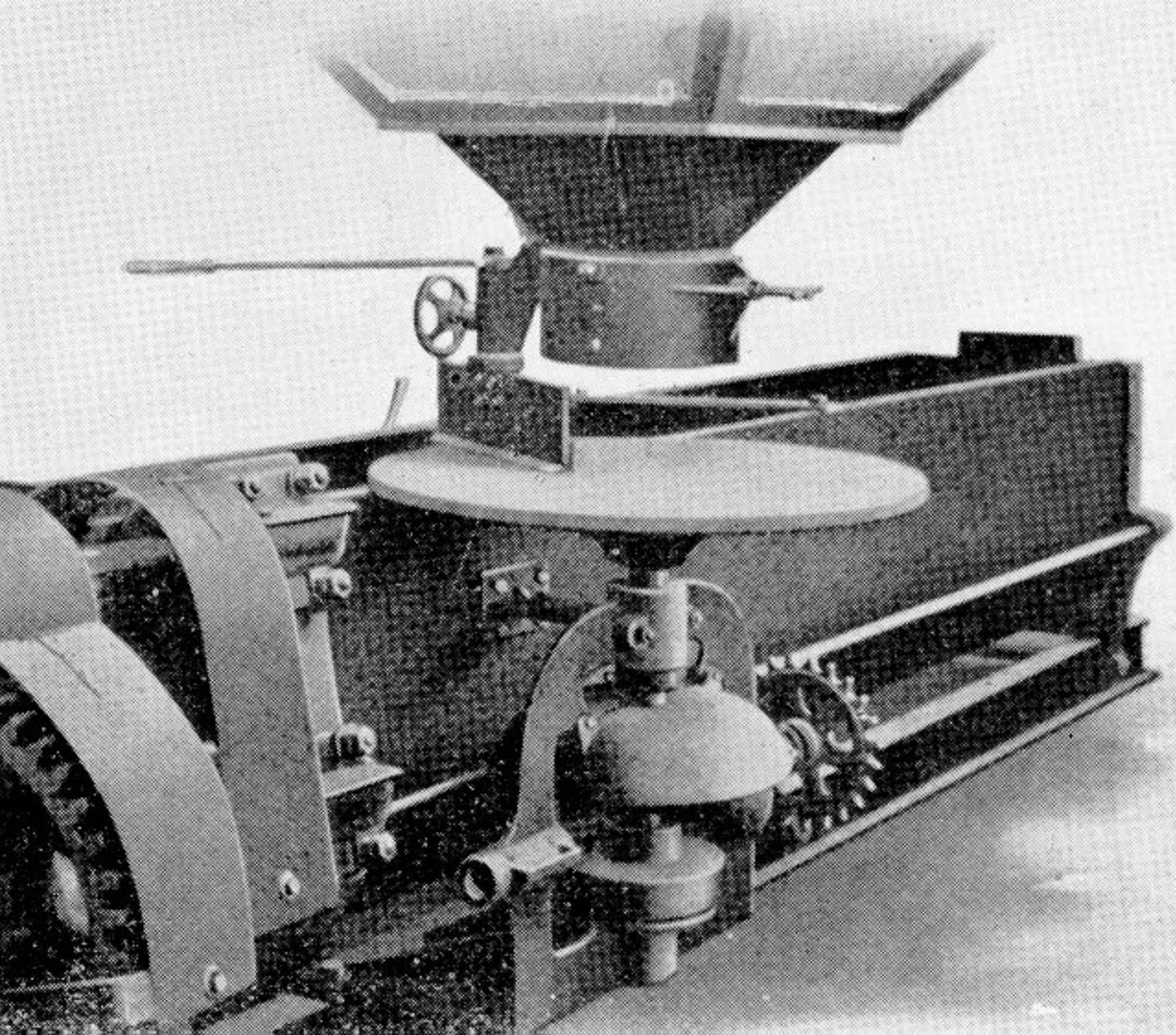




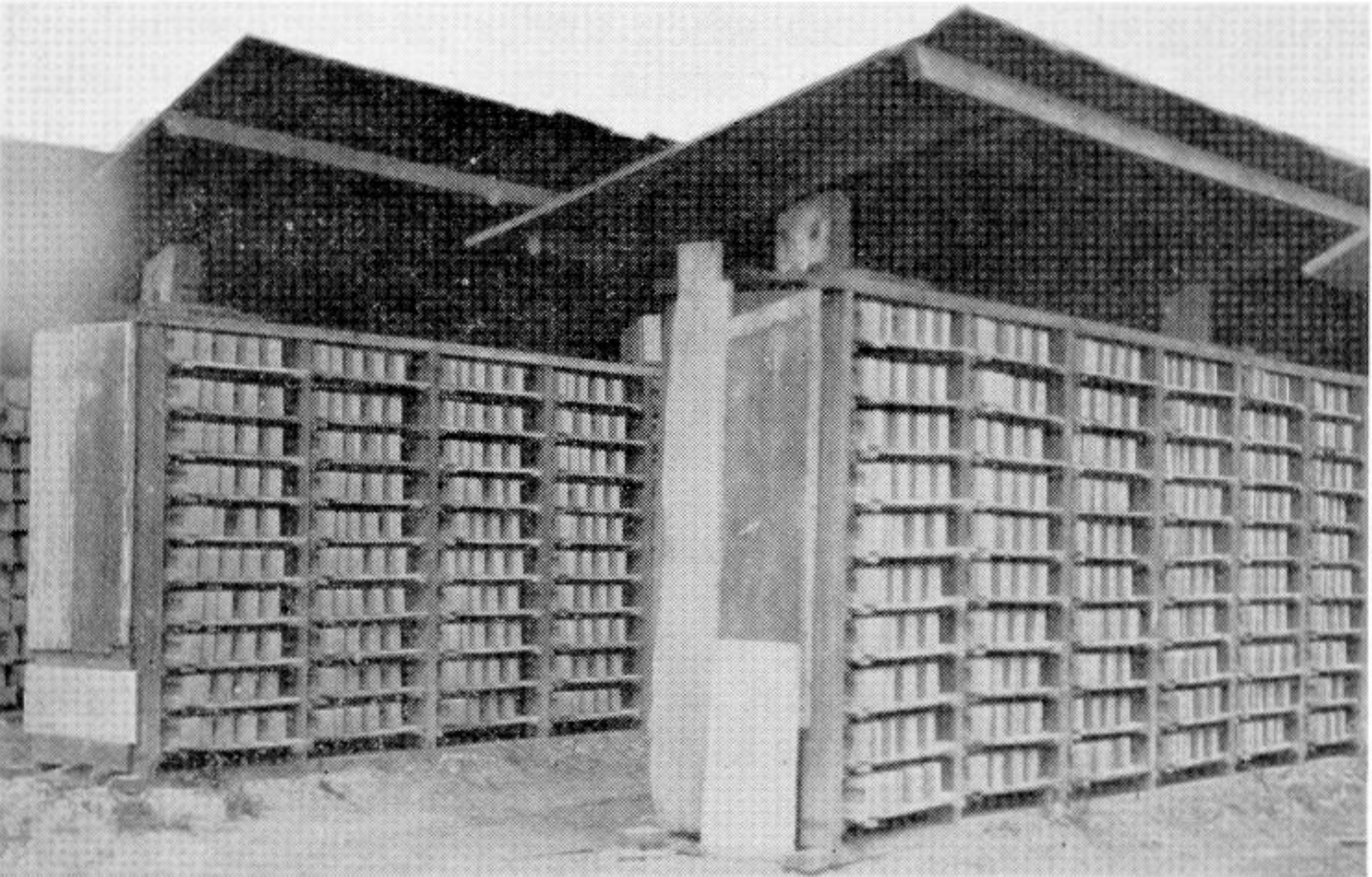
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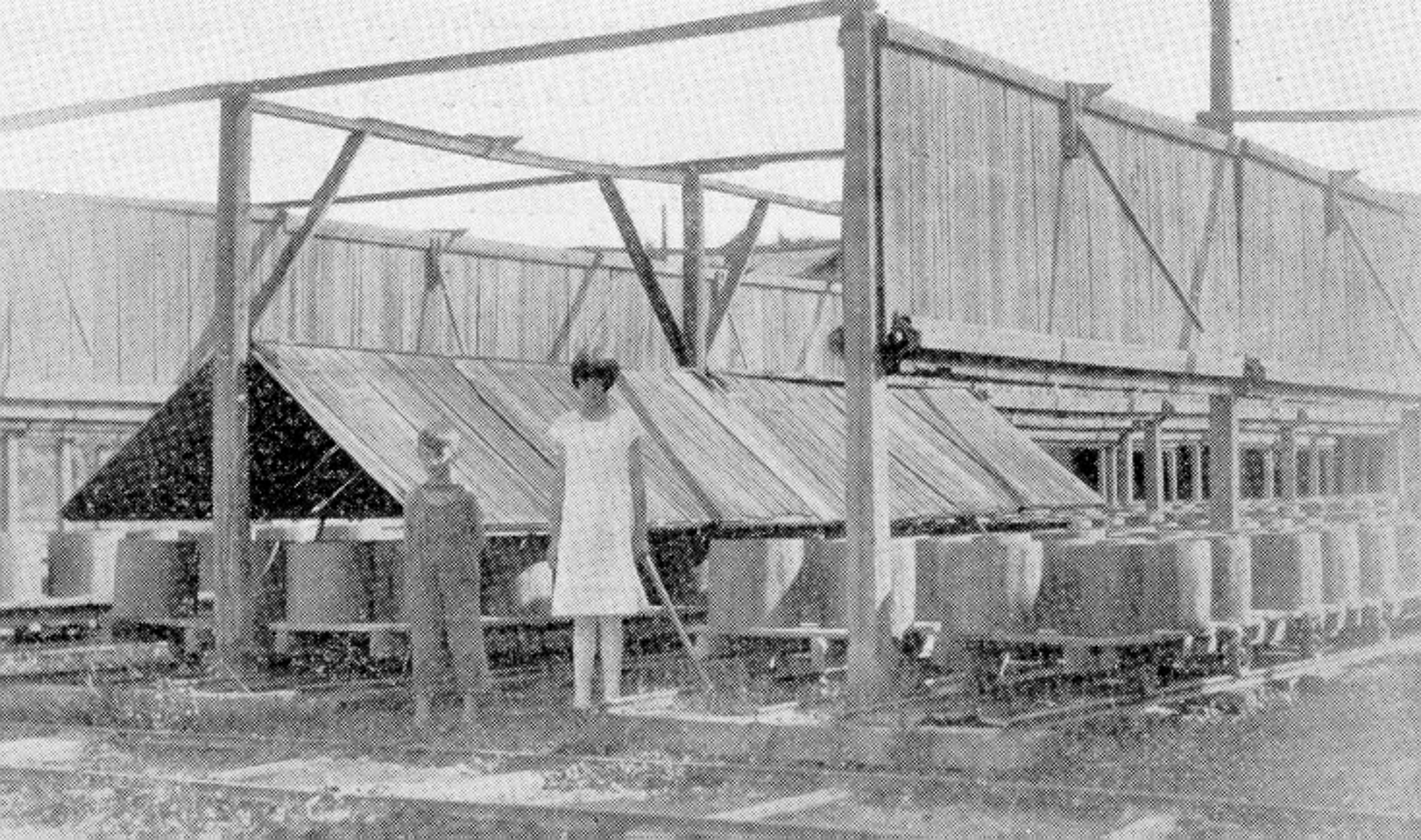


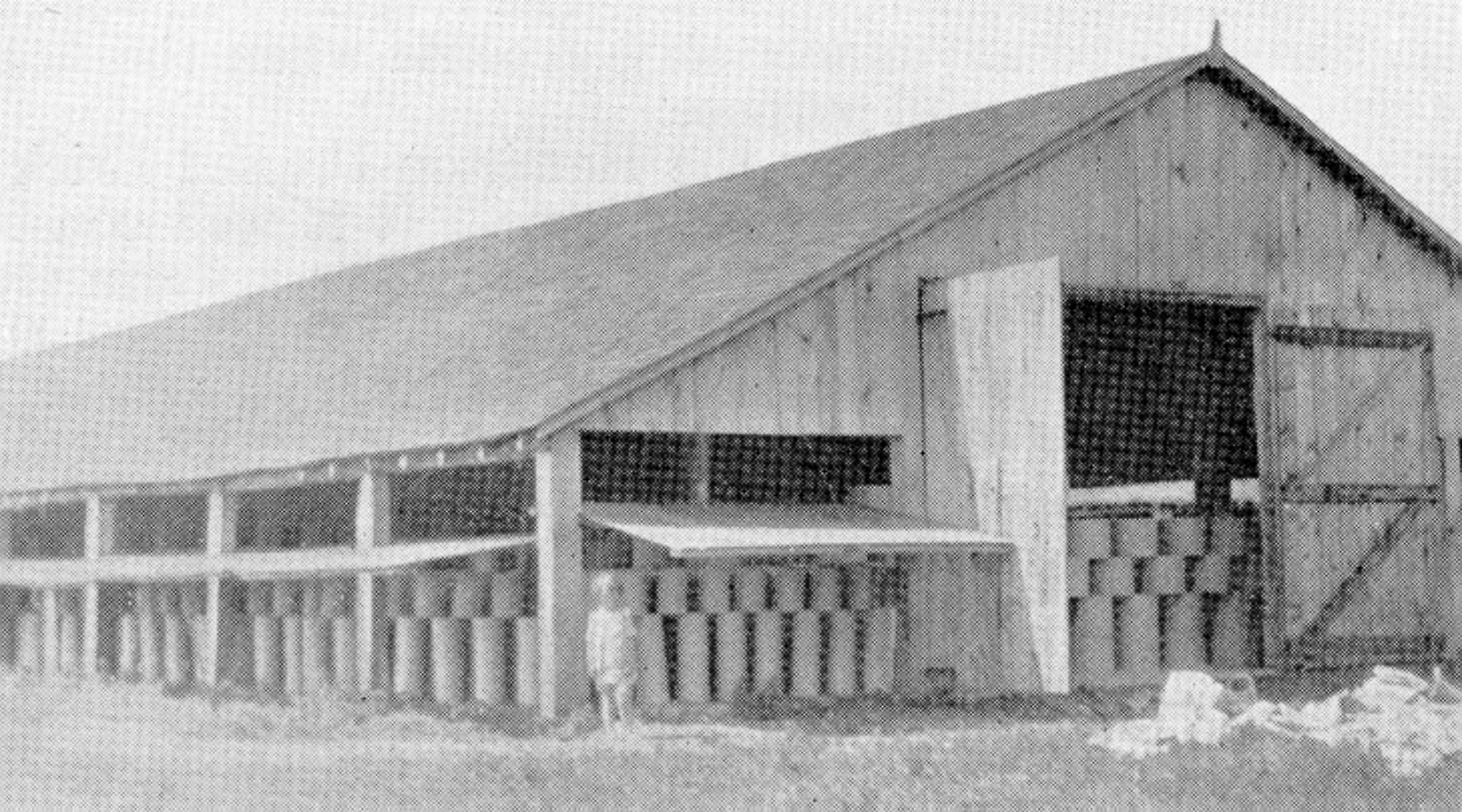

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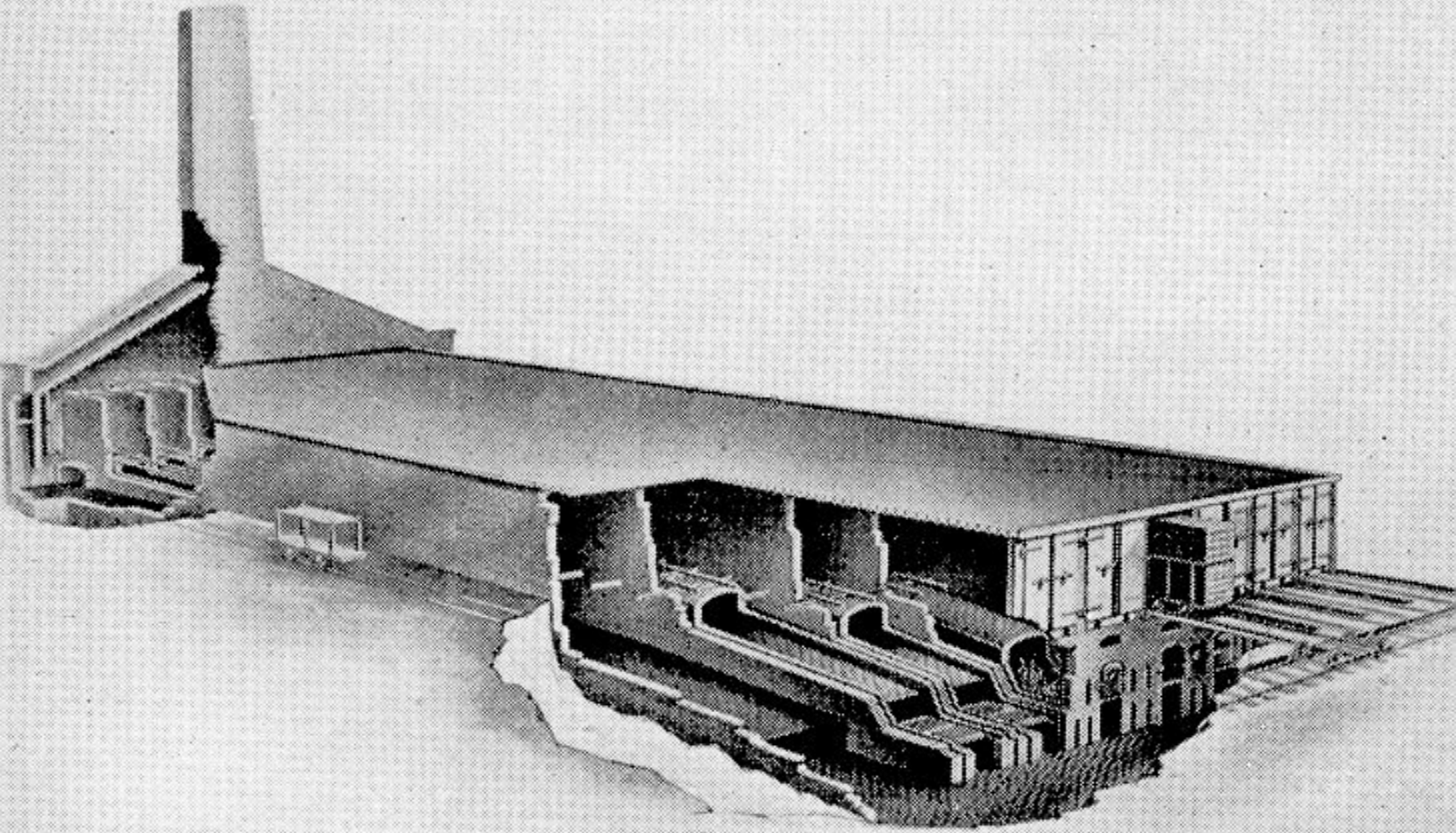












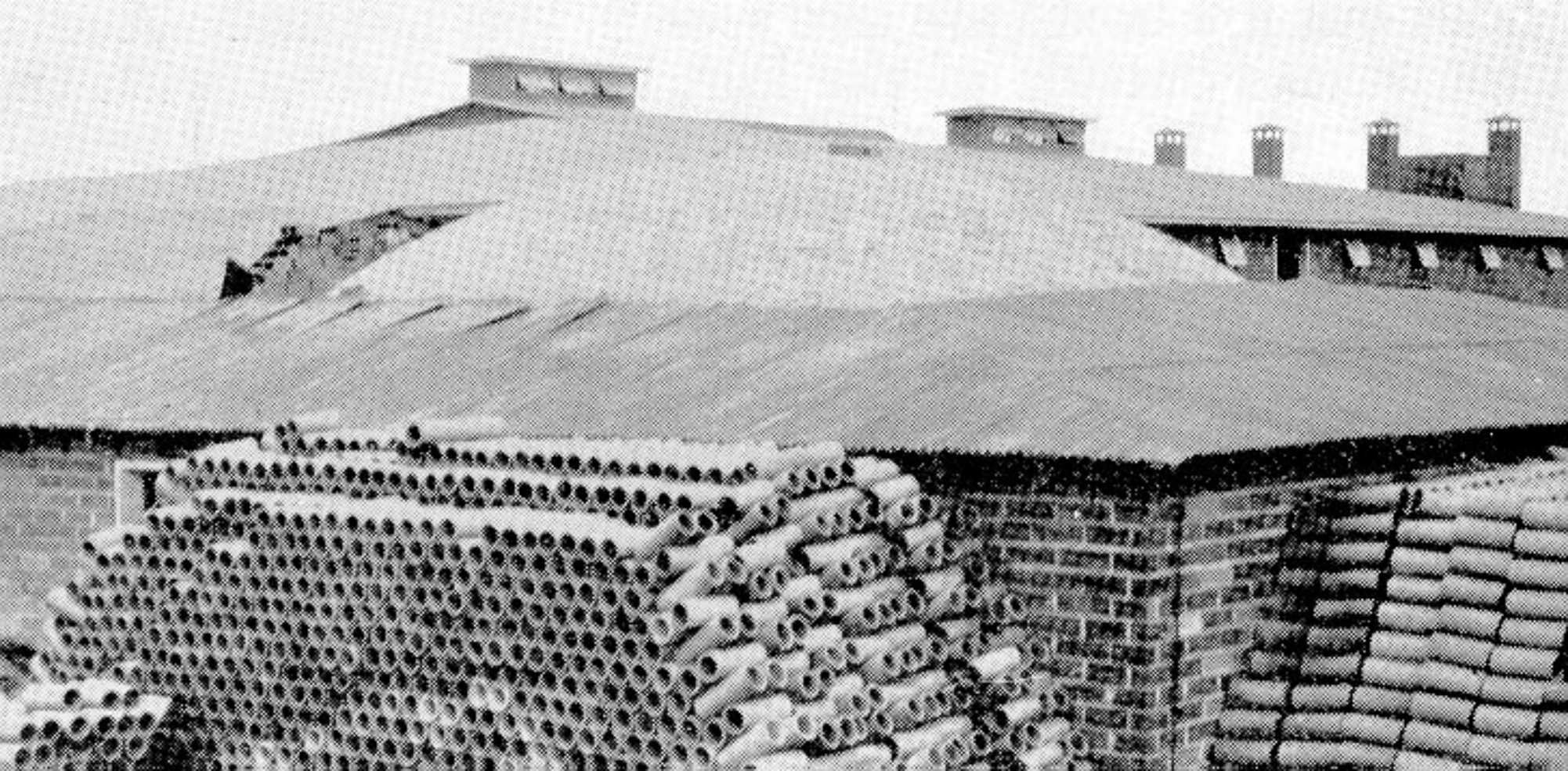


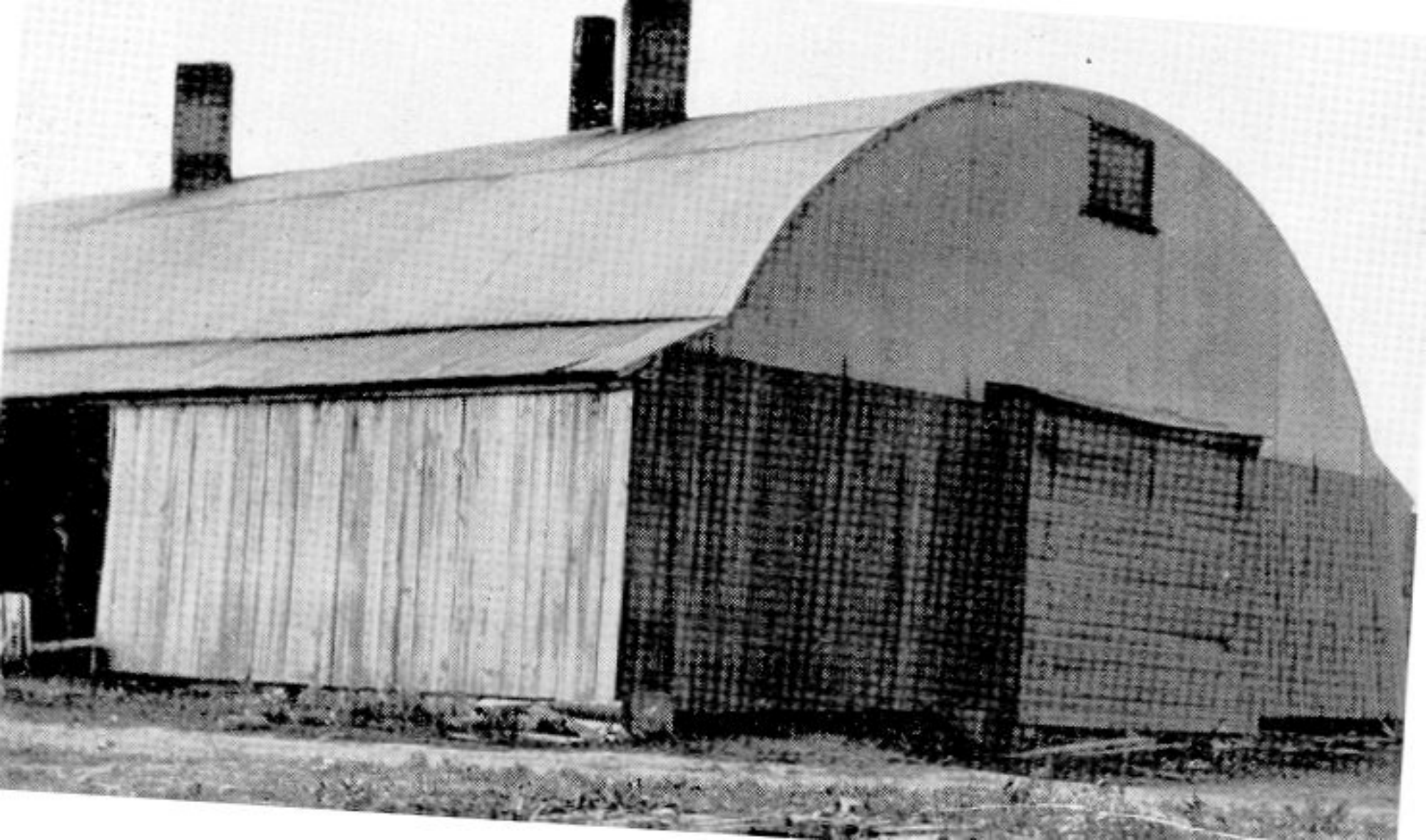






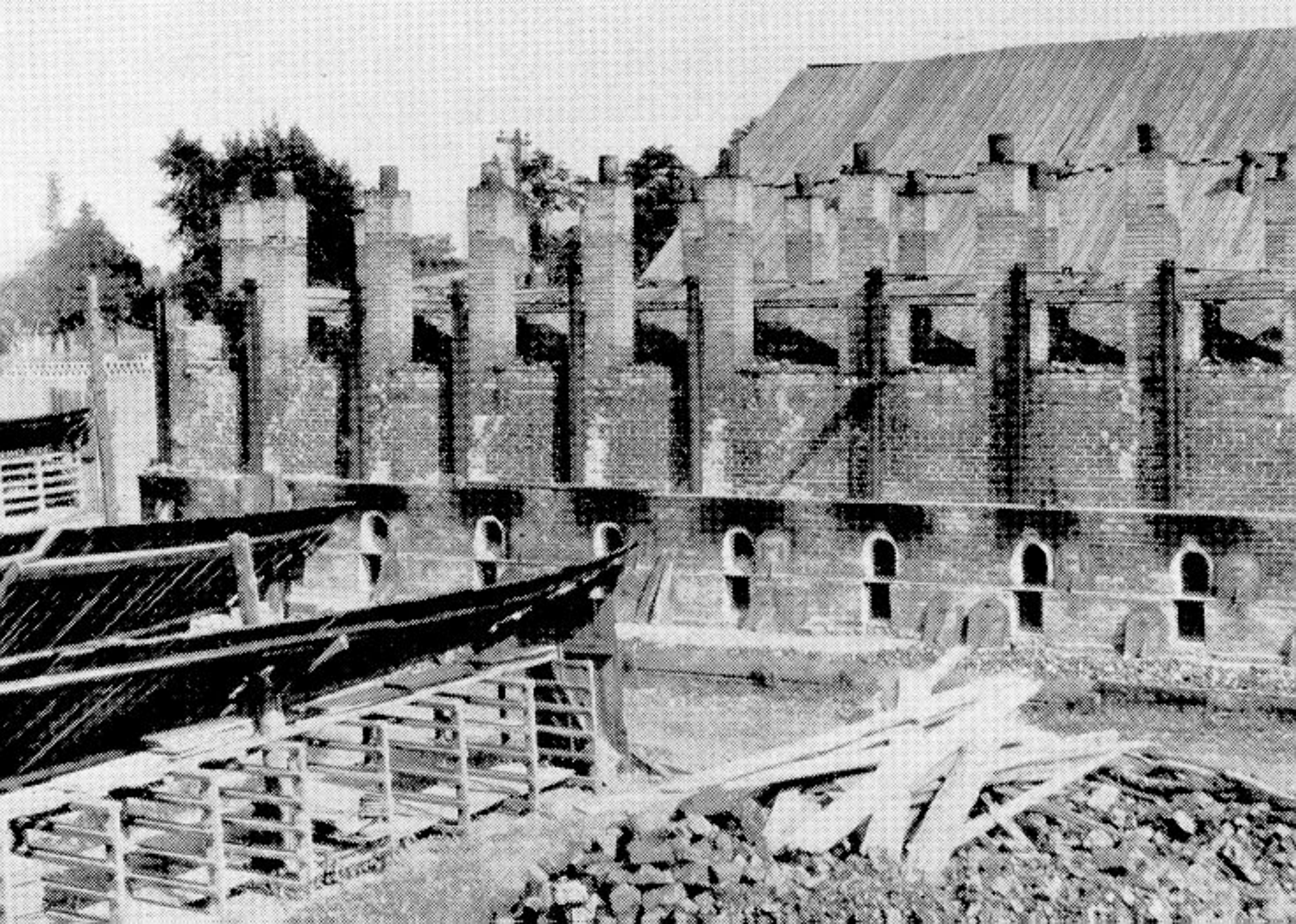


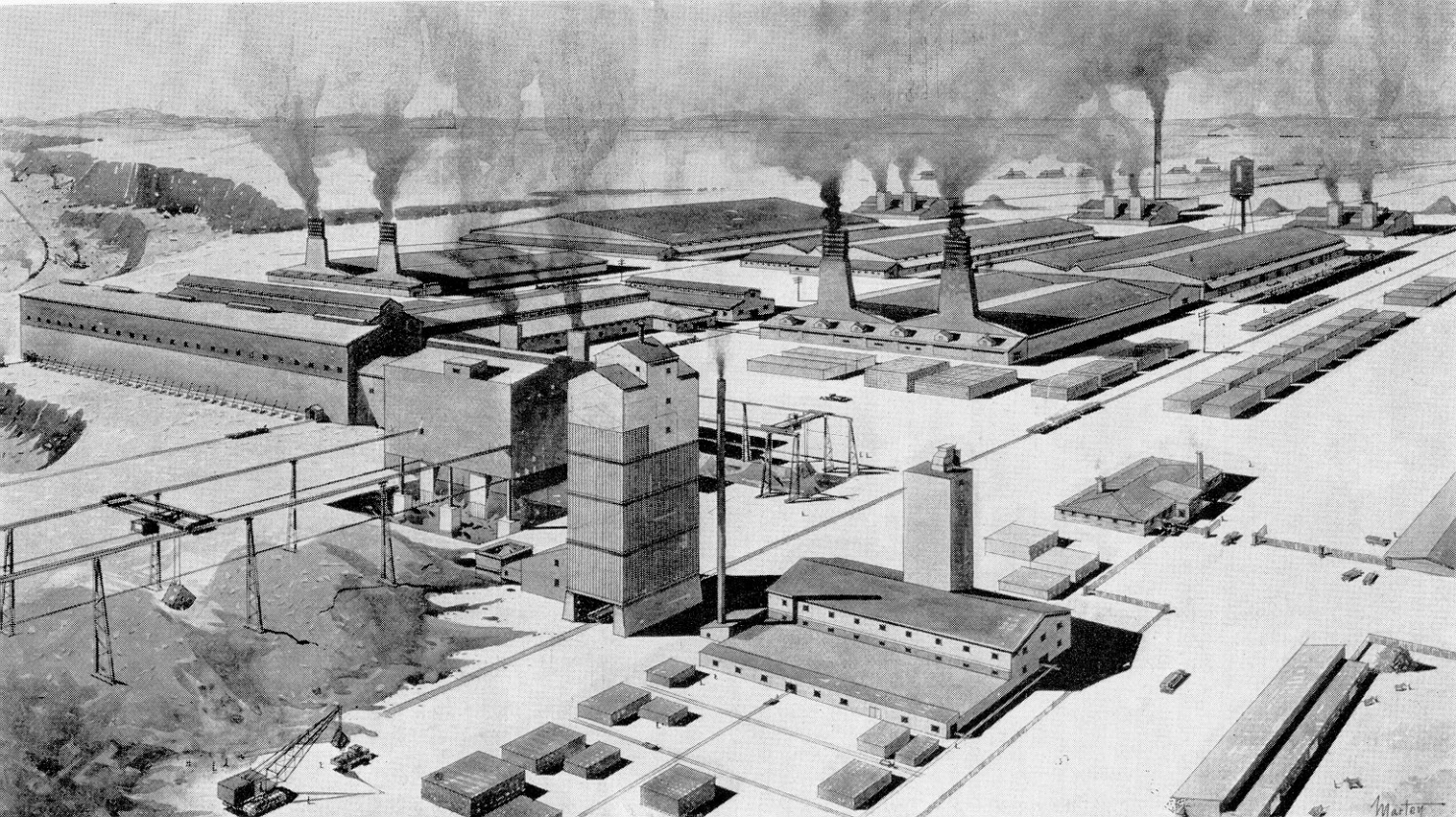














PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

THIRTY-NINTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

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Natural Gas in 1929, by R. B. Harkness - - - - - 1-36

Petroleum in 1929, by R. B. Harkness - - - - - - 37-41

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1930

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NATURAL GAS IN 1929

By R. B. Harkness

General

On the basis of production of natural gas, Ontario has had the most successful year since 1920. The graph on page 2 shows the annual production from 1906 to 1929, and Table I shows the production by fields for the past three years.

TABLE I—NATURAL GAS PRODUCTION BY FIELDS, 1927-1929

County	Field	1927	1928	1929
		M cu. ft.	M cu. ft.	M cu. ft.
Essex	Kingsville	4,994,071	5,228,451	5,780,061
Kent	Tilbury			
	Dover	189,438	178,273	366,224
Lambton	Dawn	12,666	16,204	94,027
	Oil Springs			
Middlesex	Crumlin	.....	300	300
Elgin	Bayham	40,698	44,154	46,272
Lincoln	Lincoln			
Haldimand	Haldimand	1,668,148	1,746,894	1,866,136
Wentworth	Wentworth			
Norfolk	Norfolk			
Brant	Onondaga	13,224	13,804	31,558
Welland	Welland	278,967	301,847	298,688
Bruce	Amabel	224	240	107
Peel	Caledon	1,500	100	.....
Wells in surface drift	Howard and Sarnia	52,278	42,473	39,814
Private wells	.....	60,000	60,000	60,000
Total produced	.....	7,311,214	7,632,740	8,583,187
Value	.....	$4,331,780	$4,535,312	$4,968,133
		M. cu. ft.	M. cu. ft.	M. cu. ft.
Imported mixed gas	.....	103,040	116,639	138,352
Total distributed	.....	7,414,254	7,749,379	8,721,539

The production (sales) of gas now varies with the average temperature and wind velocity. The weather in 1927 was milder than average; hence the low production. The autumn months of 1928 were colder than average; and the year 1929 was cold throughout the year. Wind velocities also play an important part in the demand for gas in house-heating.

Ten years ago it was not thought possible that our natural gas fields could ever produce eight and a half billion cubic feet of gas, and there was speculation as to whether or not they (especially the Kent fields) would be commercially productive in 1930. The projected pressure in the Tilbury field in 1929 was 120 pounds,[1] and the actual rock pressure in 1929 was double that figure.

The explanation of this unforeseen rejuvenation of the Tilbury gas field was given in the reports of the Natural Gas Commissioner for the

[1]Ont. Dept. Mines, Vol. XXXI, pt. 5, graph, p. 8.

years 1925 and 1926.[1] The increase in rock pressure antedated the increase in open flow by two years and was undoubtedly due to the conservation measures resorted to in 1918 and following years, but the increase in the open flow of the wells was directly due to the "shooting" and "cleaning out" done from 1924 to 1926. These operations are still being carried on. No doubt a considerable portion of this gas is coming from under the waters of Lake Erie, and the future of the field is accordingly difficult to gauge. It is, however, significant that the rock pressure, after increasing 50 pounds from 1923 to 1926, has in the following years decreased 70 pounds. Rock pressures are taken in August or September, and the rock pressure taken in August, 1930, following the increased production of nearly one billion feet in 1929, may give a new point to start from in estimating the life of this

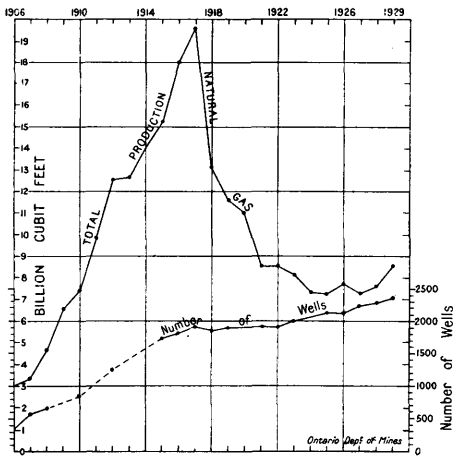


Chart showing total production of natural gas and number of wells in Ontario from 1906 to 1929.

field. It is possible that gas is again being taken too rapidly and that, if this continues, a repetition of the 1918 history may occur. By carefully observing the quantity of water pumped and the fluctuation of rock pressure between summer and winter, this can be avoided.

The supply of gas to the city of Windsor has been permanently assured by the erection of a gas-generating plant at the outskirts of the city. The plant was put into service in December, 1929, and was used for fifteen days. A more complete description of this plant and the process used is given in the next section. Windsor, being by far the greatest consumer of gas, is assured against any sudden failure in supply from the Tilbury field; Chatham is near enough to this field to have an adequate supply; and Sarnia can be supplied from the Dawn and Dover fields until other provisions can be made. Gas fields, however, rarely, if ever, fail suddenly through natural causes, and the Tilbury field appears to have a long life if not drawn on too severely.

In 1929, capital invested in all natural gas operations, including drilling, producing, and distribution, was $35,162,736; the number of men employed was 1,323; and the wages paid amounted to $1,529,367.

The capital and wages included in drilling represent both oil and gas, so far as exploratory work is concerned. There are 48 drilling rigs operating within the province.

[1]Ont. Dept. Mines, Vol. XXXV, pt. 5, p. 2; Vol. XXXVI, pt. 5, p. 2.

Improvements in Service

The Union Natural Gas Company, Limited, reports the following improvements to maintain a lower pressure on its lines and to increase the flow of gas from the wells to the consumer: Border Cities, 37 miles of pipe, 2- to 16-inch; Ruscomb to the Border Cities, 19½ miles of 10-inch high pressure line, duplicating the present 10-inch line and making a continuous duplicate line from the gas fields to the Border Cities; Petrolia, one mile of 4- and 6-inch new pipe; Blenheim, 1½ miles of 4-inch line; Chatham, 2 miles of 3-, 4-, and 6-inch lines; Sarnia, 3 miles of 3-, 4-, and 6-inch lines.

The Southern Ontario Gas Company reports the following improvements to its plant: replaced 8,000 feet of 5⅝-inch main high pressure line, east of Kingsville, with 8-inch pipe; laid two miles of 6-inch line in the Tilbury gas field to facilitate the gathering of gas to their purification plant; replaced five miles of 8-inch pipe with 10-inch pipe in the main transmission line near Ingersoll; conducted leakage surveys in the villages of Lambeth, Shedden, Fingal, Iona, Rodney, Dutton, Wallacetown, West Lorne, and Highgate.

The Dominion Natural Gas Company reports the following improvements to its plant: laid eleven miles of 6-inch high pressure line from Dundas to Burlington, where a modern distribution plant was built and gas supplied to the town in January, 1929; extended its distribution plant in East Hamilton to serve an additional portion of that city; replaced four miles of 6-inch line with 8-inch line in the pipe line between St. Catharines and Dunnville; rebuilt four miles of 6-inch pipe line in the collecting system in Wainfleet township; acquired the Sterling Gas Company's wells in Humberstone and Moulton townships and its distribution plants in these townships and in the towns of Humberstone and Port Colborne, which were rebuilt and improved; conducted leakage surveys in Hamilton, Port Colborne, Dundas, and Jarvis.

Both these companies report that they have rebuilt regulator and meter stations to conform to improved standards and have extended and improved their services to new and old customers.

Increase in Domestic Consumption

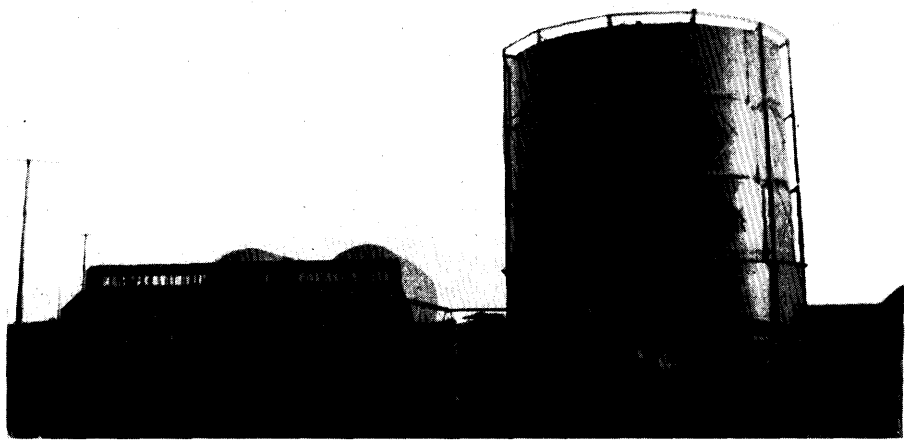
The table below shows the consumption of natural gas by pay consumers in Ontario from 1921 to 1929. It is noticeable that the quantity used per consumer is reduced from 1921 to 1925, during which times rates were increased, in some cases as much as 100 per cent. Since 1925 the gas rates have remained practically stationary, and the quantity used per consumer varies only with the average temperature for the season.

Year	No. 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

Dayton Gas-Generating Plant

The present supply of natural gas is now insufficient to meet the growing demand in the city of Windsor, and the Union Natural Gas Company (which supplies gas to the city of Windsor) has erected a gas-generating plant to supplement the natural gas supply when it falls below the demand. The Dayton process was used because of its flexibility and low initial cost. The gas produced has about the same rate of flame propagation as natural gas and presents no problem in mixing.

A brief summary of the process, which has been taken from a report by Mr. Dayton, the inventor, is as follows: A distillate (fuel oil) is mixed with a sufficient quantity of air to support a minimum combustion and



Manufactured gas generating plant and cylindrical gas holder at Windsor. The building in the left foreground holds the equipment for mixing natural and manufactured gas in predetermined proportions. Four spherical hortonspheres holding natural gas may be seen over the roof of the generating building.

result in fixed gases. The proportion of air varies with the analysis of the oil used. The gases produced and their proportions vary. The only gas analysis available is from a heavy Mexican oil of 28.3 Bé specific gravity; the analysis of the resultant gas is as follows:—

	Per cent.
Carbon dioxide (CO_2)	6.8
Illuminants (C_3H_4)	15.4
Oxygen (O_2)	1.2
Carbon monoxide (CO)	9.6
Hydrogen (H_2)	1.1
Methane (CH_4)	6.3
Nitrogen (N_2)	5.96

A small proportion of heavy oil or tar is recovered after the gas is put through a scrubber (purification process) where any hydrogen sulphide or other impurities are removed. The heating value of the above gas averages 454.7 B.t.u., depending on the quality of the oil used. From a high-grade fuel oil, gas of over 500 B.t.u. can be made. The gas is stored in a gasometer of 1,000,000 cubic feet capacity, of the three-lift type. Natural gas is stored in four hortonspheres of 1,000,000 cubic feet capacity. The mixing of the gases is done by automatically controlled valves, the gases being forced through at a carefully regulated volume and pressure into the pipe line leading into the distributing mains in the city of Windsor.

As previously stated, this plant is only put in operation when the natural gas supply fails to meet the demand. It was used on three very cold days in the latter part of November, 1929, when the main pipe line leading from the gas field to Windsor burst. The plant required one hour to be brought to a heat sufficient to generate gas; during this interval Windsor was supplied with natural gas from the reserve stored in the four hortonspheres. The proportion of "Dayton" gas mixed with natural gas ranged from 15 to 25 per cent. This plant was operated for fifteen days during the winter of 1929-30.

Exploratory Drilling

In the year 1929 very little exploratory drilling was done. The Union Natural Gas Company was successful in bringing in a producing well in the township of Raleigh, lot 147, Talbot Road North, by deepening an old well drilled fifteen or twenty years ago. More drilling will result from this. The Union Natural Gas Company has also extended its exploratory drilling from Dawn township east into Euphemia township, where it has completed a producing well in the old Shetland oil and gas field.

The Southern Ontario Gas Company drilled a deep test-hole in the Mosa oil field. It was carried through to the granite without success.

The Petrol Oil and Gas Company has been extending its drilling operations in the Tuscarora Indian Reserve, south of Brantford, and has been successful in bringing in a number of small gas wells.

Analysis of Gas Consumption

Tables II and III give details concerning the gas consumed in Ontario during 1929. 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 II—GAS CONSUMPTION IN TOWNS AND CITIES, 1929

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	
Aylmer	2,321	680	....	31,554	.....	.....	16	$0.90
Bartonville	350	55	....	3,334	.....	.....	19	.60
Belle River	810	192	....	18,493	.....	566	29	.55–.80
Belmont	350	65	....	3,015	.....	.....	9	1.00
Binbrook	100	12	1	1,552	200	.....	1	.40
Blenheim	1,572	559	1	56,754	179	8,392	20	.50–.75
Brantford	30,350	3,815	5	133,723	1,273	8,772	140	.80
Bridgeburg and Fort Erie	5,173	1,233	4	63,400	1,915	.....	8	1.00–1.30
Brigden	300	148	....	14,677	.....	1,931	30	.50–.75
Burlington	3,300	47	....	308	.....	.....	48	.75
Cainsville	600	127	....	5,879	.....	.....	4	.80
Caledonia	2,000	551	....	48,320	.....	.....	7	.60
Canfield	150	64	....	6,209	.....	267	1	.40
Cayuga	790	215	1	21,871	59	587	6	.60
Chatham	16,970	4,102	....	522,846	.....	31,648	22	.50–.75
Chippawa	1,100	14	....	790	.....	.....	5	.40
Coatsworth	100	33	2	3,143	29	94	4	.50–.75
Comber	658	144	....	17,902	.....	1,516	19	.50–.75
Cottam	300	89	3	9,628	216	695	35	.55
Courtland	380	51	....	4,125	.....	112	3	.60
Courtright	450	132	....	13,033	.....	411	49	.50–.75
Crystal Beach	352	194	....	14,462	.....	.....	1	1.00–1.30
Delhi	840	275	....	24,063	.....	1,027	4	.60
Dorchester	477	109	....	8,297	.....	.....	95	.60–.85
Dresden and Tupperville	1,455	509	....	57,368	.....	875	30	.50–.75
Dundas	5,150	1,154	3	61,987	46	4,950	172	.70
Dunnville	3,296	988	3	104,667	445	12,681	7	.60
Dutton	835	261	3	26,153	130	990	52	.55–.80
Echo Place	300	61	....	2,967	.....	.....	3	.80
Eden	80	27	....	1,446	.....	.....	11	.60
Essex	1,600	502	....	65,978	.....	4,509	33	.55–.80
Fairground	40	12	....	633	.....	.....	1	.60
Fenwick	165	95	....	6,257	.....	.....	18	.75
Fingal	410	43	....	3,648	.....	758	71	.55–.80
Fisherville	102	52	....	4,954	.....	385	2	.50–.55
Fonthill	750	240	....	6,951	.....	.....	25	.95–1.20
Galt	13,250	1,395	1	54,836	229	6,126	147	.80
Grimsby	2,000	39	....	1,129	.....	.....	10	.85
Hagersville	1,290	415	....	35,854	.....	.....	14	.60
Hamilton	127,447	5,845	4	152,101	583	303,420	47	.75–1.00
Hamilton West		189	....	6,536	.....	.....	47	.70
Hepworth	300	5	2	75	32	.....	1	.75
Highgate	410	114	1	12,035	349	.....	32	.50–.75
Ingersoll	5,150	959	2	42,457	294	4,026	100	.80
Jarvis	460	198	....	20,452	.....	.....	9	.60
Kingsville	3,590	702	1	96,705	253	475	30	.50–.55
Lake Shore	.....	347	....	8,657	.....	.....	16	1.00–1.30
Lambeth	486	86	....	5,635	.....	.....	85	.60–.85
Leamington	4,300	1,455	....	212,903	.....	4,410	20	.55
Lynedoch	151	53	....	4,081	.....	4,566	2	.60
Mabee	82	10	....	729	.....	.....	1	.60
Merlin	386	145	1	16,853	2,026	1,144	2	.50–.75
Merritton	2,522	342	....	11,898	.....	.....	35	.75
Nelles Corners	100	26	....	2,458	.....	.....	1	.50
Niagara Falls	16,400	2,830	....	115,334	.....	24,473	11	1.00–1.30
Oil Springs	512	140	....	6,348	.....	.....	2	.75
Paris	4,368	604	1	22,536	121	1,905	129	.80
Petrolia	3,148	758	....	89,694	.....	.....	60	.55–.80
Port Burwell	650	228	....	15,707	.....	.....	3	.60

TABLE II—GAS CONSUMPTION IN TOWNS AND CITIES, 1929—*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 Colborne and Humberstone	5,661	1,737	6	83,108	688	3,257	5	.60–.95
Port Dover	1,650	575	....	52,612	.....	455	1	.60
Port Rowan	669	253	....	18,140	.....	.....	1	.60
Ridgetown	2,000	654	2	72,788	2,101	873	28	.50–.75
Ridgeway	864	216	....	16,068	.....	.....	1	1.00
Rodney	680	240	1	24,600	113	697	40	.55–.80
Ruthven	438	47	....	7,391	.....	.....	25	.55
St. Anns	92	23	....	947	.....	.....	7	.75
St. Catharines	24,000	4,369	2	233,239	601	13,547	35	.75
St. George	550	100	....	3,825	.....	29	148	.80
St. Williams	300	111	....	7,575	.....	1,075	1	.60
Sarnia	16,544	4,694	....	381,867	.....	.....	69	.55–.80
Selkirk	585	146	1	13,923	105	1,249	1	.60
Shedden	400	90	....	8,082	.....	.....	63	.55–.70
Simcoe	4,582	1,632	3	192,935	498	16,051	20	.60
Smithville	330	156	....	6,832	.....	.....	6	.75
Sombra and Port Lambton	2,000	159	....	16,331	.....	487	45	.55–.80
Stevensville	450	33	....	2,409	.....	.....	1	1.00
Straffordville	300	81	....	7,491	.....	671	6	.60
Thorold	4,932	937	....	39,533	.....	.....	35	.75
Tilbury	2,000	514	1	57,634	253	642	17	.50–.75
Tillsonburg	3,257	1,018	1	85,893	353	2,322	16	.63
Vienna	284	78	1	4,061	124	.....	1	.60–.80
Vittoria	280	81	....	5,456	.....	.....	3	.60
Wallaceburg	4,530	1,235	....	142,962	.....	379,078	27	.50–.75
Wallacetown	244	47	1	4,019	15	505	60	.55–.80
Welland	10,085	2,536	3	90,779	486	14,662	3	.45–1.30
Wellandport	140	11	1	276	25	.....	3	.75
West Lorne	818	214	3	22,131	205	749	49	.55–.80
Wheatley	700	242	....	23,889	.....	1,305	12	.50–.75
Windsor (Border Cities)	66,893	16,015	....	1,637,249	.....	58,620	45	.55–.80
Woodstock	10,195	1,776	1	77,914	360	3,607	110	.80
Total	.....	73,755	66	5,647,359	14,306	931,592	.....	.....

TABLE III—GAS CONSUMPTION IN TOWNSHIPS, 1929

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	102	3	10,813	273	185	$0.55
Gosfield, South	2,291	439	1	42,187	618	25,092	.50-.55
Maidstone	2,109	75	6	7,263	1,566	530	.55-.80
Mersea	3,825	455	2	49,099	382	26,682	.55
Rochester	1,941	201	7	17,871	1,457	854	.55-.80
Sandwich, East	1,090	24	1	2,979	541	.....	.55-.80
Sandwich, West	2,754	21	.....	3,204	.....	.....	.50-.75
Sandwich, South	1,433	104	.....	13,238	.....	377	.55-.80
Tilbury, North	1,788	28	.....	2,138	.....	79	.50-.75
Tilbury, West	1,563	23	1	2,126	151	.....	.50-.75
LAMBTON:							
Dawn	2,307	61	3	4,828	615	441	.40-.65
Enniskillen	2,656	78	.....	6,923	.....	1,308	.55-.80
Moore	3,251	289	.....	25,429	.....	888	.50-.75
Sarnia	2,560	3	10	600	2,189	.....	.40
Sombra	2,875	52	.....	4,332	.....	757	.50-.75
KENT:							
Camden	1,305	10	.....	719	.....	.....	.50.-75
Chatham	4,940	73	1	5,890	36	745	.50-.75
Dover	3,600	408	1	44,622	164	11,874	.50-.65
Harwich	4,327	428	9	53,101	2,824	163	.50-.75
Howard	2,768	176	2	20,298	428	.....	.50-.75
Orford	1,875	21	3	2,637	363	.....	.50-.75
Raleigh	3,676	580	21	68,782	6,577	2,405	.50-.65
Romney	1,510	70	38	8,112	11,474	.....	.50-.65
Tilbury, East	2,914	246	75	23,925	22,220	20,918	.50-.65
ELGIN:							
Aldborough	2,837	24	1	1,715	510	.....	.55-.80
Bayham	3,162	73	16	3,574	3,398	361	.60-.80
Dunwich	2,500	53	1	4,904	91	.....	.55-.80
Malahide	2,953	55	3	2,350	470	.....	.60-.90
Southwold	3,510	109	.....	8,779	.....	1,318	.55-.80
MIDDLESEX:							
Dorchester, North	3,056	14	1	1,095	300	.....	.60-.85
Westminster	6,175	147	.....	19,017	.....	.....	.60-.85
NORFOLK:							
Charlotteville	2,600	6	6	392	960	.....	.60
Middleton	2,150	33	4	2,297	730	.....	.60
Townsend	3,715	34	.....	3,819	.....	.....	.60
Walsingham, North	1,520	5	4	459	640	.....	.60
Walsingham, South	1,581	7	7	614	1,036	.....	.60
Windham	3,205	2	2	231	320	.....	.60
Woodhouse	2,050	162	10	17,758	1,760	.....	.60
BRANT:							
Brantford	7,220	7	.....	232	.....	.....	.80
Burford	3,833	2	.....	145	.....	.....	.80
Dumfries, South	2,532	10	.....	392	.....	.....	.80
Onondaga	1,017	52	13	4,294	2,731	.....	.60-.70
Tuscarora	800	1	.....	119	.....	.....	.25
OXFORD:							
Oxford, East	1,724	8	.....	434	.....	.....	.80
Oxford, West	1,810	51	.....	5,194	.....	.....	.80

TABLE III—GAS CONSUMPTION IN TOWNSHIPS, 1929—*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	92	42	6,964	7,949	9,864	.50–.60
Cayuga, North	1,309	18	15	1,082	2,915	.....	.40–.60
Cayuga, South	510	62	16	3,964	3,056	.....	.60
Dunn	800	123	11	7,618	2,643	.....	.60
Moulton	1,628	122	30	11,031	5,007	.....	.50–.60
Oneida	1,287	67	12	6,098	2,224	.....	.50–.60
Rainham	1,695	136	28	9,996	5,389	264	.40–.60
Seneca	1,561	132	35	12,858	6,389	.....	.60
Sherbrooke	300	57	12	4,600	1,360	.....	.40–.60
Walpole	3,042	314	59	23,733	9,379	862	.60
LINCOLN:							
Caistor	1,220	88	27	5,725	3,986	202	.50–.60
Grantham	4,175	8	.....	508	.....	.....	.75
Louth	2,548	7	1	471	175	.....	.75
WELLAND:							
Bertie	3,298	186	71	13,745	14,148	.....	.50–1.00
Crowland	3,750	88	23	4,021	3,681	.....	.75–1.00
Humberstone	2,149	268	40	16,463	6,618	.....	.50–1.00
Pelham	2,365	61	2	4,239	352	.....	.75
Stamford	4,915	.....	7	.....	781	.....	.....
Thorold	3,401	8	1	130	176	.....	.75–.80
Wainfleet	2,357	93	30	5,131	5,082	.....	.40–.75
Willoughby	870	27	29	1,971	5,660	.....	1.00
WENTWORTH:							
Ancaster	4,550	55	.....	6,097	.....	.....	.70–.80
Barton	7,665	92	.....	16,501	.....	.....	.60
Binbrook	1,109	75	22	7,451	4,120	1,044	.50–.60
Glanford	1,415	126	4	15,601	739	973	.40–.60
Saltfleet	4,706	109	.....	4,586	.....	.....	.75
Total	.....	7,236	769	689,514	156,653	108,186	.....

SUMMARY

	M cu. ft.
Total distribution to customers	7,547,610
Used by companies for all purposes	136,728
Used by private well-owners	74,000
Leakage on transmission lines	578,962
Leakage on distribution plants	369,360
Leakage on rural lines	17,313
Leakage or loss on purchased gas	1,552
Total amount of gas distributed	8,725,525

Gas Wells and Their Production

In Table IV 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 IV—GAS WELLS AND THEIR PRODUCTION, 1929

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	Colchester	.....	.....	1	.....	.....		.....	96	.....
	Gosfield, South	20	.....	.....	.....	.....		171	1,260	$467
	Mersea	3	.....	.....	.....	.....		278	.....	.....
Kent	Harwich	.....	.....	.....	.....	.....	5,780,061	16	26,200	34,935
	Howard	.....	.....	3	.....	.....		9		
	Raleigh	19	.....	1	2	10,647		266	12,334	16,044
	Romney	144	1	4	3	399		262	41,517	41,286
	Tilbury, East	138	1	.....	1	200		243	12,508	18,669
	Dover	8	2	7	1	5,000	366,224	363	18,077	24,750
Lambton	Dawn	14	.....	6	.....	.....	85,279	660	75,050	101,050
	Euphemia	3	4	3	1	130		403		
	Enniskillen	3	.....	.....	.....	.....	6,348	100	730	.....
	Sarnia	14	.....	.....	.....	.....	2,400	70	5,000	50
Middlesex	Dorchester, North	3	.....	.....	.....	.....	300	25	100	.....
	Mosa	.....	.....	1	.....	.....	.....	.....	.....	.....
Elgin	Bayham	40	1	.....	.....	.....	46,272	172		
	Malahide	2	.....	.....	.....	.....		215		
Norfolk	Charlotteville	16	.....	.....	.....	.....		224		
	Houghton	3	.....	.....	.....	.....		300		
	Middleton	25	.....	.....	.....	.....		294		
	Townsend	1	.....	.....	.....	.....		300		
	Walsingham, North	9	.....	.....	.....	.....		365		
	Walsingham, South	14	1	.....	.....	.....		333		
	Windham	8	.....	.....	.....	.....		266		
	Woodhouse	56	1	.....	2	104		267		
Haldimand	Canborough	128	1	.....	.....	.....		96		
	Cayuga, North	120	5	7	19	835		247		
	Cayuga, South	58	2	.....	.....	.....		158		

	Dunn	31		8	1	97	1,866,136	197		
	Moulton	95						123	184,854	67,040
	Oneida	23						119		
	Rainham	181	1	8	33	3,884		262		
	Seneca	151	1	14	24	1,306		119		
	Sherbrooke	12						120		
	Walpole	198	1	8	17	1,747		269		
Wentworth	Binbrook	43						81		
	Glanford	11	3					65		
Lincoln	Caistor	40	1	1	5	84		90		
	Gainsborough	5						100		
Welland	Bertie	84	1					85		
	Crowland	47	1	3				100		
	Humberstone	81	9				298,688	62		
	Wainfleet	40	1					43		
	Willoughby	37	2					20		
Brant	Onondaga	26	2				31,558	103		
	Tuscarora	16		1	9	529		135	43,696	500
Bruce	Amabel	2					107	100	50	
Peel	Caledon	6								
Surface wells	Harwich	69					14,000[1]			
	Howard						25,184[2]			
	Sarnia	2					630[2]			
Private wells[3]		300					60,000[4]			
Total		2,349	42	76	118	24,962	8,583,187			

[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 and Sarnia.
[3]Principally in Haldimand, Norfolk, and Welland counties.
[4]Estimated.

In addition to the total Ontario production of 8,583,187 M cubic feet, there is a production of 3,986 M cubic feet of manufactured gas, and 138,352 M cubic feet of mixed gas is imported, making a total distributed of 8,725,525 M cubic feet.

Leakage

Tables V, VI, and VII give a statement of the measured leakage of gas from pipe lines between the wells and the consumer. This is not by any means all the leakage, for only 70 per cent. of the gas produced is measured. In order to arrive at an estimated figure for the total leakage, 30 per cent. should be added.

Although the total leakage is greater than for the year 1928, the percentage of leakage is actually less, because nearly one billion feet more gas was produced. By referring to the work done and improvements in service for the concurrent year, it will be seen that a very active effort is being made to reduce leakage. Gas companies have been making greater efforts in searching for defective and leaky pipe, and they conduct surveys of distribution plants or parts of plants to find the sources of the leakage. In most cases where excessive leakage is apparent, it can be traced to one locality where the character of the soil accelerates corrosion, where there is some defective pipe, or where poor workmanship in installing the pipe is the cause.

TABLE V—LEAKAGE IN DISTRIBUTION PLANTS, 1929

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.	
Belle River	Union Natural Gas Co	4.16	19,207	19,057	150	832	190	789	6
Belmont	Ontario Salt Co	1.67	9,686	3,015	6,671	334	65	102,615	6
Blenheim	Union Natural Gas Co	12.58	65,845	65,490	355	2,517	560	634	5
Brantford	Brantford Gas Co	91.59	156,341	143,839	12,502	18,318	3,770	3,316	4
Brigden	Union Natural Gas Co	3.68	17,656	16,608	1,048	737	150	6,920	5
Cainsville	Dominion Natural Gas Co	5.23	22,955	21,588	1,367	1,046	188	7,270	4
Chatham	Union Natural Gas Co	78.15	567,926	560,356	7,570	15,631	4,102	1,845	6
Comber	Union Natural Gas Co	3.42	19,529	19,421	108	684	144	750	5
Courtright	Union Natural Gas Co	3.76	14,908	13,645	1,263	752	132	9,568	5
Dorchester	Southern Ontario Gas Co	2.86	9,947	9,392	555	572	109	5,091	4
Dresden	Union Natural Gas Co	12.49	59,811	58,386	1,425	2,498	509	2,800	5
Dundas	Dominion Natural Gas Co	11.84	75,888	67,794	8,094	2,368	1,143	7,081	4
Dunnville	Dominion Natural Gas Co	13.17	112,163	106,662	5,501	2,634	970	5,671	4
Fenwick	Dominion Natural Gas Co	1.37	8,050	6,257	1,793	274	195	9,195	4
Galt	Dominion Natural Gas Co	30.69	72,136	61,189	10,947	6,138	1,396	7,125	4
Hagersville	Dominion Natural Gas Co	7.24	44,111	35,854	8,257	1,448	415	19,891	4
Ingersoll	Dominion Natural Gas Co	22.25	54,350	46,775	7,575	4,450	961	7,882	4
Kingsville	Southern Ontario Gas Co	14.71	109,265	101,221	8,044	2,942	703	11,442	4
Leamington	Leamington Corporation	25.47	240,950	217,313	23,637	5,094	1,451	16,290	10
Merlin	Union Natural Gas Co	2.78	21,483	20,153	1,330	556	146	9,109	6
Mount Hamilton	Dominion Natural Gas Co	23.44	85,821	59,077	26,744	4,688	2,286	11,699	4
Paris	Dominion Natural Gas Co	13.56	33,816	25,009	8,807	2,712	605	14,557	4
Petrolia	Union Natural Gas Co	16.20	99,886	90,039	9,847	3,239	758	12,991	6
Port Burwell	Dominion Natural Gas Co	3.84	12,657	9,765	2,892	768	143	20,223	4
Port Lambton	Union Natural Gas Co	1.94	7,704	7,343	361	388	70	5,157	5
Ridgetown	Union Natural Gas Co	18.16	83,381	76,085	7,296	3,632	656	11,122	5
St. Catharines	Dominion Natural Gas Co	53.38	279,008	244,238	34,770	10,676	4,671	7,443	4
St. George	Dominion Natural Gas Co	2.11	4,181	3,702	479	422	100	4,790	4
Sarnia	Union Natural Gas Co	94.80	423,853	383,055	40,798	18,961	4,694	8,692	5
Shedden-Fingal	Southern Ontario Gas Co	6.11	16,454	12,426	4,028	1,222	133	30,285	4
Simcoe	Dominion Natural Gas Co	29.33	222,970	205,921	17,049	5,866	1,635	10,427	4
Sombra	Union Natural Gas Co	2.50	9,977	9,065	912	501	90	10,133	5
South London	Southern Ontario Gas Co	8.34	18,118	14,392	3,726	1,668	147	25,347	4
Straffordville	Dominion Natural Gas Co	1.34	8,626	8,122	504	268	81	6,222	4
Thorold	Dominion Natural Gas Co	12.79	44,644	41,711	2,933	2,558	937	3,130	4

TABLE V—LEAKAGE IN DISTRIBUTION PLANTS, 1929—*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.	
Tillsonburg	Dominion Natural Gas Co	23.15	94,073	87,997	6,076	4,630	1,019	5,963	4
Vienna	Dominion Natural Gas Co	1.04	1,640	1,249	391	208	19	20,579	4
Wallaceburg	Union Natural Gas Co	22.61	147,118	141,137	5,981	4,523	1,235	4,843	6
West Hamilton	Southern Ontario Gas Co	2.09	7,904	6,536	1,368	418	189	7,238	4
Wheatley	Southern Ontario Gas Co	3.61	28,080	25,194	2,886	722	242	11,925	4
Windsor	Union Natural Gas Co	175.	1,768,891	1,695,869	73,022	35,000	16,015	4,560	5
Woodstock	Dominion Natural Gas Co	47.83	92,115	81,817	10,298	9,566	1,777	5,795	4
Total			5,193,124	4,823,764	369,360				

TABLE VI—LEAKAGE IN TRANSMISSION LINES, 1929

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	117,386	100,068	17,318	25
Gas field to Sarnia and Petrolia	6-, 8-, 10-, 12-inch	334.22	1,603,593	1,503,833	99,760	40-80
Dunnville to St. Catharines	8-inch	57.1	374,408	347,295	27,113	40-50
Kingsville to Hamilton	8-, 10-, 12-inch	710.5	1,696,263	1,440,024	256,239	85
Gas field to Chatham	6-, 8-inch	44.7	683,677	634,113	49,564	20-50
Gas field to Windsor	8-, 10-, 12-, 18-inch	351.35	2,062,776	1,973,963	88,813	30-100
Gas field to Ridgetown	6-, 8-inch	82.96	307,968	267,813	40,155	30-80
Total			6,846,071	6,267,109	578,962	

TABLE VII—LEAKAGE ON RURAL LINES, 1929

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	7,122	6,997	125	283	53	2,358	5	4
Dover	100,910	48,045	43,824	4,221	3,822	353	14,790	6	7
Enniskillen	16,394	5,777	4,823	954	621	51	18,706	6	7
Harwich	100,370	39,988	38,417	1,571	3,800	365	4,304	5	5
Howard	17,770	11,212	10,621	591	673	96	6,156	5	4
Moore	38,819	14,902	13,514	1,388	1,471	184	7,543	6	5
Raleigh	139,713	49,481	46,528	2,953	5,293	270	10,937	6	5
Raleigh (Blake system)	23,126	6,538	4,207	2,331	876	79	29,519	4	20
Rochester	34,180	21,621	21,185	436	1,296	179	2,436	5	6
Sandwich, South	8,667	7,886	7,724	162	328	57	2,842	5	6
Sombra	1,929	887	770	117	73	10	11,700	5	.....
Tilbury, East	56,158	30,515	28,051	2,464	2,127	189	13,037	6	5
Total	545,486	243,974	226,661	17,313	20,663	1,886	.....	.....	.....

Licenses Issued in 1929

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 VIII, IX, X, XI, and XII list the names of those to whom these licenses were issued in 1929.

TABLE VIII—OPERATORS LICENSED TO LEASE AND PROSPECT FOR NATURAL GAS, 1929

License No.	Name	Address
316	Acme Gas and Oil Co., Ltd.	Toronto, Ont.
314	Ajax Oil and Gas Co., Ltd.	Toronto, Ont.
329	Arner, Chas.	Toronto, Ont.
331	Bennie, A. W.	Toronto, Ont.
328	Central Development Co., Ltd.	Chatham, Ont.
306	Cherry, Robert	Collingwood, Ont.
319	Dodd, J. G.	Haileybury, Ont.
296	Dominion Natural Gas Co., Ltd.	Buffalo, N.Y.
333	Doran, Benj.	Meaford, Ont.
327	Freeman, George	Toronto, Ont.
301	Geddes, Earl W.	Chatham, Ont.
311	Glenn, S. J.	Long Branch, Ont.
321	Hill, Jos. J.	Toronto, Ont.
304	Hoover, May, Limited	Selkirk, Ont.
298	Industrial Natural Gas Co., Ltd.	Thorold, Ont.
315	McCrimmon, J. E.	Brantford, Ont.
318	McGill, Joseph	Petrolia, Ont.
322	Mayat, E. G.	Brantford, Ont.
303	Medina Natural Gas Co., Ltd.	Chatham, Ont.
324	Merchant, F.	Saginaw, Mich.
326	Messer, Julius	Kirkland Lake, Ont.
299	Neath, Charles	Chatham, Ont.
312	Ogletree, F. A.	Sarnia, Ont.
294	Patterson, Wm. C.	Jamestown, N.Y.
297	Petrol Oil and Gas Co., Ltd.	Toronto, Ont.
332	Pure Gas and Oil Co., Ltd.	Chatham, Ont.
300	Robinson, Henry	Chatham, Ont.
330	Rodgers, Alex.	Tillsonburg, Ont.
317	Rowe, M. E.	Toronto, Ont.
305	Rowe, W. G.	Toronto, Ont.
320	Ryan, Edmund L.	Toronto, Ont.
309	Smith, Dr. Luke	Oakville, Ont.
293	Snively, F. L.	Hamilton, Ont.
295	Southern Ontario Gas Co., Ltd.	Buffalo, N.Y.
307	Southern Petroleum Co., Ltd.	Burlington, Ont.
310	Stephens, Hugh	Port Bruce, Ont.
308	Switzer, Donald	Oakville, Ont.
302	United Development Co., Ltd.	Chatham, Ont.
323	Vidler, Walter R.	Toronto, Ont.
325	Willits, G. E.	Bothwell, Ont.

TABLE IX—OPERATORS LICENSED TO DRILL OR BORE FOR NATURAL GAS, 1929

License No.	Name	Address
277	Barr, Lexie	Dashwood, Ont.
278	Cainsville Oil and Gas Syndicate	Kitchener, Ont.
279	Canadian Dutch Oils, Ltd	Toronto, Ont.
280	Culver and Bloomfield	Dunnville, Ont.
309	Glenn, S. J	Long Branch, Ont.
310	Hartley, Geo. E.	Oil Springs, Ont.
296	Hoover, May, Ltd.	Selkirk, Ont.
297	Hoover, May, Ltd.	Selkirk, Ont.
298	Hoover, May, Ltd.	Selkirk, Ont.
327	Hussey, W. J.	Petrolia, Ont.
295	Hussey and Perkins	Dunnville, Ont.
294	Industrial Natural Gas Co., Ltd.	Thorold, Ont.
281	Jasperson, Bon	Kingsville, Ont.
321	Jasperson, Bon	Kingsville, Ont.
322	Jasperson, Bon	Kingsville, Ont.
323	Jasperson, Bon	Kingsville, Ont.
324	Jasperson, Bon	Kingsville, Ont.
325	Jasperson, Bon	Kingsville, Ont.
305	Kerwin and Dawson	Merlin, Ont.
288	Kiser Bros.	Chatham, Ont.
289	Kiser Bros.	Chatham, Ont.
290	Kiser Bros.	Chatham, Ont.
291	Kiser Bros.	Chatham, Ont.
292	Lauer, D. G.	Tillsonburg, Ont.
311	Lentz and Miller	Muskegon, Mich.
328	Lymburner Bros. and Webber	Dunnville, Ont.
284	McCutcheon, Thos. J.	Dunnville, Ont.
285	McCutcheon, Thos. J.	Dunnville, Ont.
286	McCutcheon, Thos. J.	Dunnville, Ont.
287	McCutcheon, Thos. J.	Dunnville, Ont.
301	McKechnie, S.	Dunnville, Ont.
282	McKillop, Wm.	Cainsville, Ont.
283	McKillop, Wm.	Cainsville, Ont.
293	McLister, J. J.	Dunnville, Ont.
312	Merchant, F.	Saginaw, Mich.
315	Pattinson, R. L.	Chatham, Ont.
316	Pattinson, R. L.	Chatham, Ont.
300	Randall, A. E.	Middleport, Ont.
303	Sarnia Oil and Gas Co., Ltd.	Sarnia, Ont.
302	Schafer and Benner	Delhi, Ont.
350	Seynuck, Tony	Acton, Ont.
308	Smith, Harry B	Windsor, Ont.
317	Stover, F. H., and Son	Chatham, Ont.
318	Stover, F. H., and Son	Chatham, Ont.
319	Stover, F. H., and Son	Chatham, Ont.
320	Stover, F. H., and Son	Chatham, Ont.
354	Sundy, Basil K.	Selkirk, Ont.
307	Wicks, F.	Petrolia, Ont.
313	Willits, G. E.	Bothwell, Ont.
314	Willits, G. E.	Bothwell, Ont.

TABLE X—OPERATORS LICENSED TO PRODUCE NATURAL GAS, 1929

License No.	Name	Address
441	Ajax Oil and Gas Co., Ltd.	Toronto, Ont.
439	Canboro Gas and Oil Co., Ltd.	Cayuga, Ont.
424	Coleman, J. A.	Wellandport, Ont.
418	Dominion Natural Gas Co., Ltd.	Buffalo, N.Y.
419	Dunn Natural Gas Co.	Dunnville, Ont.
431	Erie Gas and Oil Syndicate	Fisherville, Ont.
429	Fisherville Gas Co.	Fisherville, Ont.
423	Industrial Natural Gas Co., Ltd.	Thorold, Ont.
412	Jasperson, Bon	Kingsville, Ont.
436	Lincoln Gas Co., Ltd.	Grimsby, Ont.
428	Medina Natural Gas Co., Ltd.	Chatham, Ont.
466	Midfield Natural Gas Co., Ltd.	Hamilton, Ont.
413	Niece, Hosea, and Son	Lowbanks, Ont.
426	Oil Springs Oil and Gas Co., Ltd.	Oil Springs, Ont.
414	Patterson, Wm. C	Jamestown, N.Y.
444	Pattinson, R. L.	Chatham, Ont.
421	Petrol Oil and Gas Co., Ltd.	Toronto, Ont.
419	Pilkington Brothers (Canada), Ltd.	Toronto, Ont.
422	Provincial Natural Gas Co.	Niagara Falls, Ont
437	Rainham Gas and Oil Syndicate	Fisherville, Ont.
445	Smith, Robt. H.	Lowbanks, Ont.
415	Southern Ontario Gas Co., Ltd.	Buffalo, N.Y.
433	Springvale Gas and Oil Co., Ltd.	Hagersville, Ont.
416	Sterling Gas Co., Ltd.	Buffalo, N.Y.
457	Stevensville Natural Gas and Fuel Co.	Stevensville, Ont.
425	Union Natural Gas Co. of Canada, Ltd.	Chatham, Ont.
417	United Gas Companies, Ltd.	Buffalo, N.Y.
443	Vacuum Gas and Oil Co., Ltd.	Toronto, Ont.
427	Yager, J. J.	Selkirk, Ont.

TABLE XI—OPERATORS LICENSED TO DISTRIBUTE NATURAL GAS, 1929

License No.	Name	Address
331	Brantford Gas Co	Buffalo, N.Y.
345	Central Pipe Line Co., Ltd.	Chatham, Ont.
341	Chatham Gas Co., Ltd.	Chatham, Ont.
343	Chippewa Development Co., Ltd	Chippawa, Ont.
338	Coleman, J. A.	Wellandport, Ont.
335	Dominion Natural Gas Co., Ltd.	Buffalo, N.Y.
347	Fisherville Gas Co.	Fisherville, Ont.
363	Fonthill-Ridgeville Gas Co., Ltd.	Fonthill, Ont.
365	Grimsby Natural Gas Co., Ltd.	Grimsby, Ont.
337	Industrial Natural Gas Co., Ltd.	Thorold, Ont.
346	Lake Shore Natural Gas Co.	Fort Erie, Ont.
344	Leamington Corporation	Leamington, Ont.
332	Manufacturers Natural Gas Co., Ltd.	Buffalo, N.Y.
342	Oil Springs Oil and Gas Co., Ltd.	Oil Springs, Ont.
336	Provincial Natural Gas and Fuel Co., Ltd.	Niagara Falls, Ont.
330	Southern Ontario Gas Co., Ltd.	Buffalo, N.Y.
350	Springvale Gas and Oil Co., Ltd.	Hagersville, Ont.
333	Sterling Gas Co., Ltd.	Buffalo, N.Y.
339	Union Natural Gas Co. of Canada, Ltd.	Chatham, Ont.
334	United Gas Companies, Ltd.	Buffalo, N.Y.
340	Windsor Gas Co., Ltd.	Windsor, Ont.

TABLE XII—OPERATORS LICENSED TO OPERATE PIPE LINES, 1929

License No.	Name	Address
76	Central Pipe Line Co., Ltd.	Chatham, Ont.
74	Dominion Natural Gas Co., Ltd.	Buffalo, N.Y.
72	Southern Ontario Gas Co., Ltd.	Buffalo, N.Y.
75	Union Natural Gas Co., Ltd.	Chatham, Ont.
73	United Gas Companies, Ltd.	Buffalo, N.Y.

Logs of Wells

The logs of oil and gas wells drilled in Ontario in 1929 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.
S. ½	South half.
W. ½	West half.
B.F.	Broken front.
N.T.R.	North of Talbot Road.
R.R.	River range.
S.T.R.	South of Talbot Road.
T.L.R.	Town line range.
T.R.	Talbot road.
W.S.C.R.	West Stoney Creek Road.

District of Algoma

HENRY FREMLIN AND WILL ARMSTRONG,
ST. JOSEPH'S ISLAND
Lot 16, con. VII, Jocelyn tp.

Completed July, 1927.
Dry hole.

Formation	Thickness, ft.
Surface	148
Meaford, Dundas, and Utica	84
Samples missing	126
Trenton	132
St. Peter	165
Pre-Cambrian	25
Total depth	680

Brant County

ONONDAGA OIL AND GAS CO., BRANTFORD
Lot 21, con. III, Onondaga tp.

Completed May 11, 1927.
Open flow: 15,000 cu. ft.
Rock pressure: 120 lbs.

Formation	Thickness, ft.
Clay	60
Grey lime	62
Niagara	223
Grey shale	37
Clinton	18
Red Medina	25
Blue shale	60
White Medina	10
Red shale	157
Total depth	652

Gas at 399 and 490 feet.

ONONDAGA OIL AND GAS CO., BRANTFORD
Lots 15-18, con. III, Onondaga tp.

Completed February 8, 1927.
Open flow: 15,000 cu. ft.
Rock pressure: 85 lbs.

Formation	Thickness, ft.
Clay	92
White lime	40
Niagara lime	235
Niagara lime and shale	20
Black slate	10
Clinton	15
Red Medina	25
Blue shale	70
White Medina	8
Red shale	190
Total depth	705

Gas at 412, 508, and 640 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 13, con. VI, Tuscarora tp.

Completed November 26, 1927.
Open flow: 40,000 cu. ft.
Rock pressure: 60 lbs.

Formation	Thickness, ft.
Clay	56
Salina	41
Guelph and Niagara	299
Rochester	50
Clinton	17
Red Medina	15
Cabot Head	71
White Medina	10
Queenston red shale	109
Total depth	668

Gas at 395 and 493 feet.

SENATOR MICHENER, TORONTO
Lot 8, NE. cor. con. III, Tuscarora tp.

Completed July 5, 1927.
Dry hole.

Formation	Thickness, ft.
Clay	10
Hard pan	29
Salina	279
Guelph and Niagara	162
Rochester	50
Clinton	20
Green shale	5
Red Medina	5
White Medina	10
Red shale	10
Grey shale	65
Red shale	156
Total depth	801

Show in White Medina at 565 feet.

HEART OF RESERVE SYNDICATE, TORONTO
Lot 8, con. III, Tuscarora tp.

Completed July 25, 1927.
Dry hole.

Formation	Thickness, ft.
Clay	10
Hard pan	29
Salina	279
Guelph and Niagara	201
Rochester	50
Clinton	20
Green shale	5
Red Medina	5
White Medina	10
Red shale	10
Grey shale	65
Red shale	156
Total depth	840

Gas at 565 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 46, R.R., Tuscarora tp.

Completed June 7, 1929.
Open flow: 45,000 cu. ft.
Rock pressure: 125 lbs.

Formation	Thickness, ft.
Clay	74
Salina	15
Guelph and Niagara	261
Rochester	48
Clinton	21
Red Medina	20
Cabot Head	65
White Medina	22
Queenston	104
Total depth	630

Gas at 546 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 48, R.R., Tuscarora tp.

Completed February 23, 1929.
Open flow: 76,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Sand	10
Clay	75
Salina	15
Guelph and Niagara	247
Rochester	46
Clinton	20
Red Medina	22
Cabot Head	68
White Medina	15
Queenston	105
Total depth	623

Gas at 528 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 48, R.R., Tuscarora tp.

Completed July 6, 1929.
Rock pressure: 129 lbs.

Formation	Thickness, ft.
Clay	105
Salina	15
Guelph and Niagara	242
Rochester	50
Clinton	28
Red Medina	20
Cabot Head	55
White Medina	21
Queenston	110
Total depth	645

Gas at 515 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 42, R.R., Tuscarora tp.

Completed November 8, 1929.
Open flow: 42,240 cu. ft.
Rock pressure: 128 lbs.

Formation	Thickness, ft.
Clay	72
Salina	15
Guelph and Niagara	253
Rochester	48
Clinton	21
Red Medina	11
Cabot Head	70
White Medina	15
Queenston	120
Total depth	625

Gas at 502 feet.

PETROL OIL AND GAS CO., TORONTO
Lot 42, R.R., Tuscarora tp.

Completed December 21, 1929.
Open flow: 33,600 cu. ft.
Rock pressure: 128 lbs.

Formation	Thickness, ft.
Clay	54
Salina	5
Guelph and Niagara	256
Rochester	50
Clinton	15
Red Medina	20
Cabot Head	70
White Medina	20
Queenston	103
Total depth	593

Gas at 475 feet.

Bruce County

KINCARDINE SALT CO., KINCARDINE
Near C.N.R. station

Completed August 7, 1929.

Formation	Thickness. ft.
Surface (sand and gravel)	105
Lime	495
Red shale	41
Blue shale	39
Lime	113
Red and blue shale	35
Blue shale and clay	57
Lime	7
Cavity (salt)	7
Lime	3
Cavity (salt)	7
Lime and gypsum	24
Shale	25
Lime	9
Rock salt	31
Lime	7
Rock salt	115
Lime	5
Total depth	1,125

Elgin County

WM. STEVENS, PORT BRUCE
Lot 5, con. I, Malahide tp.

Completed December 9, 1929.

Formation	Thickness, ft.
Gravel and sand	60
Clay	96
Shale	20
Shattered lime	15
Corniferous lime	180
Oriskany sand	29
Total depth	400

Haldimand County

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lots 39 and 40, con. I, Cayuga N. tp.

Completed February 23, 1929.
Open flow: 78,000 cu. ft.
Rock pressure: 325 lbs.

Formation	Thickness, ft.
Surface	20
Flint	70
Lime and shale	274
Niagara	230
White shale	50
Clinton	30
Red Medina	40
Grey shale	50
White Medina	12
Red shale	4
Total depth	780

Gas at 668 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 40, S.T.R., Cayuga N. tp.

Completed March 29, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	17
Hard lime	80
Lime and shale	288
Niagara	230
White shale	50
Clinton	30
Red Medina	40
Blue shale	50
White Medina	12
Red shale	4
Total depth	801

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 26, con. I, N.T.R., Cayuga N. tp.

Completed April 29, 1929.
Open flow: 82,000 cu .ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	40
Lime and shale	260
Niagara	225
Shale	50
Clinton	28
Red Medina	38
Grey shale	53
White Medina	14
Red shale	5
Total depth	713

Gas at 570 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 26, con. I, N.T.R., Cayuga N. tp.

Completed May 20, 1929.
Open flow: 48,000 cu. ft.
Rock pressure: 285 lbs.

Formation	Thickness, ft.
Surface	48
Lime and shale	247
Niagara	225
Shale	52
Clinton	28
Red Medina	38
Grey shale	54
White Medina	12
Big red	4
Total depth	708

Gas at 597 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 26, con. I, N.T.R., Cayuga N. tp.

Completed June 17, 1929.
Open flow: 44,502 cu. ft.
Rock pressure: 254 lbs.

Formation	Thickness, ft.
Surface	57
Lime and shale	257
Niagara	225
Shale	49
Clinton	28
Red Medina	38
Grey shale	55
White Medina	12
Red shale	3
Total depth	724

Gas at 603 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 27, con. I, N.T.R., Cayuga N. tp.

Completed July 15, 1929.
Open flow: 60,000 cu. ft.
Rock pressure: 307 lbs.

Formation	Thickness, ft.
Surface	58
Lime and shale	231
Niagara	225
Shale	50
Clinton	28
Red Medina	38
Grey shale	53
White Medina	12
Red shale	6
Total depth	701

Gas at 602 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 27, con. I, Cayuga N. tp.

Completed August 14, 1929.
Open flow: 92,000 cu. ft.
Rock pressure: 287 lbs.

Formation	Thickness, ft.
Surface	60
Lime and shale	226
Niagara	225
Shale	52
Clinton	28
Red Medina	38
Grey shale	54
White Medina	15
Red shale	1
Total depth	699

Gas at 568 feet.

DOMINION NATURAL GAS CO., BUFFALO, N Y.
Lot 28, con. I, N.T.R., Cayuga N. tp.

Completed September 9, 1929.
Open flow: 27,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	47
Lime and shale	231
Niagara	225
Shale	50
Clinton	28
Red Medina	39
Grey shale	55
White Medina	15
Big red	4
Total depth	694

Gas at 557 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 26, con. I, N.T.R., Cayuga N. tp.

Completed October 4, 1929.
Open flow: 391,825 cu. ft.
Rock pressure: 300 lbs.

Formation	Thickness, ft.
Surface	43
Lime and shale	241
Niagara	225
Shale	52
Clinton	28
Red Medina	39
Grey shale	55
White Medina	14
Red shale	4
Total depth	701

Gas at 586 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 26, con. I, N.T.R., Cayuga N. tp.

Completed October 24, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	54
Lime and shale	214
Niagara	225
Shale	52
Clinton	28
Red Medina	38
Grey shale	55
White Medina	20
Red shale	3
Total depth	689

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 9, N.T.R., Cayuga N. tp.

Completed December 4, 1929.
Open flow: 67,910 cu. ft.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Surface	42
Shale and lime	163
Niagara	233
Shale	53
Clinton	25
Red Medina	42
Grey shale	60
White Medina	10
Red shale	50
Total depth	678

Gas at 627 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 28, con. I, N.T.R., Cayuga N. tp.

Completed November 20, 1929.
Open flow: 22,000 cu. ft.
Rock pressure: 265 lbs.

Formation	Thickness, ft.
Surface	51
Lime and shale	224
Niagara	225
Shale	50
Clinton	28
Red Medina	38
Grey shale	55
White Medina	16
Red shale	4
Total depth	691

Gas at 555 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 11, con. III, Dunn tp.

Completed August 12, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	22
Flint	61
Lime and shale	362
Niagara	220
Shale	72
Clinton	33
Red Medina	56
Grey shale	46
White Medina	5
Red shale	3
Total depth	880

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 12, con. II, Rainham tp.

Completed February 13, 1929.
Open flow: 590,000 cu. ft.
Rock pressure: 380 lbs.

Formation	Thickness, ft.
Surface	10
Flint	100
Lime and shale	355
Niagara	240
White shale	52
Clinton	30
Red Medina	40
Grey shale	57
White Medina	33
Red shale	63
Total depth	980

Gas at 909 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 8, con. III, Rainham tp.

Completed February 18, 1929.
Open flow: 221,000 cu. ft.
Rock pressure: 380 lbs.

Formation	Thickness, ft.
Surface	16
Flint	64
Lime and shale	371
Niagara	236
Shale	59
Clinton	29
Red Medina	35
Shale	55
White Medina	18
Red shale	17
Total depth	900

Gas at 785 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 12, con. II, Rainham tp.

Completed March 23, 1929.
Open flow: 121,000 cu. ft.
Rock pressure: 312 lbs.

Formation	Thickness, ft.
Surface	27
Flint	90
Lime and shale	345
Niagara	240
Shale	52
Clinton	30
Red Medina	40
Blue shale	56
White Medina	15
Red shale	3
Total depth	898

Gas at 804 to 809 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 12, con. II, Rainham tp.

Completed April 13, 1929.
Open flow: 34,000 cu. ft.
Rock pressure: 364 lbs.

Formation	Thickness, ft.
Surface	15
Flint	100
Lime and shale	345
Niagara	240
Shale	51
Clinton	30
Red Medina	40
Grey shale	57
White Medina	16
Red shale	22
Total depth	916

Gas at 886 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y
Lot 6, con. II, Rainham tp.

Completed May 18, 1929.
Open flow: 231,000 cu. ft.
Rock pressure: 305 lbs.

Formation	Thickness, ft.
Surface	29
Flint	71
Lime and shale	385
Niagara	240
Shale	60
Clinton	32
Red Medina	40
Blue shale	60
White Medina	15
Red shale	8
Total depth	940

Gas at 805 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 3, con. V, Rainham tp.

Completed June 8, 1929.
Open flow: 198,000 cu. ft.
Rock pressure: 473 lbs.

Formation	Thickness, ft.
Surface	2
Flint	90
Lime and shale	358
Niagara	250
Grey shale	44
Clinton	27
Red Medina	40
Blue shale	55
White Medina	15
Red shale	5
Total depth	886

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 6, con. III, Rainham tp.

Completed June 13, 1929.
Open flow: 55,000 cu. ft.
Rock pressure: 382 lbs.

Formation	Thickness, ft.
Surface	25
Flint	69
Lime and shale	396
Niagara	226
Grey shale	57
Clinton	25
Red Medina	42
Blue shale	60
White Medina	20
Red shale	25
Total depth	945

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lots 2 and 3, con. IV, Rainham tp.

Completed July 6, 1929.
Open flow: 272,000 cu. ft.
Rock pressure: 385 lbs.

Formation	Thickness, ft.
Surface	2
Flint	90
Lime and shale	378
Niagara	245
Grey shale	43
Clinton	25
Red Medina	40
Blue shale	60
White Medina	17
Red shale	59
Total depth	959

Gas at 897 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 6, con. III, Rainham tp.

Completed July 9, 1929.
Open flow: 198,000 cu. ft.
Rock pressure: 400 lbs.

Formation	Thickness, ft.
Surface	14
Flint	100
Lime and shale	361
Niagara	245
Shale	55
Clinton	25
Red Medina	42
Shale	55
White Medina	20
Red shale	10
Total depth	927

Gas at 820 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 11, con. II, Rainham tp.

Completed June 26, 1929.
Open flow: 60,000 cu. ft.

Formation	Thickness, ft.
Surface	10
Flint	70
Lime and shale	380
Niagara	240
Shale	54
Clinton	28
Red Medina	40
Grey shale	57
White Medina	16
Red shale	50
Total depth	945

Gas at 889 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 4, con. IV, Rainham tp.

Completed August 6, 1929.
Open flow: 60,000 cu. ft.
Rock pressure: 473 lbs.

Formation	Thickness, ft.
Surface	21
Flint	94
Lime and shale	363
Niagara	250
Grey shale	46
Clinton	27
Red Medina	40
Blue shale	62
White Medina	15
Red shale	4
Total depth	922

Gas at 823 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 6, con. II, Rainham tp.

Completed August 9, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	20
Flint	91
Lime and shale	371
Niagara	243
Grey shale	56
Clinton	30
Red Medina	42
Red shale	55
White Medina	17
Red shale	6
Total depth	931

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 10, con. II, Rainham tp.

Completed August 13, 1929.
Open flow: 640,000 cu. ft.
Rock pressure: 356 lbs.

Formation	Thickness, ft.
Surface	16
Flint	100
Lime and shale	348
Niagara	240
Grey shale	54
Clinton	28
Red Medina	41
Blue shale	41
Total depth	868

Gas at 802 to 810 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 4, con. IV, Rainham tp.

Completed August 31, 1929.
Open flow: 33,000 cu. ft.
Rock pressure: 456 lbs.

Formation	Thickness, ft.
Surface	14
Flint	88
Lime and shale	359
Niagara	257
Shale	40
Clinton	30
Red Medina	40
Blue shale	60
White Medina	14
Red shale	3
Total depth	905

Gas at 803 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 7, con. II, Rainham tp.

Completed September 3, 1929.
Open flow: 22,000 cu. ft.
Rock pressure: 356 lbs.

Formation	Thickness, ft.
Surface	22
Flint	75
Lime and shale	395
Niagara	237
Grey shale	58
Clinton	25
Red Medina	42
Blue shale	55
White Medina	17
Red shale	6
Total depth	932

Gas at 827 to 832 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 6, con. IV, Rainham tp.

Completed October 2, 1929.
Open flow: 55,000 cu. ft.
Rock pressure: 410 lbs.

Formation	Thickness, ft.
Surface	14
Flint	110
Lime and shale	371
Niagara	248
Grey shale	37
Clinton	28
Red Medina	40
Blue shale	50
White Medina	15
Red shale	4
Total depth	917

Gas at 823 to 828 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 10, con. II, Rainham tp.

Completed October 7, 1929.
Open flow: 58,000 cu. ft.
Rock pressure: 386 lbs.

Formation	Thickness, ft.
Surface	14
Flint	100
Lime and shale	353
Niagara	240
Grey shale	54
Clinton	30
Red Medina	40
Blue shale	58
White Medina	17
Red shale	6
Total depth	912

Gas at 783 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 8, con. II, Rainham tp.

Completed October 16, 1929.
Open flow: 46,000 cu. ft.

Formation	Thickness, ft.
Surface	23
Flint	67
Lime and shale	370
Niagara	244
Grey shale	63
Clinton	30
Red Medina	42
Blue shale	55
White Medina	17
Red shale	7
Total depth	918

Gas at 827 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 3, con. II, Rainham tp.

Completed November 8, 1929.
Open flow: 34,000 cu. ft.
Rock pressure: 425 lbs.

Formation	Thickness, ft.
Surface	18
Flint	100
Lime and shale	367
Niagara	256
Shale	43
Clinton	28
Red Medina	43
Blue shale	60
White Medina	15
Red shale	5
Total depth	935

Gas at 827 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 9, con. II, Rainham tp.

Completed November 20, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	18
Flint	82
Lime and shale	379
Niagara	231
Grey shale	60
Clinton	30
Red Medina	42
Blue shale	55
White Medina	17
Red shale	5
Total depth	919

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 13, con. I, Rainham tp.

Completed November 29, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	7
Flint	90
Lime and shale	354
Niagara	240
Shale	50
Clinton	27
Red Medina	40
Grey shale	55
White Medina	18
Red shale	5
Total depth	886

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 3, con. II, Rainham tp.

Completed December 21, 1929.
Open flow: 43,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Surface	8
Flint	107
Lime and shale	370
Niagara	251
Grey shale	53
Clinton	28
Red Medina	45
Blue shale	55
White Medina	15
Red shale	4
Total depth	936

Gas at 835 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 18, con. I, Seneca tp.

Completed January 25, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	68
Shale	149
Niagara and lime	233
Shale	51
Clinton	27
Red Medina	43
Shale	52
White Medina	12
Red shale	4
Total depth	639

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 15, Fishcarrier and Young tract, Seneca tp.

Completed February 2, 1929.
Open flow: 24,000 cu. ft.

Formation	Thickness, ft.
Surface	69
Lime and shale	145
Niagara	230
Shale	48
Clinton	25
Red Medina	35
Shale	55
White Medina	15
Red shale	50
Total depth	672

Gas at 632 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 10, con. II, Seneca tp.

Completed February 27, 1929.
Open flow: 26,000 cu. ft.
Rock pressure: 188 lbs.

Formation	Thickness, ft.
Surface	52
Shale	133
Niagara and lime	233
Shale	42
Clinton	24
Red Medina	36
Shale	55
White Medina	12
Red shale	4
Total depth	591

Gas at 477 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 265A (S.E. pt. Fishcarrier tract and N.W. pt. Young tract, fronting on Grand river), Seneca tp.

Completed March 12, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	40
Lime and shale	155
Niagara	240
Shale	49
Clinton	25
Red Medina	40
Shale	51
White Medina	10
Red shale	3
Total depth	613

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 10, con. II, Seneca tp.

Completed March 20, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	65
Shale	119
Lime and Niagara	226
Shale	49
Clinton	25
Red Medina	45
Shale	51
White Medina	10
Red shale	3
Total depth	593

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Young tract, Seneca tp.

Completed April 16, 1929.
Open flow: 55,340 cu. ft.
Rock pressure: 210 lbs.

Formation	Thickness, ft.
Surface	80
Shale	125
Niagara and lime	233
Shale	48
Clinton	22
Red Medina	38
Shale	60
White Medina	10
Red shale	3
Total depth	619

Gas at 518 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Young tract, Seneca tp.

Completed May 2, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	81
Shale	120
Niagara and lime	230
Shale	52
Clinton	25
Red Medina	40
Shale	59
White Medina	10
Red shale	2
Total depth	619

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Nelles tract, Seneca tp.

Completed May 10, 1929.
Open flow: 68,000 cu. ft.
Rock pressure: 160 lbs.

Formation	Thickness, ft.
Surface	33
Lime and shale	155
Niagara	237
Shale	45
Clinton	29
Red Medina	40
Shale	55
White Medina	12
Red shale	50
Total depth	656

Gas at 602 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Nelles tract, Seneca tp.

Completed June 4, 1929.
Open flow: 21,000 cu. ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface	53
Lime and shale	125
Niagara	265
Shale	46
Clinton	25
Red Medina	30
Shale	60
White Medina	10
Red shale	50
Total depth	664

Gas at 609 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Nelles tract, Seneca tp.

Completed June 1, 1929.
Open flow: 78,410 cu. ft.

Formation	Thickness, ft.
Surface	82
Lime and shale	115
Niagara	230
Shale	51
Clinton	27
Red Medina	42
Shale	60
White Medina	10
Red shale	50
Total depth	667

Gas at 615 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Nelles tract, Seneca tp.

Completed June 17, 1929.
Open flow: 65,000 cu. ft.
Rock pressure: 200 lbs.

Formation	Thickness, ft.
Surface	73
Shale	129
Niagara	229
Shale	38
Clinton	25
Red Medina	42
Shale	61
White Medina	10
Red shale	50
Total depth	657

Gas at 601 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Nelles tract, Seneca tp.

Completed July 10, 1929.
Dry hole.

Formation	Thickness. ft.
Surface	55
Shale	130
Niagara	200
Guelph	79
Shale	17
Clinton	25
Red Medina	40
Red shale	50
White Medina	5
Red shale	2
Total depth	603

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 18, con. II, Seneca tp.

Completed July 12, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	85
Shale	115
Niagara	233
Shale	46
Clinton	24
Red Medina	41
Grey shale	57
White Medina	10
Red shale	2
Total depth	613

Gas at 486 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 5, Young tract, Seneca tp.

Completed August 1, 1929.
Open flow: 78,410 cu ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface	74
Shale	111
Niagara	225
Shale	53
Clinton	28
Red Medina	40
Shale	65
White Medina	10
Red shale	2
Total depth	608

Gas at 494 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Nelles tract, Seneca tp.

Completed August 21, 1929.
Open flow: 30,000 cu. ft.
Rock pressure: 135 lbs.

Formation	Thickness, ft.
Surface	60
Shale	117
Niagara and lime	231
Shale	49
Clinton	27
Red Medina	40
Shale	58
White Medina	12
Red shale	50
Total depth	644

Gas at 586 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Nelles tract, Seneca tp.

Completed September 3, 1929.
Open flow: 24,600 cu. ft.
Rock pressure: 265 lbs.

Formation	Thickness, ft.
Surface	63
Shale	125
Niagara	200
Guelph	64
Shale	20
Clinton	25
Red Medina	35
Blue shale	55
White Medina	7
Red shale	14
Total depth	608

Gas at 592 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Young tract, Seneca tp.

Completed September 14, 1929.
Open flow: 63,000 cu. ft.
Rock pressure: 195 lbs.

Formation	Thickness, ft.
Surface	80
Shale	105
Niagara and lime	238
Shale	49
Clinton	25
Red Medina	42
Shale	59
White Medina	10
Red shale	4
Total depth	612

Gas at 487 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Nelles tract, fronting on Grand river, Seneca tp.

Completed October 2, 1929.
Open flow: 43,000 cu. ft.
Rock pressure: 146 lbs.

Formation	Thickness, ft.
Surface	87
Shale	112
Niagara	200
Lime	65
Shale	15
Clinton	25
Red Medina	35
Shale	57
White Medina	12
Red shale	27
Total depth	635

Gas at 603 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Young tract along north line central, Seneca tp.

Completed September 28, 1929.
Open flow: 30,000 cu. ft.
Rock pressure: 174 lbs.

Formation	Thickness, ft.
Surface	69
Shale	128
Niagara	230
Shale	52
Clinton	27
Red Medina	34
Grey shale	59
White Medina	10
Red shale	2
Total depth	611

Gas at 501 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Young tract, Seneca tp.

Completed October 18, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	70
Shale	130
Niagara	230
Shale	42
Clinton	24
Red Medina	31
Shale	73
White Medina	10
Red shale	5
Total depth	615

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 9, con. I, Seneca tp.

Completed November 6, 1929.
Open flow: 30,270 cu. ft.
Rock pressure: 190 lbs.

Formation	Thickness, ft.
Surface	35
Shale	170
Niagara	233
Shale	45
Clinton	23
Red Medina	45
Shale	60
White Medina	10
Red shale	50
Total depth	671

Gas at 620 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Nelles tract, Seneca tp.

Completed November 4, 1929.
Open flow: 42,738 cu. ft.
Rock pressure: 223 lbs.

Formation	Thickness, ft.
Surface	88
Shale	122
Niagara	205
Guelph	20
Shale	21
Shale	10
Clinton	23
Red Medina	40
Shale	52
White Medina	10
Red shale	49
Total depth	640

Gas at 589 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Nelles tract, W.S.C.R., Seneca tp.

Completed November 28, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	90
Shale	105
Niagara	210
Guelph and lime	26
Shale	43
Clinton	29
Red Medina	39
Shale	48
White Medina	10
Red shale	2
Total depth	602

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 20, con. X, Walpole tp.

Completed January 22, 1929.
Open flow: 121,000 cu. ft.
Rock pressure: 415 lbs.

Formation	Thickness, ft.
Surface	2
Flint	75
Lime and shale	392
Niagara	250
Shale	35
Clinton	25
Red Medina	35
Shale	55
White Medina	11
Red shale	3
Total depth	883

Gas at 794 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con, IV, Walpole tp.

Completed February 27, 1929.
Open flow: 84,000 cu. ft.
Rock pressure: 185 lbs.

Formation	Thickness, ft.
Surface	10
Flint	80
Lime and shale	395
Niagara	230
White shale	74
Clinton sand	27
Red Medina	38
Blue shale	60
White Medina	13
Red shale	5
Total depth	932

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 20, con. X, Walpole tp.

Completed February 22, 1929.
Open flow: 96,000 cu. ft.
Rock pressure: 462 lbs.

Formation	Thickness, ft.
Surface	2
Flint	70
Lime and shale	390
Niagara	254
White shale	40
Clinton	28
Red Medina	40
Blue shale	55
White Medina	10
Red shale	4
Total depth	893

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 6, con. IX, Walpole tp.

Completed March 1, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	24
Flint	70
Lime and shale	361
Niagara	280
Shale	36
Clinton	33
Red Medina	32
Blue shale	60
White Medina	10
Red shale	4
Total depth	910

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 23, con. IV, Walpole tp.

Completed April 11, 1929.
Open flow: 52,000 cu. ft.
Rock pressure: 225 lbs.

Formation	Thickness, ft.
Surface	15
Flint	80
Lime and shale	360
Niagara	230
Grey shale	89
Clinton	27
Red Medina	38
Blue shale	61
White Medina	15
Red shale	30
Total depth	945

Gas at 912 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 17, con. XI, Walpole tp.

Completed April 18, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	4
Flint	63
Lime and shale	391
Niagara	255
Grey shale	30
Clinton	30
Red Medina	35
Blue shale	60
White Medina	5
Red shale	4
Total depth	877

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 3, con. I, Walpole tp.

Completed May 21, 1929.
Open flow: 121,000 cu. ft.

Formation	Thickness, ft.
Surface	27
Flint	158
Lime and shale	350
Niagara	305
Shale	40
Clinton	24
Red Medina	48
Blue shale	65
White Medina	10
Red shale	5
Total depth	1,032

Gas at 929 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 23, con. IV, Walpole tp.

Completed May 28, 1929.
Open flow: 34,000 cu. ft.
Rock pressure: 285 lbs.

Formation	Thickness, ft.
Surface	19
Flint	71
Lime and shale	370
Niagara	230
Grey shale	97
Clinton	28
Red Medina	35
Blue shale	60
White Medina	15
Red shale	30
Total depth	955

Gas at 923 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lots 14 and 15, con. XI, Walpole tp.

Completed June 6, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	4
Flint	64
Lime and shale	394
Niagara	255
Shale	30
Clinton	26
Red Medina	35
Blue shale	65
White Medina	9
Red shale	4
Total depth	886

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 22, con. III, Walpole tp.

Completed June 20, 1929.
Open flow: 18,000 cu. ft.
Rock pressure: 273 lbs.

Formation	Thickness, ft.
Surface	11
Flint	89
Lime and shale	375
Niagara	230
Shale	87
Clinton	28
Red Medina	35
Shale	62
White Medina	14
Red shale	2
Total depth	933

Gas at 840 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 2, con. I, Walpole tp.

Completed June 29, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	28
Flint	119
Lime and shale	393
Niagara	325
Grey shale	38
Clinton	25
Red Medina	47
Blue shale	60
White Medina	10
Red shale	2
Total depth	1,047

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 18, con. IX, Walpole tp.

Completed July 25, 1929.
Open flow: 241,000 cu. ft.
Rock pressure: 425 lbs.

Formation	Thickness, ft.
Surface	1
Flint	75
Lime and shale	392
Niagara	250
Grey shale	35
Clinton	33
Red Medina	35
Blue shale	64
White Medina	12
Red shale	58
Total depth	955

Gas at 897 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lot 22, con. II, Walpole tp.

Completed July 29, 1929.
Open flow: 171,000 cu. ft.

Formation	Thickness, ft.
Surface	10
Flint	90
Lime and shale	410
Niagara	230
Shale	89
Clinton	27
Red Medina	37
Shale	60
White Medina	14
Red shale	4
Total depth	971

Gas at 878 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.

Lots 4 and 5, con. I, Walpole tp.

Completed August 9, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	15
Flint	145
Lime and shale	370
Niagara	283
Shale	49
Clinton	27
Red Medina	45
Blue shale	60
White Medina	14
Red shale	2
Total depth	1,010

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 22, con. II, Walpole tp.

Completed August 20, 1929.
Open flow: 210,000 cu. ft.
Rock pressure: 384 lbs.

Formation	Thickness, ft.
Surface	10
Flint	90
Lime and shale	405
Niagara	230
Grey shale	109
Clinton	25
Red Medina	38
Blue shale	60
White Medina	12
Red shale	5
Total depth	984

Gas at 848 to 862 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 18, con. VIII, Walpole tp.

Completed August 22, 1929.
Open flow: 43,000 cu. ft.

Formation	Thickness, ft.
Surface	18
Flint	57
Lime and shale	392
Niagara	250
Shale	35
Clinton	25
Red Medina	35
Blue shale	65
White Medina	10
Red shale	6
Total depth	893

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 4, con. I, Walpole tp.

Completed September 27, 1929.
Open flow: 140,000 cu. ft.
Rock pressure: 408 lbs.

Formation	Thickness, ft.
Surface	26
Flint	142
Lime and shale	372
Niagara	286
Grey shale	53
Clinton	27
Red Medina	40
Blue shale	65
White Medina	13
Red shale	2
Total depth	1,026

Gas at 921 to 926 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. III, Walpole tp.

Completed October 8, 1929.
Open flow: 157,000 cu. ft.
Rock pressure: 407 lbs.

Formation	Thickness, ft.
Surface	10
Flint	90
Lime and shale	395
Niagara	230
Grey shale	103
Clinton	24
Red Medina	38
Blue shale	60
White Medina	12
Red shale	5
Total depth	967

Gas at 874 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 21, con. III, Walpole tp.

Completed November 5, 1929.
Open flow: 121,000 cu. ft.
Rock pressure: 396 lbs.

Formation	Thickness, ft.
Surface	15
Flint	75
Lime and shale	375
Niagara	230
Grey shale	110
Clinton	25
Red Medina	37
Blue shale	65
White Medina	15
Red shale	60
Total depth	1,007

Gas at 942 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lots 4 and 5, con. I, Walpole tp.

Completed November 13, 1929.
Open flow: 21,000 cu. ft.
Rock pressure: 350 lbs.

Formation	Thickness, ft.
Surface	46
Flint	130
Lime and shale	354
Niagara	303
Shale	48
Clinton	25
Red Medina	40
Shale	65
White Medina	10
Red shale	4
Total depth	1,025

Gas at 926 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 19, con. VIII, Walpole tp.

Completed December 7, 1929.
Open flow: 55,000 cu. ft.
Rock pressure: 443 lbs.

Formation	Thickness, ft.
Surface	18
Flint	54
Lime and shale	390
Niagara	250
Grey shale	39
Clinton	28
Red Medina	35
Blue shale	67
White Medina	8
Red shale	4
Total depth	893

Gas at 789 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lots 6 and 7, con. X, Walpole tp.

Completed April 24, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	38
Flint	47
Lime and shale	365
Niagara	282
Grey shale	32
Clinton	35
Red Medina	25
Blue shale	61
White Medina	9
Red shale	4
Total depth	898

Water at 495 feet.

Halton County

F. A. Ogletree, Sarnia

Lot 7, con. III, Nelson tp.

Completed December, 1929.
Dry hole.

Formation	Thickness, ft.
Clay	3
Hudson River shale	887
Utica shale	170
Trenton	665
Arkose	15
Total depth	1,740

Gas at 225, 250, 450, and 485 feet.
Water at 42, 1,070, and 1,725 feet.

Kent County

Acme Gas and Oil Co., Ltd., Toronto

Lot 2, con. IV, Dover E. tp.

Completed October 7, 1929.

Formation	Thickness, ft.
Surface	75
Soapstone	187
Limestone	1,571
Red Medina	30
Clinton shales	137
White Medina	35
Shales, red and grey	587
Brown shale	150
Trenton lime	426
Total depth	3,198

Gas at 3,040 feet.

Ajax Oil and Gas Co., Ltd., Toronto

Lot 2, con. IV, Dover E. tp.

Completed June 5, 1929.
Open flow: 5,000,000 cu. ft.
Rock pressure: 1,216 lbs.

Formation	Thickness, ft.
Surface	80
Soapstone	160
Middle lime	15
Soapstone	25
Limestone	1,575
Clinton shales	100
Red Medina shales	64
White Medina	30
Red shale	300
Grey shale	275
Brown shale	150
Black shale	31
Trenton lime	385
Total depth	3,190

Gas at 3,075 to 3,085 feet.

Ajax Oil and Gas Co., Ltd., Toronto

Lot 3, con. IV, Dover E. tp.

Completed September 14, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	75
Soapstone	180
Middle lime	20
Soapstone	20
Limestone	1,560
Clinton shales	100
Red Medina shales	50
Red shales	315
Grey shales	200
Brown shales	150
Black shales	17
Trenton lime	503
Total depth	3,190

Gas at 3,250 feet.

Ajax Oil and Gas Co., Ltd., Toronto

Lot 3, con. IV, Dover W. tp.

Completed November 27, 1929.

Formation	Thickness, ft.
Surface	78
Soapstone	192
Big lime	165
Water sands and gypsum	440
Hard lime, white	225
Salina and shale breaks	400
Guelph	200
Niagara	155
Shale break	150
White Medina	30
Big red shale	350
Hudson River	260
Utica	142
Trenton	362
Total depth	3,149

Gas at 2,952 feet.

Union Natural Gas Co., Chatham

Lot 2, con. III, Dover W. tp.

Completed September 16, 1929.

Formation	Thickness, ft.
Surface	70
Hamilton lime and shale	205
Onondaga, Detroit River, Salina, Guelph and Niagara	1,715
Rochester	32
Clinton	4
Cabot Head	117
Manitoulin	50
Queenston	117
Hudson River	480
Utica	70
Collingwood	40
Trenton	195
Total depth	3,095

Gas at 3,058 feet.
Water at 3,090 feet.

Union Natural Gas Co., Chatham

Lot 2, con. III, Dover W. tp.

Completed April 30, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	78
Huron shale	3
Hamilton shale and lime	172
Onondaga, Detroit River, Salina, Guelph and Niagara	1,622
Rochester	15
Clinton	5
Cabot Head	80
Manitoulin	90
Queenston	255
Hudson River	380
Utica	85
Trenton	880
Arkose (blue and grey)	30
Granite	5
Total depth	3,700

Gas at 2,935 feet.
Water at 1,815 feet.

Acme Gas and Oil Co., Ltd., Toronto

Lot 13, S.½ of S.½ con. II, Howard tp.

Completed October 28, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	102
Huron	40
Hamilton	240
Onondaga	30
Total depth	412

ACME GAS AND OIL CO., LTD., TORONTO
Lot 14, E. pt., con. I, Howard tp.

Completed November 15, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	76
Huron	15
Hamilton	233
Onondaga	79
Total depth	403

UNION NATURAL GAS CO., CHATHAM
Lot 4, T.L.R., Howard tp.

Completed August 14, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	190
Huron black shale	85
Hamilton lime and shale	226
Onondaga, Detroit River, Salina, Guelph and Niagara	1,614
Rochester	30
Clinton	20
Cabot Head	80
Manitoulin	62
Queenston	10
Total depth	2,317

Gas at 200 feet.
Water at 705 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 7, con. XI, Howard tp.

Completed June 15, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	330
Hamilton shale and lime	222
Onondaga, Detroit River, Salina, Guelph and Niagara	1,323
Total depth	1,875

UNION NATURAL GAS CO., CHATHAM
Lot 4, con. XI, Howard tp.

Completed May 1, 1929.

Formation	Thickness, ft.
Surface	195
Hamilton lime and shale	342
Onondaga, Detroit River, Salina, Guelph and Niagara	1,593
Rochester	40
Cabot Head	130
Manitoulin	25
Queenston	5
Total depth	2,330

Gas at 603 feet.
Water at 2,115 feet.

ACME GAS AND OIL CO., LTD., TORONTO
Lot 18, con. I, Howard tp.

Completed November 29, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	41
Gravel	34
Hardpan	7
Top lime	38
Upper soap	108
Lime streaks	14
Upper soap	34
Middle lime	12
Lower soap	25
Dark streak of shale	7
Onondaga lime	141
Oriskany sandstone	5
Total depth	466

ACME GAS AND OIL CO., LTD., TORONTO
Lot 6, con. XV, Orford tp.

Completed December 9, 1929.
Dry hole.

Formation	Thickness ft.
Sand	9
Gravel	5
Clay	16
Hardpan	18
Boulders	5
Hardpan	15
Grey shale	32
Upper soap	155
Middle lime	12
Lower lime	24
Dark streak	7
Lower lime	125
Big lime	22
Oriskany sandstone	8
Total depth	453

UNION NATURAL GAS CO., CHATHAM
Lot 148, N.T.R., Raleigh tp.

Completed November 28, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	193
Soap, Hamilton	127
Onondaga, Detroit River	670
Salina	654
Total depth	1,644

Salt water at 1,620 to 1,625 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 145, N.T.R., Raleigh tp.

Completed November 25, 1929.

Formation	Thickness, ft.
Surface	200
Hamilton shale	74
Onondaga, Detroit River, Salina	1,316
Total depth	1,590

Gas at 1,561 feet.
Salt water at 1,580 to 1,590 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 147, N.T.R., Raleigh tp.

Completed October 11, 1929.

Formation	Thickness, ft.
Surface	195
Hamilton shale	75
Onondaga, Detroit River, Salina	1,295
Total depth	1,565

Gas at 1,561 feet.
Water at 710 feet.

SOUTHERN ONTARIO GAS CO, BUFFALO, N Y.
Lot 190, T..R., Romney tp.
Completed May 21, 1929

Formation	Thickness, ft.
Clay	159
Brown lime	117
Grey lime	169
Sharp sand	105
Dark-grey lime	30
Brown lime	90
Grey lime	160
Brown lime	70
Grey lime	120
Dark-grey lime	85
Slate and shale	65
Light-grey lime	205
Total depth	1,375

Gas at 1,360 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 190, T.R., Romney tp.
Completed July 13, 1929.
Dry hole.

Formation	Thickness, ft.
Clay	166
Slate and soap	24
Brown lime	90
Grey lime	160
Sharp sand	120
Light-grey lime	75
Dark-grey lime	115
Brown lime	60
Dark-grey lime	190
Light-brown lime	45
Light-grey lime	75
Slate and shale	60
Light-grey lime	240
Total depth	1,420

Salt water and showing of oil at 1,420 feet.
Gas at 1,250 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 200, T.R., Romney tp.
Completed September 10, 1929.
Dry hole.

Formation	Thickness, ft.
Clay	169
Soap and slate	131
Dark-grey lime	30
Brown lime	60
Light-grey lime	40
Dark-grey lime	135
Sharp sand	170
Brown lime	70
Grey lime	45
Brown lime	40
Light-grey lime	270
Slate and shale	45
Grey lime	219
Total depth	1,424

Gas at 1,414 feet.

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 196, con. I, N.T.R., Romney tp.
Completed November 2, 1929.
Dry hole.

Formation	Thickness, ft.
Clay	175
Broken formation	7
Soap	83
Brown lime	45
Light-brown lime	50
Grey lime	185
Sharp sand	185
Grey lime	70
Light-brown lime	60
Light-grey lime	45
Dark-grey lime	95
Light-grey lime	35
Grey lime	95
Light-grey lime	25
Slate and shale	55
Dark-grey lime	190
Light-grey lime	49
Total depth	1,449

Salt water and showing of oil at 1,449 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 183, S.T.R., Romney tp.
Completed June 24, 1929.

Formation	Thickness, ft.
Surface	190
Onondaga, Detroit River, Salina	1,141
Total depth	1,331

Gas at 1,328 feet.
Water at 1,331 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 26, con. III, Romney tp.
Completed May 25, 1929.

Formation	Thickness, ft.
Surface	168
Hamilton lime and shale	82
Onondaga, Detroit River, Salina	1,195
Total depth	1,445

Gas at 1,300 feet.
Water at 745 feet.

Lambton County

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. XIII, Dawn tp.
Completed September 20, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	45
Huron black shale	90
Hamilton lime and shale	260
Onondaga, Detroit River, Salina, Guelph and Niagara	1,585
Rochester shale	20
Total depth	2,000

Oil at 1,730 feet.
Water at 450 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 23, con. V, Dawn tp.
Completed April 10, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	65
Huron brown shale	165
Hamilton lime and shale	285
Onondaga, Detroit River, Salina	1,250
Guelph and Niagara	393
Rochester	17
Clinton	5
Cabot Head	80
Manitoulin	45
Queenston	23
Total depth	2,328

Water at 1,835 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 25, con. VI, Dawn tp.

Completed January 12, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	86
Huron shale	179
Hamilton lime and shale	260
Onondaga	145
Detroit River	530
Salina	575
Guelph and Niagara	215
Rochester shale	40
Clinton	13
Cabot Head	72
Manitoulin	75
Queenston	10
Total depth	2,200

Gas at 1,607 feet.
Oil at 1,650 to 1,755 feet.
Salt at 1,760 to 1,775 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. XIV, Dawn tp.

Completed March 29, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	21
Huron black shale	79
Hamilton lime and shale	313
Onondaga, Detroit River, Salina, Guelph and Niagara	1,527
Rochester	40
Clinton (shale)	5
Cabot Head	75
Manitoulin	60
Queenston	13
Total depth	2,133

Water at 515 feet.
Salt at 1,405 to 1,530 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. XI, Dawn tp.

Completed August 19, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	40
Huron black shale	100
Hamilton shale	305
Onondaga lime	155
Detroit River, Salina, Guelph and Niagara	1,345
Rochester shale	45
Clinton	5
Cabot Head shale	80
Manitoulin	55
Queenston shale	5
Total depth	2,135

Gas at 1,710 feet.
Water at 1,722 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 23, con. VII, Dawn tp.

Completed July 3, 1929
Dry hole.

Formation	Thickness, ft.
Surface	60
Brown shale, Huron shale	100
Hamilton lime and shale	282
Onondaga	183
Detroit River	635
Salina	620
Guelph and Niagara	230
Rochester shale	40
Clinton	5
Cabot Head	65
Manitoulin	64
Queenston	6
Total depth	2,290

Water at 1,750 feet.

G. E. WILLITS AND ASSOCIATES, BOTHWELL
Lot 26, W. ½, con. X, Euphemia tp.

Completed August 31, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	79
Grey shale	26
Top rock	4
Upper soap	138
Middle lime	18
Lower soap	19
Dark streak	5
Drilled into lower lime	139
Total depth	428

G. E. WILLITS AND ASSOCIATES, BOTHWELL
Lot 25, E. ½, con. X, Euphemia tp.

Completed September 16, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	97
Pipe clay	10
Top rock	3
Upper soap	144
Middle lime	13
Lower soap	19
Dark streak	6
Drilled into lower lime	114
Total depth	405

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. V, Euphemia tp.

Completed October 2, 1929.

Formation	Thickness, ft.
Surface	55
Upper soap	195
Middle lime	15
Lower soap	25
Onondaga lime	125
Detroit River lime	485
Salina	680
Guelph and Niagara	260
Rochester shale	50
Red shale (Cabot Head)	30
Manitoulin: Blue shale	80
Manitoulin: White Medina	10
Manitoulin: Grey-blue shale	25
Red shale (Queenston)	11
Total depth	2,046

Gas at 1,580 feet.
Salt from 1,295 to 1,455 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 25, con. IV, Euphemia tp.

Completed November 15, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	55
Hamilton lime	25
Upper soap	150
Middle lime	18
Lower soap	14
Onondaga lime	158
Detroit River	475
Salina	710
Guelph and Niagara	260
Total depth	1,865

Gas at 1,630 feet.
Salt at 1,260 to 1,470 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 24, con. V, Euphemia tp.

Completed November 28, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	57
Huron shale	13
Hamilton lime and shale	250
Onondaga Detroit River Salina	1,262
Guelph and Niagara	263
Rochester	7
Total depth	1,852

Show of oil at 1,582 feet.
Water at 1,830 feet.

UNION NATURAL GAS CO., CHATHAM
Lot 25, con. L, Euphemia tp.

Completed June 5, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	42
Huron shale	68
Hamilton lime and shale	235
Onondaga	130
Detroit River	490
Salina	565
Guelph and Niagara	170
Total depth	1,700

Oil at 595 feet.
Water at 1,670 feet.
Salt at 1,325 to 1,500 and 1,510 to 1,530 feet.

WESTERN SALT CO., LTD., COURTRIGHT
Lot 23, W. pt. Front con., Moore tp.

Completed December 13, 1929.
Dry hole.

Formation	Thickness, ft.
Clay	160
Grey shale	70
Black shale	20
Blue shale	270
Dark lime	100
Light-grey lime	170
White lime	100
Buff lime	330
Dark-blue lime	110
Blue shale	70
Sand and shale	40
Pepper and salt	50
Blue shale	132
First salt	5
First lime	108
Second salt	15
Second lime	10
Blue shale	50
Blue lime	15
Third salt	25
Third lime	10
Fourth salt	20
Fourth lime	10
Fifth salt	55
Broken lime	5
Sixth salt	155
Sixth lime	6
Seventh salt	24
Broken lime	5
Brown lime	40
Grey lime	20
Blue lime	94
Eighth salt	96
Grey lime	5
Brown lime	108
Dark-grey lime	20
Light-grey lime	20
Dark-grey lime	25
Light-grey lime	69
Dark shale	23
Dark lime	8
Blue shale	6
Red shale	35
Blue shale	61
Lime	33
Sandy lime	27
Blue shale	10
Red shale	115
Lime	15
Grey shale	480
Lime (Trenton)	970
Total depth	4,420

Gas at 2,540 feet.
Water at 4,420 feet.

SARNIA GAS CO., SARNIA
Lot 16, con. I, Moore tp.

Completed October 23, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	145
Huron	15
Hamilton	444
Onondaga and Detroit River	596
Salina	893
Guelph and Niagara	242
Rochester shale	32
Cabot Head	90
Manitoulin dolomite	63
Queenston shale	310
Hudson River	220
Utica shale	158
Trenton lime	957
Potsdam	13
Granite	2
Total depth	4,180

Showing of gas at 3,490 feet.
Showing of oil at 3,690 feet.
Water at 147 and 705 feet.

Middlesex County

JUDSON AND TRELEAVEN, PORT HURON, MICH.
Lot 17, con. XII, Metcalfe tp.

Completed May 29, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	79
Hardpan	4
Soap	20
Shale	35
Top rock	72
Soap	140
Middle lime	32
Soap	5
Lime	5
Struck soap and lime	26
Big lime	84
Total depth	502

JUDSON AND TRELEAVEN, PORT HURON, MICH.
Lot 20, con. XIII, Metcalfe tp.

Completed April 29, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	87
Hardpan	11
Shale	32
Soap	20
Top rock	45
Soap	170
Middle lime	25
Lower soap	19
Big lime	91
Total depth	500

ARCHIBALD TRELEAVEN, LONDON
Lot 19, con. XII, Metcalfe tp.

Completed July 22, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	73
Hardpan	6
Soap	24
Shale	35
Top rock	72
Soap	140
Middle lime	32
Soap	5
Lime	5
Struck soap and lime	26
Big lime	84
Total depth	502

SOUTHERN ONTARIO GAS CO., BUFFALO, N.Y.
Lot 6, con. VI, Mosa tp.

Completed December 16, 1929.
Dry hole.

Formation		Thickness, ft.
Surface (clay)		82
Soap		128
Middle lime		20
Lower soap		24
Big lime (Onondaga)		140
Detroit River	White and brown lime	296
	Sharp sand	155
	White lime	80
	Brown lime	18
Lime and shale		82
Salina	Brown and white lime, shale	260
	Salt	59
	Brown lime	12
	Salt	84
	Brown and grey lime with shale	229
	White lime and gypsum	20
Guelph and Niagara		156
Rochester shale		50
Brown shale and sand (Clinton)		5
Cabot Head	Red shale	5
	Grey shale	35
	Red shale	25
Manitoulin	Blue shale	30
	White Medina	25
Red shale (Queenston)		330
Blue shale (Dundas)		400
Brown shale (Utica)		115
Trenton		885
Arkose		5
Granite.		
Total depth		3,755

Oil at 154 feet.
Gas at 1,560 feet.
Salt water at 1,835 feet.

Norfolk County

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 5, con. III, Woodhouse tp.

Completed February 2, 1929.
Open flow: 70,000 cu. ft.
Rock pressure: 250 lbs.

Formation	Thickness, ft.
Surface	95
Brown lime	91
Flint	119
Mixed lime and shale	400
Niagara lime	231
Grey shale	60
Clinton sand	42
Red Medina sand	6
Blue shale	70
White Medina sand	10
Red shale	4
Total depth	1,128

Gas at 1,029 feet.

DOMINION NATURAL GAS CO., BUFFALO, N.Y.
Lot 2, B.F., Woodhouse gore

Completed February 2, 1929.
Open flow: 34,000 cu. ft.
Rock pressure: 490 lbs.

Formation	Thickness, ft.
Surface	167
Brown and grey lime	113
Flint	125
Lime	45
Shale	370
Niagara lime	210
Shale	67
Clinton sand	19
Red Medina	22
Blue shale	81
White Medina	8
Red shale-mud	6
Total depth	1,233

Gas at 1,138 feet.

Welland County

INDUSTRIAL NATURAL GAS CO., THOROLD
Lot 18, con. VII, Crowland tp.

Completed August, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	108
Lime and shale	132
Niagara	260
Shale	50
Clinton	27
Red Medina	70
Shale	25
White Medina	25
Red shale	6
Total depth	703

Trace of gas at 577 feet.

INDUSTRIAL NATURAL GAS CO., THOROLD
Lot 18, con. VII, Crowland tp.

Completed September 5, 1929.
Dry hole.

Formation	Thickness, ft.
Surface	108
Salina	132
Guelph and Niagara	240
Rochester shale	50
Clinton	27
Red Medina	70
Manitoulin	25
White Medina	25
Queenston	6
Total depth	683

PETROLEUM IN 1929

By R. B. Harkness

General

The production of petroleum in the year 1929 amounted to 121,125 barrels, valued at $253,678. This shows a loss of 13,039 barrels for the year, but a gain in value, owing to an increase in average price of 23 cents per barrel. Details of production by fields are given in Tables I and II.

The decrease in production is distributed generally throughout the fields of the province, none of which have shown a gain. The probable cause of this decrease has been the severe winter. The wells may be scattered over an area of a hundred acres or more, and the distance from the wells to the pumping plant may be as much as 400 yards. During a cold winter with a heavy snowfall, the rods (known as jerk lines) that run from the central pumping plant to the wells become covered with snow and ice. There were also 50 per cent. more wells abandoned in 1929 than in 1928. In addition, the spring floods, following the excessive snow, also caused more than the usual breaks in the casings and a consequent flood of fresh water, which delayed operations. The operators were discouraged to some extent by the reduction in price of the year before, and a number of them abandoned operations entirely. Other owners had their wells operated by sharing the profits with the operator. In most cases repairs were neglected.

TABLE I—OIL WELLS AND THEIR PRODUCTION, 1929

Field	Wells			Wells drilled		Production		Gain or loss in 1929		Average production per well per year
	Operating	Not operating	Abandoned	Producing	Dry			Gain	Loss	
						bbls.	gals.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	905	925	60	.....	.....	56,284	9	.....	4,263	62.6
Oil Springs	1,048	126	53	.....	.....	30,737	7	.....	4,915	29
Moore tp	21	76	11	.....	.....	1,229	31	.....	918	58.15
Sarnia tp	57	69	3	.....	.....	749	2	.....	474	12.32
Plympton tp	19	14	1	.....	.....	314	23	.....	56	16.19
Bothwell	265	38	15	.....	.....	23,236	8	.....	1,018	87.23
Dover West tp	2	.....	.....	.....	.....	714	30	.....	58	357.15
Raleigh tp	.....	6	.....	.....	.....	.....	.....	.....	.....	.....
Onondaga tp	21	16	.....	.....	.....	242	22	57	.....	11.19
Mosa tp	84	24	3	.....	.....	6,850	21	.....	417	81.19
Thamesville	8	20	.....	.....	.....	426	28	.....	579	53.12
Euphemia tp	.....	97	.....	.....	2	.....	.....	.....	.....	.....
Dunwich tp	10	89	.....	.....	.....	148	14	148	.....	14.29
Dawn tp	.....	40	.....	.....	.....	.....	.....	.....	.....	.....
Brooke tp	2	1	.....	.....	.....	52	2	52	.....	26.1
Tilbury East tp	1	.....	.....	.....	.....	138	21	.....	598	138.21
Other fields	.....	1	.....	1	11	.....	.....	.....	.....	.....
Total	2,443	1,542	146	1	13	121,125	8	257	13,296	.....
								Net loss, 13,039		

TABLE II—OIL PRODUCED IN ONTARIO BY FIELDS, 1922-1929

Field	1922	1923	1924	1925	1926	1927	1928	1929
	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.	bbls.
Petrolia and Enniskillen	64,935	64,159	60,916	53,166	55,485	59,424	60,547	56,284
Oil Springs	43,214	39,090	41,320	39,137	38,349	37,281	35,653	30,737
Moore tp.	7,275	4,790	4,483	8,195	2,438	2,112	2,148	1,230
Sarnia tp.	3,224	2,387	2,068	1,905	1,890	1,590	1,221	749
Plympton tp.	695	872	525	1,424	1,047	1,241	371	315
Bothwell	25,681	27,665	26,700	26,243	25,382	25,224	24,255	23,236
Tilbury East tp.	127	1,950	.....	.....	.....	60	736	138
Dover West tp.	5,482	5,618	3,898	2,957	959	602	773	715
Raleigh tp.	663	302	783	887	676	276	.....	.....
Onondaga tp.	489	237	456	261	361	210	186	243
Mosa tp.	11,959	10,319	8,862	8,397	7,868	7,447	7,268	6,851
Thamesville	384	567	.....	289	2,376	4,139	1,006	427
Euphemia tp.	.....	.....	.....	39	.....	.....	.....	.....
Dunwich tp.	387	594	1,351	1,001	139	.....	.....	148
Dawn tp.	217	.....	.....	.....	.....	.....	.....	.....
Romney tp.	.....	849	2,955	1,235	.....	.....	.....	.....
Brooke tp.	.....	.....	.....	.....	.....	.....	.....	52
Total	164,732	159,399	154,317	144,249	136,971	139,606	134,164	121,125
Value	$466,587	$395,300	$390,423	$369,154	$376,822	$289,391	$249,981	$253,678
Average price	$2.65	$2.47	$2.51¼	$2.56	$2.73	$2.11	$1.86	$2.09

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.

The capital invested in operating oil wells and the equipment pertaining to these is $1,990,801. The number of men employed operating the wells shown in Table I is 134, and the wages paid to them $103,519. This information has been supplied by the Dominion Bureau of Statistics, Ottawa.

Refining Operations

Four refineries were in operation in the year 1929 and worked at full capacity, giving the greatest output of refined products in the history of Canadian refining operations.

PETROLEUM REFINERIES, 1929

Company	Location of refinery	Head office address	Days operated
British American Oil Co., Ltd.	Foot of Cherry St., Toronto	Royal Bank Bldg., Toronto	304
Canadian Oil Companies, Ltd.	Petrolia	Excelsior Life Bldg., Toronto	365
Imperial Oil Refineries, Ltd.	Sarnia	Sarnia	365
McColl Bros.	Foot of Cherry St., Toronto	114 Don Esplanade, Toronto	365

The total number of employees for the year was 2,312; the salaries and wages paid amounted to $3,657,619; and the capital invested was $26,784,547.

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 1929. 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 January 25	$2.00
January 26 to April 25	1.90
April 26 to May 20	2.05
May 21 to June 30	2.20
July 1 to December 31	2.10

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.

Products of Ontario Refineries

Table III gives a summary of the output of the refineries in Ontario in the year 1929. It will be noted that the proportion of Ontario crude refined to the total refined has fallen to 1.35, the lowest yet in the history of the industry, while the imported crude has increased over the previous year.

The value of refined products shows an increase of about $5,000,000 per year over the past two years, which, with the imported refined products, shows a total consumption of 53,107,070, or $8,000,000 more than in 1928. This is the value at wholesale prices, delivered at wholesalers' warehouses.

TABLE III—PETROLEUM REFINING OPERATIONS, 1925-1929

Schedule	Unit of measure	1925	1926	1927	1928	1929
Canadian crude produced	Gallons[1]	5,024,770	4,693,999	4,886,199	4,695,714	4,239,383
	Value	$369,154	$376,822	$289,391	$266,346	$253,678
Imported crude distilled	Gallons	161,895,295	183,347,749	218,200,977	257,929,514	321,687,678
	Value	$13,056,823	$16,940,505	$15,900,079	$17,617,756	$23,341,514
Canadian crude distilled	Gallons	4,859,148	5,017,500	5,205,097	4,484,858	4,426,863
	Value	$358,245	$422,159	$363,320	$283,959	$292,949
Percentage of total		2.92	2.66	2.33	1.71	1.35
PRODUCTS						
Gasoline	Gallons	73,083,022	84,936,377	100,944,586	122,792,092	151,160,958
	Selling value	$11,032,134	$14,983,322	$13,641,570	$18,199,305	$21,698,302
Illuminating oil	Gallons	18,677,629	8,088,787	23,712,369	21,304,385	19,138,614
	Selling value	$2,222,569	$1,266,577	$2,828,872	$2,650,877	$2,516,618
Lubricating oil	Gallons	13,297,275	16,025,753	17,040,724	16,822,292	20,452,106
	Selling value	$2,364,320	$3,540,786	$3,237,375	$2,813,371	$3,707,592
Engine distillate and naphtha	Gallons		53,869	4,045,416	3,062,787	5,845,447
	Selling value		$10,774	$510,960	$445,526	$811,240
Gas and fuel oil	Gallons	46,064,129	41,883,125	53,767,638	76,469,354	99,035,616
	Selling value	$2,947,378	$2,949,770	$3,280,343	$4,104,338	$5,016,370
Tar and grease	Pounds	9,301,674	11,260,812	11,254,706	14,626,752	18,078,346
	Selling value	$177,474	$221,826	$221,694	$267,563	$325,206
Paraffin wax and candles	Pounds	15,502,029	9,858,490	9,526,072	17,030,064	10,784,609
	Selling value	$734,322	$648,303	$505,133	$599,341	$538,233
Acid and petroleum coke	Short tons	31,501	45,774	44,768	49,409	67,599
	Value	$212,085	$265,481	$282,828	$314,794	$396,565
Acid oil	Gallons	1,858,176	711,970	768,171	[2]	[2]
	Value	$85,761	$35,823	$46,634	[2]	[2]
Still gas	M cu. ft.	431,713	630,325	811,666	823,320	1,103,142
	Value	$167,869	$256,935	$207,370	$185,595	$270,479
Asphalt	Gallons			1,060,761	1,276,098	2,664,199
	Selling value			$58,919	$65,003	$137,714
Miscellaneous	Value	$1,596	$2,978	$434,655	$387,544	$258,113
Total value of refined products		$19,945,508	$24,182,575	$25,256,353	$30,033,257	$35,676,432
Employees	Average No.	2,165	2,241	1,871	1,853	2,313
	Wages	$2,702,034	$2,876,150	$2,883,575	$3,013,872	$3,657,619
Capital invested		$16,372,960	$20,441,740	$19,354,638	$19,570,531	$26,784,547

[1]Gallons refer to Imperial gallons.
[2]Included in acid coke.

Petroleum and Refined Products Imported

Table IV shows the quantity and value of refined products imported into Ontario during the years 1928 and 1929. This tabulation shows a general increase, particularly in refined gasoline. Lubricating oils have not shown a corresponding increase; this apparently is due to the increase in production in our own refineries.

The petroleum products imported into Ontario would equal the output of an average refinery.

TABLE IV—PETROLEUM AND REFINED PRODUCTS IMPORTED IN 1928 AND 1929[1]

Import	1928		1929	
	Imperial gallons	Value	Imperial gallons	Value
CRUDE PETROLEUM:				
Petroleum, 0.790 specific gravity or heavier, for refining	260,328,023	$11,588,107	328,662,742	$15,857,155
REFINED PETROLEUM:				
For use in concentrating ores	4,877	$2,890	3,762	$2,406
Gasoline lighter than 0.725 specific gravity (casing-head gasoline)	51,505,215	5,668,996	60,813,222	6,083,445
Gasoline between 0.770 and 0.725 specific gravity and other gasoline	9,312,836	1,064,398	16,791,277	1,910,086
Kerosene and illuminating oils	1,863,101	162,494	2,102,344	172,629
Gas oils, between 0.8235 and 0.775 specific gravity, other than naphtha and benzine	40,787	4,088	11,736	1,188
Lubricating oil consisting wholly or in part of petroleum, costing less than 25 cents per gallon	2,307,134	380,503	2,617,988	446,677
Lubricating oils, all other	3,841,470	1,482,804	4,009,183	1,706,904
Fuel oil, 0.8235 specific gravity and heavier	9,029,113	586,014	7,317,164	447,084
All other oils	158,019	88,258	153,421	96,101
Total	78,062,552	$9,440,445	93,820,097	$10,866,520
PETROLEUM PRODUCTS:				
Axle grease.....lbs.	2,604,351	$118,581	2,577,524	$117,144
Vaseline, toilet and medicinal petroleum	.....	121,687	.....	153,117
Paraffin wax.....lbs.	1,324,590	71,047	1,554,440	64,444
Paraffin wax candles.....lbs.	213,560	47,778	305,700	58,474
Other petroleum products.....gals.	1,735,097	309,136	1,477,860	239,496
Total	.....	$668,229	.....	$632,675
Total value	.....	$21,696,781	.....	$27,356,350

[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 1929	$27,356,350
Duty paid on the above, calculated on the existing tariff schedule	872,194
Sales tax at 2 per cent. on taxable items	221,042
Freight, approximately	12,765,155
Total value delivered in Ontario	$41,214,741

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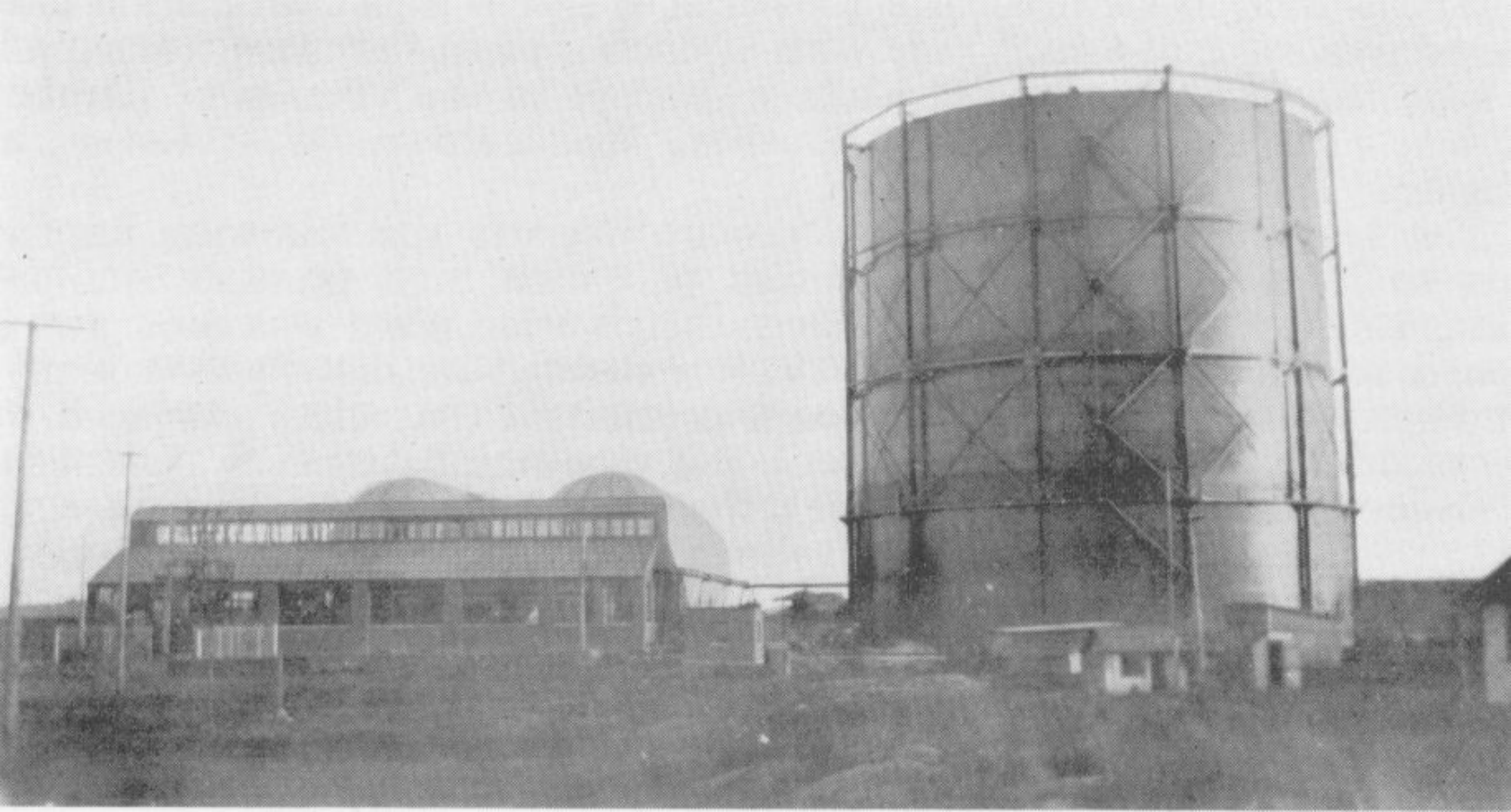
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PROVINCE OF ONTARIO
DEPARTMENT OF MINES

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

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INVESTIGATIONS OF NON-METALLIC MINERAL RESOURCES OF ONTARIO, 1929

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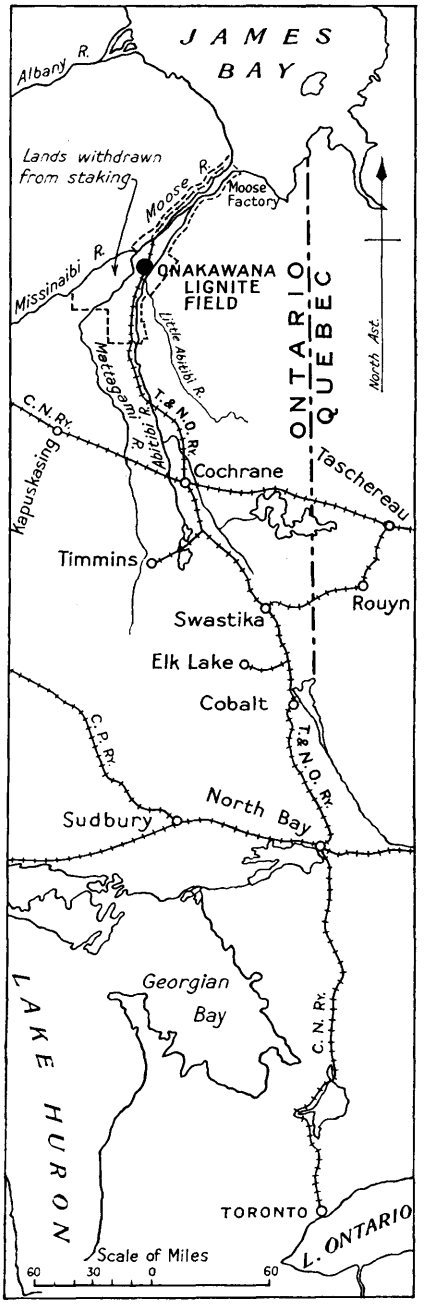


Fig. 1—Key map showing location of the Onakawana lignite deposit and the areas withdrawn from staking by Order-in-Council.

The Onakawana Lignite Deposit, Moose River Basin

(Progress Report to May 31, 1930)

By W. S. Dyer

Introduction

In previous reports of the Ontario Department of Mines[1] the exposures of lignite on the rivers in the Moose River basin were described and the geology of the Cretaceous sediments in which they occur was discussed. One paper also gave the results of tests performed by officials of the Fuel Testing Laboratories, Mines Branch, Department of Mines, Ottawa, on lignite collected by the Ontario Department of Mines at the outcrop at Blacksmith Rapids (now known as Onakawana) on the Abitibi river. The



View of the Onakawana river.

present paper gives the results of the drilling and shaft-sinking programme carried out by the Ontario Department of Mines in 1929 and up to May 31, 1930.

Early in 1929, the Ontario Legislature voted $25,000 for the carrying out of a drilling programme in the Moose River basin. The original programme included five holes in the vicinity of Blacksmith rapids: Four were to be short holes in search of lignite and the fifth, a deeper one to the granite, was to determine the thickness and character of the sedimentary formations and to test for oil or gas. Afterwards, similar series of holes were to be drilled on the Moose, Mattagami, and Missinaibi rivers. The success at Blacksmith rapids was such that the drills have been kept continuously drilling short holes to explore the lignite area; even the deep hole to the granite has been postponed.

[1]Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928; Vol. XXXVIII, pt. 4, 1929.

Acknowledgments

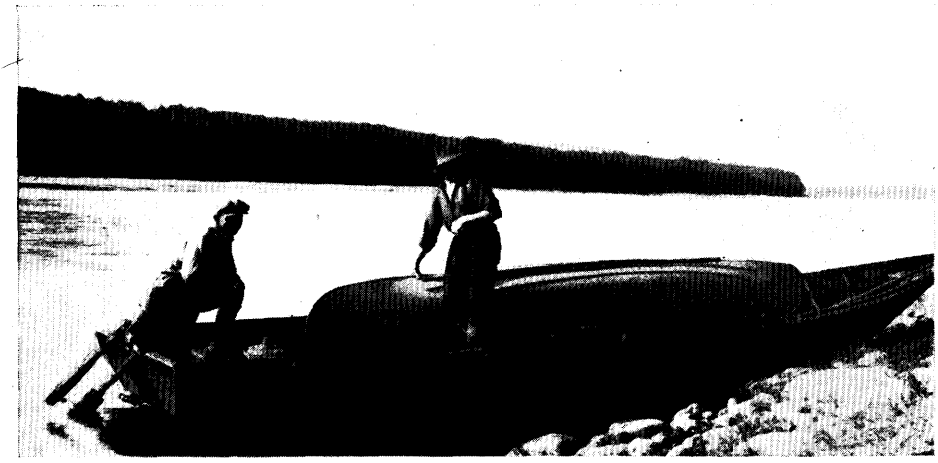
The writer wishes to acknowledge the valuable service rendered by his assistants, particularly A. R. Crozier, A. D. Williams, and B. C. Coles.

Progress in Exploration

Drilling commenced on June 21, 1929, and 50 holes have been completed. Drilling was continuous until October 31, when transportation became so difficult that work was suspended until January, 1930. For the first four months in 1930 two drills were at work where one had formerly been used.

By October, 1929, drilling results were so promising that a further allowance was voted for exploratory work, including shaft-sinking, and mining lignite for test purposes. The following is a summary of results:—

1. Fifty holes have been drilled, with an average depth of about 135 feet. Forty of these holes have struck lignite, and in 34 of them 10 feet or more of lignite has been penetrated.



Abitibi river at the Onakawana lignite field, showing method of river transportation.

2. Approximately three square miles of territory has been proved to be underlain by the lignite seam, or seams, averaging between 20 and 25 feet in thickness. In one group of 7 holes, within an area of 250 acres, the seam averaged 45 feet in thickness; and in the best hole the seam was 64 feet thick.

3. Drilling is being continued and possibilities to the west of the proved field are not exhausted.

4. A 35-mile winter road was cut out from Coral rapids to the camp. Over this road tractors and teams hauled in mining equipment and supplies, and hauled out lignite.

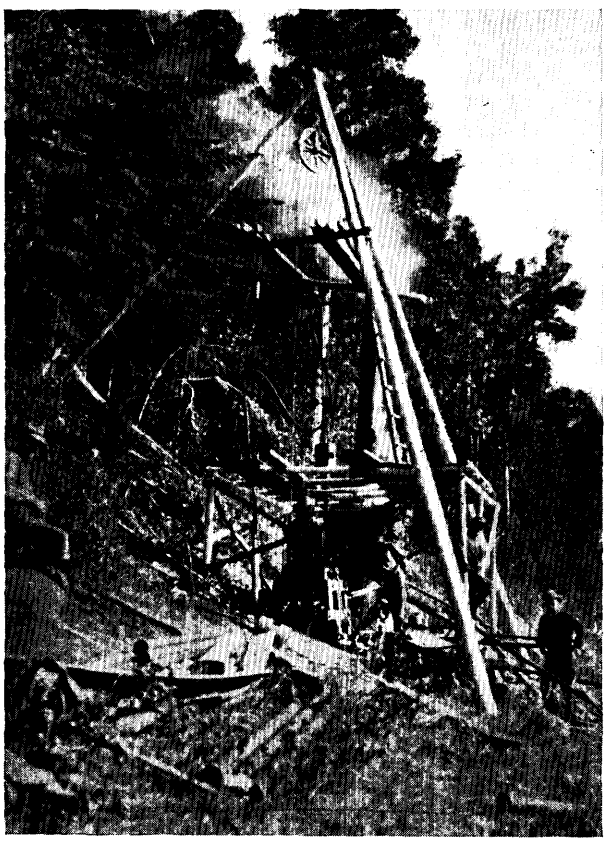
5. Fourteen buildings have been erected, at headquarters, at the halfway, and at the former end of steel, including quarters for the staff and men, cook cabins, storehouses, stables, and a blacksmith's shop.

6. One shaft was sunk 77 feet, the lower 23 feet of which was in lignite; 125 feet of drifting was done, and over 300 tons of lignite were mined. Shaft-sinking equipment includes hoists, boilers, a 310 cubic foot gasoline-driven compressor, and the necessary pumps and other mining equipment. The shaft is double-compartment, 11- by 6-foot outside measurements; 8- by 8-inch sawn timber is used, the setts are $4\frac{1}{2}$-foot centres, and the lagging is 6 by 3 inches.

Geology of the Field

The geological formations in the Onakawana lignite field, as made known by drilling, with their maximum thickness, are as follows:—

	Feet
PLEISTOCENE:	
Marine clay	18
Boulder clay and interglacial sands and stratified clay	130
LOWER CRETACEOUS or UPPER JURASSIC (Mattagami formation):	
Lignite	64
Dark-grey to light-grey plastic clay	155
UPPER DEVONIAN (Long Rapids formation):	
Dark-brown and greenish-grey shales	17+



Diamond-drill in operation on the bank of the Abitibi river, Onakawana lignite field, 1929.

Judging by outcrops observed generally in the Moose River basin, the formations expected to underlie the Cretaceous are as follows:—

UPPER DEVONIAN:	
Long Rapids formation:	Bituminous, dark-grey shale.
Williams Island formation:	Limestone and calcareous shale.
MIDDLE DEVONIAN:	
Abitibi River formation:	Grey fossiliferous limestone.
LOWER DEVONIAN (?):	
Moose River formation:	Limestone and gypsum.

The Moose River formation will doubtless be found to be underlain first by other limestones, shales, or sandstones, possibly of Silurian age, and

then by the pre-Cambrian granites, gneisses, etc. Owing to the lack of good outcrops very little has been learned of the thicknesses of the formations, but it is thought that at least 800 feet of sediments should overlie the pre-Cambrian in the lignite field.

The Cretaceous sediments and the lignite lie in a structural basin, the boundaries of which are indefinite and must be determined by drilling. So far, it has not been determined whether this basin was formed before or after the deposition of the Cretaceous.

Similar basins are indicated by outcrops of Cretaceous clay, sands, and lignite, and by structural features indicative of basins, on the Mattagami and Missinaibi rivers. It is possible that these three basins are actually parts of one large basin, but this can only be proved by drilling.

The Cretaceous age of the fire clays and lignites of the Mattagami river was first suggested by Joseph Keele, of the Geological Survey of Canada, and was later corroborated by the work of McLearn and Bell of the same organization. The suggestion that the Cretaceous sediments lay in structural basins, and the fact that the lignite and associated clays of the Abitibi were Cretaceous rather than interglacial, was the work of the Ontario Department of Mines.

Description of the Lignite Seam

The lignite seam, or series of seams, at Onakawana is nearly flat-lying, and in the great majority of drill-holes has been found to be overlain by boulder clay and underlain by dark-grey plastic clay of Cretaceous age. In the western part of the field, the lignite appears to consist of two main seams separated by a belt of fire clay from 1 to 26 feet thick. Drilling has proceeded to sufficient depth to preclude the occurrence of deeper seams. The thickness of the lignite and of the overburden at each drill-hole is shown on the accompanying plan (Fig. 3), as well as in the summary of logs.

Erosion by the continental ice-sheet has been erratic. The ice-sheet has closely overridden the lignite seam and has cut varying distances into it in different parts of the field. This is well shown in the accompanying cross-sections (Figs. 4 and 5). At certain points, particularly toward the eastern end of the field, the ice-sheet has completely carried away the lignite, leaving nothing but boulder clay in its place. It is more than probable that before glacial erosion took place, the seam was more extensive and more uniform in thickness.

It is this same erratic erosion that forms the greatest difficulty in exploratory work in the field. There is nothing on the surface to indicate the thickness of the boulder clay, hence, it is very difficult, if not impossible, to foretell before drilling whether the seam will have escaped erosion or not.

The contour map (Fig. 7) based on the bottom of the lignite seam shows that the seam is not flat, but that it dips to the northwest in places (between drill-holes Nos. 27 and 35) as much as 70 feet in less than a half a mile, and that there are two well-marked embayments, one in the vicinity of holes Nos. 1, 9, and 10, and one at holes Nos. 35, 37, and 38.

Quality of the Lignite

The following is a report received from R. E. Gilmore, Superintendent of the Fuel Research Laboratories, Mines Branch, Department of Mines, Ottawa, on analysis of the first car-load ever shipped from the mine:—

The car-lot sample of lignite coal shipped by the Onakawana Coal Company, as per arrangements with Mr. T. F. Sutherland and Dr. W. S. Dyer, Deputy Minister and Geologist, respectively, of the Ontario Department of Mines, with the Mines Branch (Ottawa) was sampled on arrival according to the usual procedure for such shipments. The bulk sample so obtained showed the following analysis:—

	As received	Air-dried	Dry basis
PROXIMATE ANALYSIS:			
Moisture	51.8	18.3	.....
Ash	6.9	11.7	14.3
Volatile matter	19.6	33.2	40.7
Fixed carbon	21.7	36.8	45
Total	100	100	100
ULTIMATE ANALYSIS:			
Carbon	29.9	50.8	62.1
Hydrogen	7.8	5.4	4.1
Ash	6.9	11.7	14.3
Sulphur	1	1.7	2.1
Nitrogen	.3	.5	.7
Oxygen (by difference)	54.1	29.9	16.7
Total	100	100	100
CALORIFIC VALUE:			
B.t.u. per pound	5,020	8,510	10,410

The reserve part of the bulk sample, after being spread out on the floor for from 48 hours for the larger lumps to 72 hours for the fines, was screened and the following results obtained:—

	Weight	Percentage of total partially air-dried lignite
	pounds	
Large lumps on 1½-inch screen	143	30
Smaller lumps through 1½-inch on ½-inch screen	116	24
Smalls through ½-inch on 6-mesh screen	119	25
Fines through 6-mesh screen	100	21
Total	478	100

COMPARATIVE PROXIMATE ANALYSES OF DIFFERENT SCREEN SIZES

Laboratory designation	6751	A-B	C	D	
Description	Bulk ample	Lumps on 1½-inch screen	Lumps on ½-inch screen	Smalls on 6-mesh screen	Fines through 6-mesh screen
AS RECEIVED OR PARTIALLY AIR-DRIED BASIS:					
Moisture	51.8	48.4	46.7	46.5	47.9
Ash	6.9	5.2	6.7	9.8	10.6
Volatile matter	19.6	22.8	26	22.4	19.8
Fixed carbon	21.7	23.6	20.6	21.3	21.7
B.t.u. per pound	5,020	5,580	5,550	.....	.....
AIR-DRIED AT 60 PER CENT. (ROOM TEMPERATURE) HUMIDITY:					
Moisture	18.3	19.9	19	19.1	18.3
Ash	11.7	8	10.1	14.8	16.7
Volatile matter	33.2	35.4	39.5	33.9	31
Fixed carbon	36.8	36.7	31.4	32.2	34
B.t.u. per pound	8,510	8,670	8,430	.....	.....
CALCULATED TO DRY BASIS:					
Ash	14.3	10	12.5	18.3	20.4
Volatile matter	40.7	44.2	48.8	41.9	37.9
Fixed carbon	45	45.8	38.7	39.8	41.7
Sulphur	2.1	1.1	1.4	2.8	2.6
B.t.u. per pound	10,410	10,810	10,410	.....	.....
CALORIFIC VALUE—DRY AND ASH-FREE BASIS:					
B.t.u. per pound	12,150	12,000	11,900	.....	.....

The "bulk" sample taken at the time the car-lot was unloaded was frozen, and only after allowing it to thaw out and to air dry partially was it feasible to conduct a screen analysis, for which a reduction of the moisture content to at least 45 per cent. or so is desirable. The moisture content, when crushed and dried at 60 per cent. humidity, averaged roughly 19 per cent.; and the ash content, on the dry basis, varied from 10 per cent. in the larger lumps to 20 per cent. in the fines. The comparatively high ash content of the bulk sample was apparently due to the presence of clayey material, either from partings in the coal seam or from refuse material in the shaft at the time of mining.

Additional analyses made by the Chemical Branch of the Ontario Department of Mines are as follows:—

Description	As received basis	Dry basis				
	Moisture	Fixed carbon	Volatile matter	Ash	Sulphur	B.t.u.
	per cent.	per cent.	per cent.	per cent.	per cent.	
Shaft No. 1, depth 64 feet	49.15	43.60	49.36	7.04	2.20	11,590
Shaft No. 1, drift 1A:						
0–2 feet	50.02	46.04	44.67	9.29	.75	10,333
2–4 feet	50.06	46.27	44.98	8.75	.87	10,345
4–6 feet	51.88	47.24	44.69	8.07	1.02	10,459
6–7 feet	49.49	44.78	46.78	8.44	1.01	10,428
Pocket of fines	54.44	46.28	46.18	7.54	.56	10,480
Shaft No. 1, side wall of drift 75 feet from shaft	50.13	44.05	48.58	7.37	1.31	10,551
Shaft No. 1, roof of drift under clay parting	49.97	44.31	44.07	11.62	2.76	10,008

The above analyses show that the lignite is high in moisture but comparatively low in ash and sulphur. It is, perhaps, more nearly comparable to the lignite from the Estevan field of southern Saskatchewan than to any other coal in this country. The analyses on the "air-dried" and "dry" basis of the Onakawana lignite is quite close to that of the Estevan lignite, but Onakawana lignite contains about 15 per cent. more moisture as mined and is physically different, presenting a more immature appearance.

The lignite as it occurred in the shaft and drifts was clean and uniform practically throughout. Pockets of fines, however, were present in one or two places in the drifts. It is thought that this material marks the position of fractures in the seam caused by settling due to the load of the ice-sheet. At one place, a pocket of clay varying from 2 feet to 6 inches in width runs diagonally through the seam. This pocket probably represents a fracture filled with Cretaceous clay intruded from above the seam. Cretaceous clay was found to overlie the seam at this point, although boulder clay overlies it at the shaft. The coal was well bedded parallel to the seam. Two types of lignite occur, the woody and the peaty. The woody material consists of lignified trunks and branches of trees and makes up about half the seam. The peaty type is lignified vegetable debris. In the outcrop, the woody material remains more or less intact, while the peaty material is broken down into fines. Much "mother of coal" was found along the bedding planes of the peaty material. The origin of the lignite is thought to be the ordinary one for most of the large seams of the world; that is, *in situ*, and under swamp conditions.

Logs of Drill-Holes

The logs of the 50 drill-holes, in summarized form, are as follows:—

DRILL-HOLE No. 1

	Feet
Boulder clay	0–42
LIGNITE	42–56
Brown to black plastic clay (Cretaceous)	56–61
Grey plastic clay (Cretaceous)	61–190
Brown shales (Upper Devonian)	190–210

DRILL-HOLE No. 2

	Feet
Boulder clay and sand	0–114
Cretaceous clay	114–156

DRILL-HOLE No. 3

	Feet
Boulder clay	0–100

DRILL-HOLE No. 4

	Feet
Boulder clay	0–35
Light-grey Cretaceous clay	35–100

DRILL-HOLE No. 5

	Feet
Boulder clay, sand, and gravel	0–75
Light-grey Cretaceous clay	75–132
Brown shales (Upper Devonian)	132–144

DRILL-HOLE No. 6

	Feet
Muskeg	0–2
Soft, grey clay (Marine Champlanian)	2–8
Boulder clay	8–35
Dark-grey to brown Cretaceous clay	35–54
LIGNITE	54–75
Dark-grey Cretaceous clay	75–81
Grey, sandy clay	81–88

DRILL-HOLE No. 7

	Feet
Muskeg	0–2
Marine clay	2–20
Boulder clay and sand	20–123
Light-grey Cretaceous clay	123–210
Brown shale (Upper Devonian)	210–227

DRILL-HOLE No. 8

	Feet
Muskeg	0–2
Marine clay	2–14
Boulder clay and sand	14–78
LIGNITE	78–80
Dark-grey Cretaceous clay	80–92
Light-grey Cretaceous clay	92–108

DRILL-HOLE No. 9

	Feet
Muskeg	0–2
Marine clay	2–5
Boulder clay	5–51
LIGNITE	51–59
Boulder clay and lignite	59–66
LIGNITE	66–90
Dark-grey Cretaceous clay	90–96
Light-grey Cretaceous clay	96–100

DRILL-HOLE No. 10

	Feet
Muskeg	0–2
Marine clay	2–6
Boulder clay and stratified clay	6–61
LIGNITE	61–97
Dark-grey Cretaceous clay	97–103
Light-grey Cretaceous clay	103–120

DRILL-HOLE No. 11

	Feet
Marine silt	0–10
Gravel and sand	10–15
Boulder clay and stratified clay	15–54
LIGNITE	54–77
Grey Cretaceous clay	77–78
LIGNITE	78–79
Light-grey Cretaceous clay	79–107

DRILL-HOLE No. 12

	Feet
River sands and silts	0–10
Boulder clay, gravel, and sand	10–82
LIGNITE	82–100
Dark-grey Cretaceous clay	100–108
Light-grey Cretaceous clay	108–115

DRILL-HOLE No. 13

	Feet
River sands and silts	0–12
Boulder clay, sand, and gravel	12–82
LIGNITE	82–95
Dark-grey Cretaceous clay	95–100
Light-grey Cretaceous clay	100–113

DRILL-HOLE No. 14

	Feet
River silts	0–14
Boulder clay and sand	14–67
LIGNITE	67–75
Black Cretaceous clay	75–81
LIGNITE	81–97
Black Cretaceous clay	97–102

DRILL-HOLE No. 15

	Feet
River silts	0–4
Boulder clay and sand	4–74
Dark-grey Cretaceous clay	74–84
LIGNITE	84–98
Dark-grey Cretaceous clay	98–112
Light-grey Cretaceous clay	112–114

DRILL-HOLE No. 16

	Feet
Boulder clay and stratified clay	0–83
LIGNITE	83–102
Dark-grey Cretaceous clay	102–120
Light-grey Cretaceous clay	120–257
Brown shale (Upper Devonian)	257–270

DRILL-HOLE No. 17

	Feet
River sand	0–15
Boulder clay, sand, and stratified clay	15–86
Black Cretaceous clay	86–92
LIGNITE	92–105
Dark-grey Cretaceous clay	105–115
Light-grey Cretaceous clay	115–116

DRILL-HOLE No. 18

	Feet
Marine clay	0–8
Boulder clay, gravel, and stratified clay	8–66
LIGNITE	66–67
Black Cretaceous clay	67–68
Sand	68–70
Light-grey Cretaceous clay	70–90

DRILL-HOLE No. 19

	Feet
River silt	0–8
Boulder clay and stratified clay	8–114
Dark Cretaceous clay	114–115
Grey Cretaceous clay	115–126
Light-grey Cretaceous clay	126–130

DRILL-HOLE No. 20

	Feet
River silts	0–8
Boulder clay and sand	8–94
Sand with fragments of lignite	94–104
Sand	104–140

DRILL-HOLE No. 21

	Feet
Muskeg	0–1
Grey, soft clay (Marine Champlanian)	1–12
Boulder clay and stratified clay	12–62
Mixed lignite and Cretaceous clay	62–64
LIGNITE	64–78
Black Cretaceous clay	78–92
White sand with fragments of lignite	92–100
Light-grey Cretaceous clay	100–110

DRILL-HOLE No. 22

	Feet
Recent clay, gravel, and sand	0–12
Sand and stratified clay	12–56
Boulder clay	56–66
Light-grey Cretaceous clay	66–170
Brown shale (Upper Devonian)	170–182

DRILL-HOLE No. 23

	Feet
Marine clay	0–15
Boulder clay and sand	15–112
Black Cretaceous clay, grading into grey Cretaceous clay	112–130

DRILL-HOLE No. 24

	Feet
Muskeg	0–4
Marine clay	4–20
Boulder clay and stratified clay	20–94
Mixed black Cretaceous clay and lignite	94–98
LIGNITE	98–110
Dark-grey Cretaceous clay	110–114
Light-grey Cretaceous clay	114–120

DRILL-HOLE No. 25

	Feet
Muskeg	0–4
Marine clay	4–12
Boulder clay and stratified clay	12–81
Black Cretaceous clay	81–82
LIGNITE	82–92
Black Cretaceous clay	92–100
Light-grey Cretaceous clay	100–110

DRILL-HOLE No. 26

	Feet
Muskeg	0–3
Marine clay	3–10
Sand	10–22
Boulder clay and sand	22–67
Black Cretaceous clay with many fragments of lignite	67–70
LIGNITE	70–92
Interstratified lignite and clay	92–97
Dark-grey Cretaceous clay	97–105
Light-grey Cretaceous clay	105–110

DRILL-HOLE No. 27

	Feet
River silts	0–8
Boulder clay, interglacial stratified clay, and sand and gravel	8–69
LIGNITE	69–71
Black Cretaceous clay	71–73
Light-grey Cretaceous clay with a few fragments of lignite	73–85
Light-grey Cretaceous clay	85–100

DRILL-HOLE No. 28

	Feet
Muskeg	0–4
Marine clay	4–10
Marine silt	10–20
Boulder clay, sand, and gravel	20–86
Reworked Cretaceous clay, boulder clay, and fragments of lignite	86–110
LIGNITE	110–122
Cretaceous clay and lignite, probably thin layers of each	122–127
Black Cretaceous clay	127–129
Light-grey Cretaceous clay	129–131

DRILL-HOLE No. 29

	Feet
Muskeg	0–4
Marine clay	4–13
Boulder clay and interglacial clay	13–66
Black Cretaceous clay	66–74
LIGNITE	74–112
Dark Cretaceous clay	112–113
LIGNITE	113–132
Dark Cretaceous clay	132–136
Light-grey Cretaceous clay	136–140

DRILL-HOLE No. 30

	Feet
Muskeg	0–2½
Marine clay	2½–13
Boulder clay and interglacial stratified clay	13–49
Boulder clay, reworked Cretaceous clay, and fragments of lignite	49–114
Light-grey Cretaceous clay	114–130

DRILL-HOLE No. 31

	Feet
Muskeg	0–3
Marine clay	3–11
Boulder clay, sand, gravel	11–77
LIGNITE	77–92
Dark Cretaceous clay	92–105
Grey Cretaceous clay, with possibly a 6-inch seam of lignite	105–110
Light-grey Cretaceous clay	110–115

DRILL-HOLE No. 32

	Feet
Muskeg	0–3
Marine clay	3–10
Sand and gravel	10–33
Boulder clay	33–82
LIGNITE	82–85½
Black Cretaceous clay	85½–95
Light-grey Cretaceous clay	95–105

DRILL-HOLE No. 33

	Feet
Muskeg	0–4
Marine clay	4–12
Boulder clay and stratified clay	12–71
Black to dark-grey Cretaceous clay and lignite	71–77
LIGNITE	77–83½
Black Cretaceous clay	83½–95
LIGNITE	95–137
Black Cretaceous clay	137–145
Light-grey Cretaceous clay	145–147

DRILL-HOLE No. 34

	Feet
Muskeg	0–3½
Marine clay	3½–11
Boulder clay, stratified clay and sand	11–72
Black Cretaceous clay and sand (probably falling in from above)	72–82
LIGNITE and a little sand or gravel (probably falling in from above)	82–84
LIGNITE	84–105
Black Cretaceous clay	105–110
LIGNITE	110–130
Black Cretaceous clay	130–140
Light-grey Cretaceous clay	140–143

DRILL-HOLE No. 35

	Feet
Muskeg	0–5
Marine clay	5–10
Sand	10–15
Boulder clay, sand, stratified clay	15–76
Grey Cretaceous clay	76–90
Dark Cretaceous clay	90–102
LIGNITE	102–125
Light-grey Cretaceous clay	125–126
LIGNITE	126–156
Dark-grey to light-grey Cretaceous clay	156–160

DRILL-HOLE No. 36

	Feet
Muskeg	0–5
Marine clay	5–10
Boulder clay, gravel	10–72
Black Cretaceous clay	72–74
LIGNITE	74–117
Grey Cretaceous clay	117–124
LIGNITE	124–145
Dark-grey Cretaceous clay	145–150
Light-grey Cretaceous clay	150–152

DRILL-HOLE No. 37

	Feet
Muskeg	0–3
Marine clay	3–12
Boulder clay, sand, and gravel	12–72
Cretaceous clay and LIGNITE	72–77
LIGNITE	77–97
Cretaceous clay	97–116
Sand, white and clean	116–121
LIGNITE and sand	121–123
LIGNITE	123–152
Dark-grey Cretaceous clay	152–158
Light-grey Cretaceous clay	158–160

DRILL-HOLE No. 38

	Feet
Muskeg	0–4
Marine clay	4–21
Boulder clay, stratified clay and sand	21–98
LIGNITE	98–110
Grey Cretaceous clay	110–112
Sand, white and clean	112–129
LIGNITE	129–133
Grey Cretaceous clay	133–135
LIGNITE	135–152
Dark-grey Cretaceous clay	152–156
Light-grey Cretaceous clay	156–157

DRILL-HOLE No. 39

	Feet
Muskeg	0–4
Marine clay	4–14
Boulder clay, sand, stratified clay	14–104
Dark Cretaceous clay with fragments of lignite	104–107
White sand	107–118
LIGNITE	118–134
Dark Cretaceous clay	134–143
Light-grey Cretaceous clay	143–150

DRILL-HOLE No. 40

	Feet
Muskeg	0–3
Marine clay	3–15
Boulder clay, sand, and stratified clay	15–120
LIGNITE	120–122
Dark-grey Cretaceous clay	122–130
LIGNITE	130–148
Dark-grey Cretaceous clay	148–152
Light-grey Cretaceous clay	152–154

DRILL-HOLE No. 41

	Feet
Muskeg	0–4
Marine clay	4–18
Boulder clay, sand, and gravel	18–106
LIGNITE	106–108
Cretaceous clay	108–110
LIGNITE	110–135
Black Cretaceous clay	135–136
LIGNITE	136–137
Black Cretaceous clay	137–139
Cream-coloured Cretaceous clay	139–148
Light-grey Cretaceous clay	148–155

DRILL-HOLE No. 42

	Feet
Muskeg	0–4
Marine clay	4–20
Boulder clay, stratified clay, sand, and gravel	20–136
LIGNITE	136–154
Grey Cretaceous clay	154–156
Light-grey Cretaceous clay	156–158

DRILL-HOLE No. 43

	Feet
Muskeg	0–4
Sand and gravel with a little clay	4–20
Boulder clay	20–94
LIGNITE	94–109
Dark-grey Cretaceous clay	109–114
LIGNITE	114–130
Dark-grey Cretaceous clay with a few thin layers of lignite	130–138
Dark-grey Cretaceous clay	138–141
Light-grey Cretaceous clay	141–143

DRILL-HOLE No. 44

	Feet
Muskeg	0–3
Marine clay	3–20
Boulder clay, sand	20–118
LIGNITE	118–126
Dark-grey Cretaceous clay	126–128
LIGNITE	128–144
Dark-grey Cretaceous clay	144–156
Light-grey Cretaceous clay	156–160

DRILL-HOLE No. 45

	Feet
Muskeg	0–4
Marine clay	4–14
Boulder clay, stratified clay, sand and gravel	14–144
LIGNITE	144–159
Dark-grey Cretaceous clay	159–167
Light-grey Cretaceous clay	167–170

DRILL-HOLE No. 46

	Feet
Muskeg	0–4
Marine clay	4–14
Boulder clay, sand, gravel, and stratified clay	14–104
Black Cretaceous clay	104–105
Black Cretaceous clay and lignite	105–108
LIGNITE	108–117
Black Cretaceous clay	117–132
Light-grey Cretaceous clay	132–135

DRILL-HOLE No. 47

	Feet
Muskeg	0–4
Marine clay	4–12
Boulder clay, stratified clay, sand and gravel	12–109
LIGNITE	109–114
Dark Cretaceous clay	114–137
Light-grey Cretaceous clay	137–146

DRILL-HOLE No. 48

	Feet
Muskeg	0–4
Marine clay	4–11
Boulder clay, sand, and gravel	11–72
LIGNITE	72–101
Dark Cretaceous clay	101–102
LIGNITE	102–114
Dark Cretaceous clay	114–118
LIGNITE	118–120
Dark Cretaceous clay	120–122
White sand	122–125
Dark Cretaceous clay	125–139
Light-grey Cretaceous clay	139–147

DRILL-HOLE No. 49

	Feet
Muskeg	0–4
Marine clay	4–19
Boulder clay, sand, and gravel	19–120
White sand with lignite fragments	120–130
LIGNITE	130–134
Dark Cretaceous clay	134–139
Light-grey Cretaceous clay	139–146

DRILL-HOLE NO. 50

	Feet
Muskeg	0–4
Marine clay	4–16
Boulder clay and stratified clay	16–112
LIGNITE	112–113
Light-grey Cretaceous clay	113–115
LIGNITE	115–120
Dark Cretaceous clay	120–121
LIGNITE	121–144
Dark Cretaceous clay	144–148
Light-grey Cretaceous clay	148–150

Testing of Fire Brick Made from Mattagami River Fire Clay

By R. J. Montgomery

Introduction

In order to determine the suitability of Cretaceous fire clay of the Moose River basin for the manufacture of fire brick, a series of test pieces was made up for the Department of Mines by Smith and Stone, Limited, Georgetown, through the kindness of B. Stone. In some of them, the clay alone was used; in others the clay was mixed with varying percentages and different types of grog. The various mixes were moulded and burned to cone 11 in a porcelain kiln.

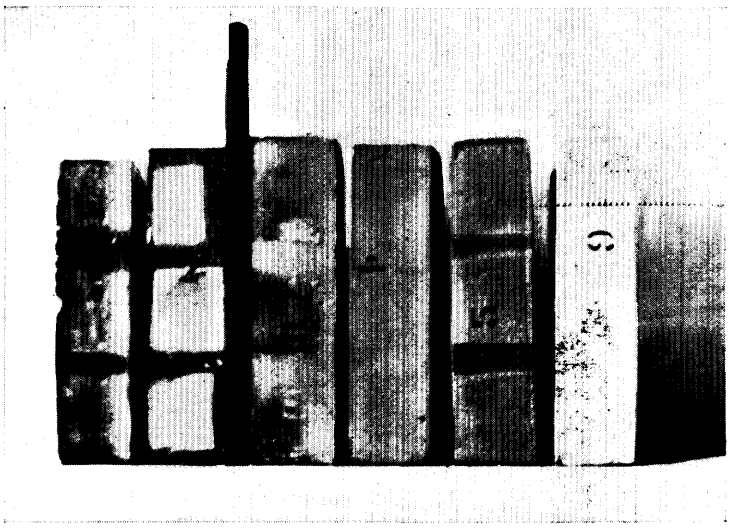


Fig. 1—Fire brick made from Mattagami fire clay, using varying percentages and different types of grog, before testing.

Clay Used

Several bags of clay were obtained by W. S. Dyer from the dump at the shaft sunk for lignite on the west side of the Mattagami river at Great bend, 7 miles below the foot of Long rapids. A sample (No. 64-1) was taken from one bag and analysed and tested.[1] This sample is thought to be fairly representative, but it is possible that all the bags of clay were not alike, and that the clay in the bags may not be an average of the dump, since it is known that more refractory clays occur in the area; if the deposit were opened up, no doubt a greater degree of selection could be exercised. Samples taken from this location were tested at an earlier date,[2] and the fusion

[1]Ont. Dept. Mines, Vol. XXXVIII, pt. 4, 1929, pp. 22-25 (sample C).
[2]Ont. Dept. Mines, Vol. XXXVII, pt. 6, 1928, pp. 112-114.

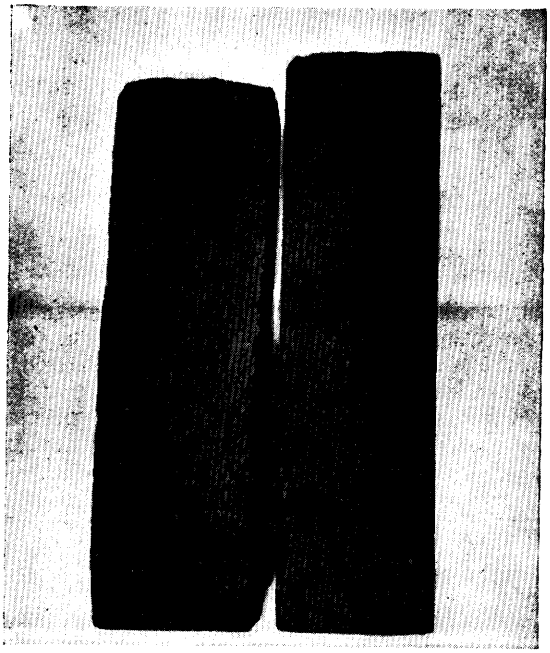


Fig. 2—Ohio Woodland fire brick before and after testing.

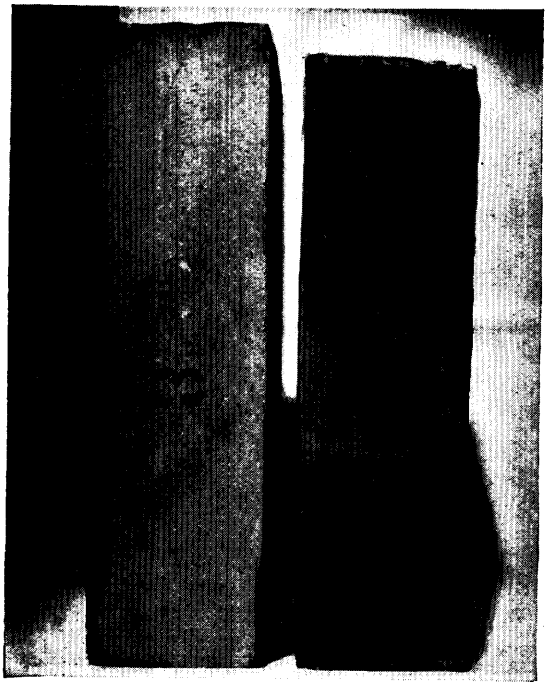


Fig. 3—Fire brick made from a mixture of 60 per cent. raw Mattagami clay and 40 per cent. sagger grog, before and after testing.

points were found to range from cone 30 to cone 32. If part of the clay from which the test bricks were made had a fusion point of cone 30, the brick would not be as satisfactory as if all the clay used had a fusion point of cone 32.

Mixes Used

1. Raw Mattagami clay.
2. Eighty per cent. raw Mattagami clay and 20 per cent. saggers as grog.
3. Sixty per cent. raw Mattagami clay and 40 per cent. saggers as grog.
4. Sixty per cent. raw Mattagami clay and 40 per cent. Pennsylvania flint fire clay as grog.
5. Sixty per cent. raw Mattagami clay and 40 per cent. ganister rock (silica) as grog.
6. Mattagami clay with china clay and potter's flint, and crushed ganister rock as grog.
7. Sixty per cent. raw Mattagami clay and 40 per cent. burned Mattagami clay.

Sieve tests were made on the sagger grog and the burnt Mattagami grog with the following results:—

	Crushed sagger	Burned Mattagami
On 4 mesh	1	.....
On 6 mesh	26.2	25.7
On 8 mesh	45.8	68.1
On 10 mesh	15.9	5.5
On 14 mesh	3.8	.4
On 20 mesh	1.9	.3
On 28 mesh	1.2	.....
On 35 mesh	1.2	.....
Through 35 mesh	3	.....
Total	100	100

Trials were made by Mr. Stone using a coarser grog (30 per cent. on 4 mesh, 57 per cent. on 6 mesh, 10 per cent. on 8 mesh), but the structure was very poor. The burned Mattagami grog, as given above, was also too coarse, giving too open a structure that did not withstand the load test well. The clay was calcined to cone 11. No sample was received of the Pennsylvania flint fire clay, which was the normal grade used at the Smith and Stone plant and bought in the open market. The ganister rock was furnished through the kindness of V. Taylor, superintendent of the silica brick plant of the Algoma Steel Corporation. No sample was received for sieve test.

Appearance of the Brick and Burning Shrinkage

Fig. 1 shows the appearance of brick series Nos. 1 to 6. No. 7 was made in a different-sized mould and was not included in this photograph.

The effect on the size of the brick of adding 20 and 40 per cent. grog is seen in bricks Nos. 2 and 3, as compared with brick No. 1, which has no grog. Brick No. 1 gave a total shrinkage of about 17 per cent. No. 2 with 20 per cent. grog had a shrinkage of about 15 per cent.; whereas in No. 3 with 40 per cent. grog the shrinkage was reduced to about 12 per cent.

Bricks Nos. 1 and 2 cracked considerably during burning. The high shrinkage of the fine-grained clay caused differential strains which the strength of the piece could not resist.

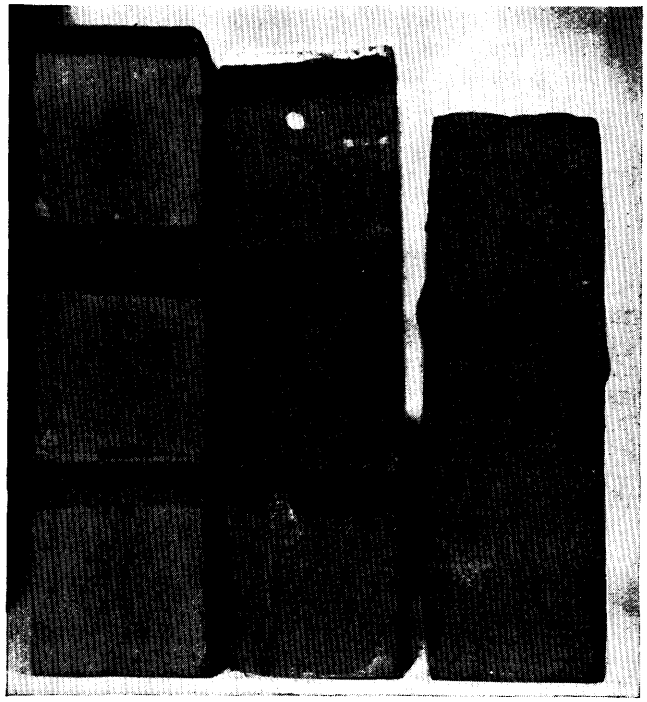


Fig. 4—Fire brick made from a mixture of 60 per cent. Mattagami clay and 40 per cent. Pennsylvania flint fire clay as grog. The brick shown on the left is before testing; the middle brick, after testing at 1,300° C.; and the brick on the right, after testing at 1,350° C.

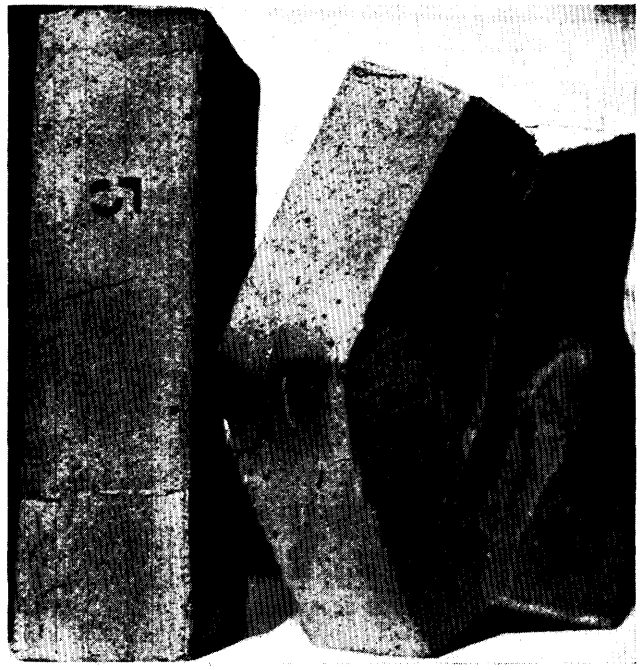


Fig. 5—Fire brick made from a mixture of 60 per cent. raw Mattagami clay and 40 per cent. sagger grog before and after testing.

The remainder of the series with 40 per cent. grog gave reasonably good bodies. An improvement could undoubtedly be made by varying the coarseness and kind of grog and possibly by increasing it somewhat above 40 per cent.

Load Test at High Temperature

The ability of a fire brick to withstand load at high temperature is a good index of its general quality. It indicates the temperature at which the fluxes present become sufficiently active to cause a general softening of the bond of the brick. The brick as a whole may not soften, but the impurities present will form enough glassy matrix to allow the brick to shrink under load. The standard of the American Society for Testing Materials for this test calls for a load of 25 pounds per square inch on end at 1350° C. for heavy-duty brick; 1300° C. for moderate-duty brick; and 1100° C. for light-duty brick.

Of the first-quality brick on the market, only a few will give a good test at 1350° C. Many moderate-duty brick are classed as first quality. The heavy-duty brick are usually obtained by a very special selection of grog and clay, correctly proportioned, blended, and burned.

As a control or comparison, three first-quality brick were tested and are listed below with the test series. Bricks (a) and (b) are considered to be among the best bricks on the market and are special blends of selected material; (c) is a normal or average first-quality fire brick.

Sample	Temperature of test	Shrinkage per cent.
(a) Hearth & Bosh brand	1350° C.	2.1
(b) Woodland (Pennsylvania)	1350° C.	4.2
(c) Ohio Woodland (Fig. 2)	1300° C.	5.5
3. 60 per cent. Mattagami raw, 40 per cent. sagger grog (Fig. 3)	1300° C.	6.2
4. 60 per cent. Mattagami raw, 40 per cent. flint fire clay (Fig. 4)	1300° C.	4.1
4. 60 per cent. Mattagami raw, 40 per cent. flint fire clay (Fig. 4)	1350° C.	failed[1]
5. 60 per cent. Mattagami raw, 40 per cent. ganister rock (Fig. 5)	1300° C.	failed[2]
6. Blend of Mattagami, china clay, flint, and crushed ganister rock as grog (Fig. 6)	1300° C.	2.8
7. 60 per cent. Mattagami raw, 40 per cent. Mattagami burnt (Fig. 7)	1300° C.	11.2

Brick Nos. 3 and 4 are of commercial quality but could be improved by a better proportioning of the amount and size of the grog.

No. 5 is hardly a commercial mix and could be used only in special cases where rapid temperature changes are not encountered. As silica or ganister brick bonded with clay are not used in Canada, no further work will be done on this combination.

No. 6 is a good-looking brick. An improved brick could be obtained by blending with other materials.

No. 7 is composed entirely of Mattagami fire clay. The shrinkage on this sample was large and was due, it is believed, to the open porous structure as much as to the softening of the clay. The grog was coarse and the clay not well blended with it. It is believed that a better brick could be made with this combination than is indicated by the 11.2 per cent. shrinkage.

[1]Load was removed after 1 hour at 1350° C. as the shrinkage was excessive.

[2]The brick cracked during testing as shown in Fig. 5. There was also a certain amount of softening.

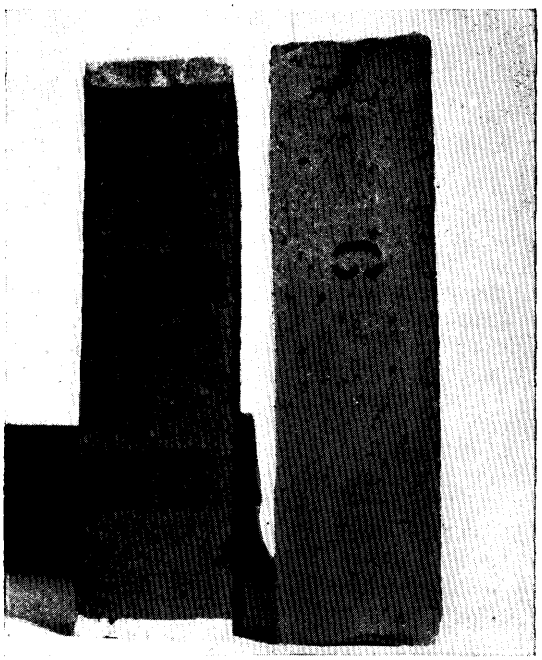


Fig. 6—Fire brick made from a mixture of Mattagami fire clay, china clay, potter's flint, and crushed ganister rock as grog.

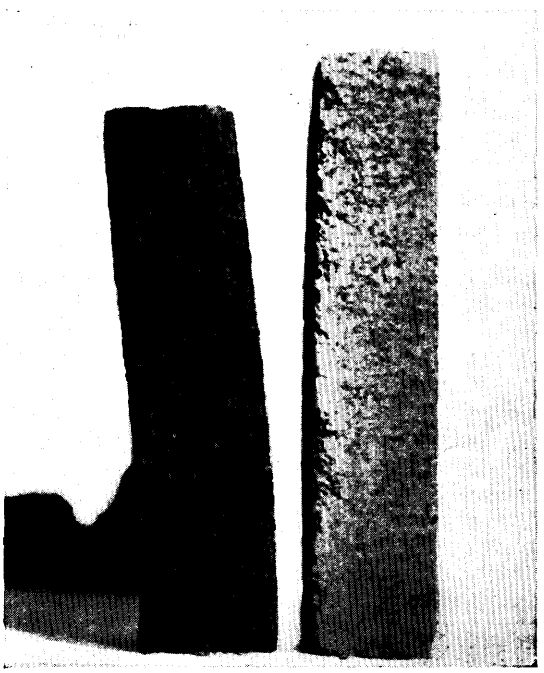


Fig. 7—Fire brick made from a mixture of 60 per cent. Mattagami fire clay and 40 per cent. burned Mattagami fire clay as grog.

Conclusions

1. Mattagami fire clay will make an average first-quality fire brick.
2. The brick will about equal the Ohio Woodland in quality but will not equal the Woodland Pennsylvania or Hearth and Bosh, well known commercial brands.
3. The clay can not be used alone but will require about 40 per cent. or more of grog.
4. Selection of size and kind of grog is important and will affect the quality of the finished product. Ganister rock is not a satisfactory grog.
5. The clay starts to soften under load at about 1200° C. and becomes quite active at about 1300° C., resulting in failure at 1350° C.
6. A careful selection of clay from this deposit might yield a somewhat better brick.

Non-Metallic Mineral Resources of Hastings County

By F. F. Osborne

Introduction

This report is the result of a survey of the non-metallic mineral resources of Hastings county. The writer reviewed the rather voluminous literature on the subject and spent the months of June, July, August, and part of September, 1929, in field work. An attempt was made to visit all the important mineral localities; there were a number that could not be visited without excessive expenditure of time in the field, but the many excellent reports that have been published made this unnecessary.

Gold, copper, iron, lead, manganese, molybdenum, nickel, silver, and zinc are known to occur in Hastings county, and the ores of some of these metals have been worked in the past. At the present time, however, no occurrences of metallic minerals are worked in the county.

Acknowledgments

The interest taken in the work by the residents of Hastings county makes it impossible to list the many people who accorded courtesies in the field. Without exception the persons called on gave information freely, and a considerable number volunteered information and their services as guides. H. R. Pearce, of Marmora, acted as field assistant throughout the summer.

Previous Work in the Area

In 1889, the Geological Survey of Canada published a "Geological and Topographical Map of the Madoc and Marmora Mining District," on a scale of 40 chains to the inch, by Eugene Coste and James White. Although this was not accompanied by a report, marginal notes and the method of locating mineral occurrences make this still one of the most valuable maps of the area.

The report of the Royal Commission appointed to investigate the mineral resources of Ontario appeared in 1890. It contains considerable information regarding the mineral deposits of Hastings and especially the history of some of the early mining ventures.

Modern investigations in Hastings county may be said to date from the discovery of corundum, in October, 1896. Corundum was first identified from rocks in Hastings county by W. F. Ferrier, of the Geological Survey of Canada. The land was at once withdrawn from staking by the Ontario government and W. G. Miller was commissioned to investigate the extent of the corundum-bearing belt. His field work was done in 1897 and 1898. The Geological Survey of Canada also had parties in the field.

F. D. Adams and A. E. Barlow spent eight seasons in a geological examination of the Haliburton-Bancroft area and did much to elucidate the geology of the northern part of Hastings. Progress reports appeared at intervals during these years. Their final report,[1] published in 1910 by the Geological Survey of Canada, was accompanied by two maps: the Haliburton sheet,[2] on a scale of 4 miles to the inch, and the Bancroft map,[3]

[1]F. D. Adams and A. E. Barlow, "Geology of the Haliburton and Bancroft Areas," Geol. Surv. Can., Mem. 6, 1910.

[2]Map No. 708.

[3]Map No. 770.

on a scale of 2 miles to the inch. The mapping is lithological, that is rocks of the same kind are mapped together regardless of their origin and age.

Since the inception of the Ontario Bureau of Mines, Hastings county has received mention in a great many publications.

In 1902, W. G. Miller reported on "The Eastern Ontario Gold Belt."[1] The map accompanying this report shows the geology of a strip of country extending across the county. Other publications describe the geology of the county.

Hastings county, as one of the important pre-Cambrian areas, was visited by the International Committee of 1906 on the nomenclature and correlation of the pre-Cambrian rocks of eastern Ontario, southwestern Quebec, and the Adirondacks. They concluded that Hastings county was the only locality in southeastern Ontario where there was any evidence of a series younger than the Grenville.

In 1907, Miller and Knight[2] came to the conclusion that the Hastings could be separated from the Grenville as a younger series. The study of the pre-Cambrian geology of southeastern Ontario was continued, and in 1914 a comprehensive report[3] was published, accompanied by maps of key areas, five of which cover parts of Hastings county.[4]

The International Geological Congress visited Hastings county in 1913, and the guide book[5] to the excursion provides some of the best descriptions available of the geology of parts of Hastings county.

The most recent work is that of M. E. Wilson, of the Geological Survey of Canada, in the Madoc area. The maps and reports of his work are not yet available, with the exception of his descriptions of the talc[6] and fluorspar[7] deposits. He has indicated in some minor publications that he accepts the conclusion of Miller and Knight that the Hastings series is younger than the Grenville. Apparently he regards the greenstones assigned by Miller and Knight to the Keewatin as interbedded flows within the Grenville.

The publications of the Mines Branch, Department of Mines, Ottawa, contain many references to the mineral occurrences of Hastings county.

The available topographical maps of Hastings are poor. Many of the surveys of the townships were made over a hundred years ago, and the maps, on a scale of half a mile to the inch, are incomplete and difficult to use. On some of the sheets, correction surveys have been made. A series of topographic maps covering part of Hastings, which are of value because they show the owners of the ground, may be found in "A Historical Atlas of the Counties of Hastings and Prince Edward," published by Belden and Company, Toronto, 1878. The "Standard Topographical Maps" of the Department of the Interior, on a scale of 3.95 miles to the inch, are the best available. The Belleville and Pembroke sheets, published in 1927, include Hastings county, and have been used as a base for the map of the county which accompanies this report.

During 1929, the Department of National Defence had a party in the field making surveys for a contoured topographical map of that part of Hastings lying south of 44° 30′. This map will be of particular interest because of the data that will be available to work out the Pleistocene history of the county and to trace part of the shore line of ancient Lake Iroquois.

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[1]Ont. Bur. Mines, Vol. XI, 1902, pp. 186-207.

[2]W. G. Miller and C. W. Knight, Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, pp. 221-223.

[3]W. G. Miller and C. W. Knight, "The Pre-Cambrian Geology of Southeastern Ontario," Ont. Bur. Mines, Vol. XXII, pt. 2, 1913.

[4]Map No. 22*b*—Actinolite-Cloyne Sheet. Scale, ½ mile to the inch.
Map No. 22*c*—Hazzard's Corners Area. Scale, ¼ mile to the inch.
Map No. 22*d*—Madoc Area. Scale, 1,000 feet to the inch.
Map No. 22*e*—Queensboro Pyrite Area. Scale, 800 feet to the inch.
Map No. 22*f*—Gilmour Area. Scale, ¼ mile to the inch.

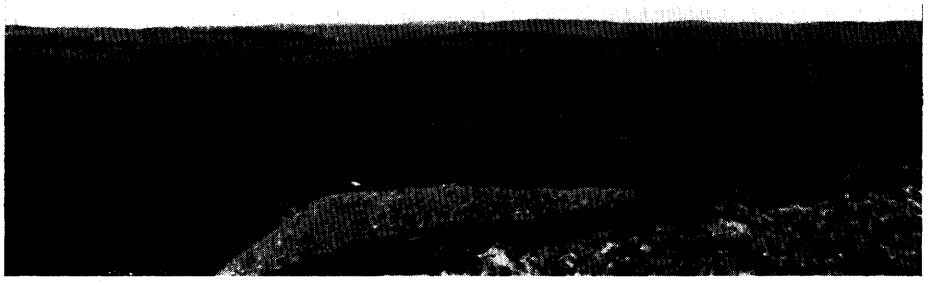
[5]Guide Book No. 6, Ont. Bur. Mines, 1913.

[6]"Talc Deposits of Canada," Geol. Surv. Can., Econ. Series No. 2, 1926, pp. 68-94.

[7]"Fluorspar Deposits of Canada," ibid, No. 6, 1929, pp. 40-77.

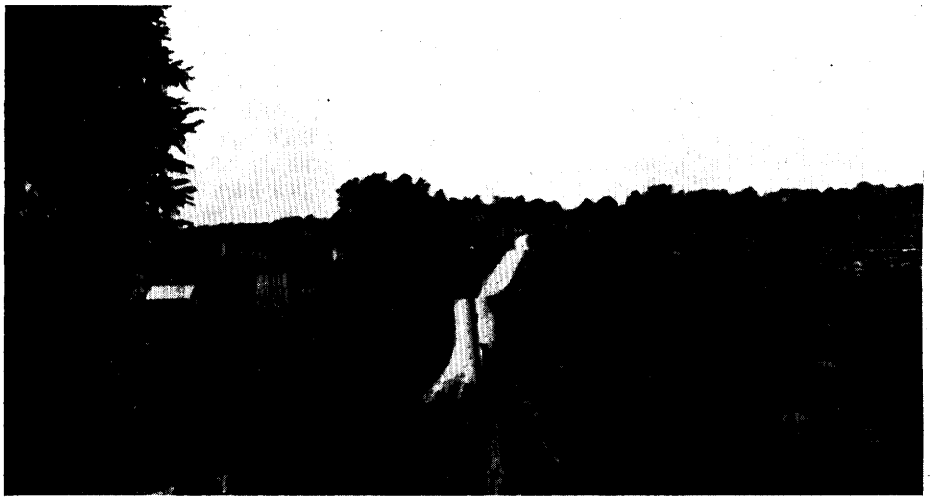
Drainage

The divide separating the waters flowing into Lake Ontario and the Ottawa river is approximately along the north boundaries of the townships of Wollaston, Limerick, and Cashel. The southern part of the county is



View looking east from the dump of the McDonald feldspar mine, Monteagle township. The even skyline is characteristic of the northern part of Hastings county. The relief in this locality is more marked than the average.

drained by a number of short rivers into Lake Ontario. The Moira River system is almost entirely in Hastings county. Moira river is subject to considerable seasonal fluctuations: During the season of 1929, the part of the river above the mouth of the Black river was dry in some places



Morainic topography north of Marlbank.

and in others the water was practically stagnant. The reason for the seasonal fluctuation in flow is the lack of large lakes along the river.

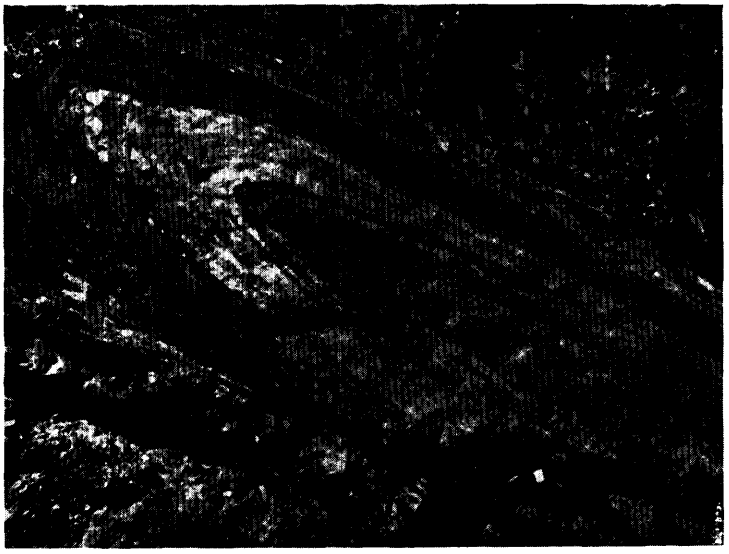
The Crow River system empties into the Trent; it is fed by the many lakes in the townships of Wollaston, Tudor, Lake, and Limerick, and is therefore less subject to seasonal variation than the Moira. A number

of years ago, when there was active lumbering on the river and the dams were maintained, the flow was more uniform. The Crow river is much more suitable for power development than the Moira.

The York river, which is a branch of the Madawaska, drains the northern part of the county; it is fed by many lakes and is, therefore, more uniform in volume than the Moira. It has a number of suitable power sites.

GEOLOGY

Hastings county lies in two geological provinces. The rocks of the southern part are of Paleozoic age, and the northern part belongs to the great pre-Cambrian or Canadian shield. Prior to the deposition of the Paleozoic rocks, the old mountain ranges had been worn down to a broad plain over which the rivers wandered sluggishly. The old erosion surface



Overturned anticline in gneisses. This is the common type of folding in the non-calcareous rock of the northern belt. Note the thickening along the top of the anticline. The hammer is 14 inches long.

is known as a peneplain; and the few hills that rise above it, owing to their superior resistance to the processes of erosion, are known as monadnocks. For a time these hills formed islands in the sea, which in early Paleozoic time advanced from the south and covered the whole county. The flat-lying Paleozoic limestones, which are now found in the southern part of Hastings and probably once covered the whole county, were deposited from these seas.

After the deposition of the limestone, the land was raised again above the seas, and the veneer of limestone was eroded from part of the county. In places remnants of the limestone were left between streams, and these form the outliers, which are commonly flat-topped hills bounded by steep slopes showing the edge of the flat-lying Paleozoic beds. The limestones are flat-lying or nearly so. They show a dip of a few feet a mile toward Lake Ontario. To the west of Hastings county, they have a dip of about 25 feet a mile toward the lake.

The most recent episode has been the advances of sheets of ice from the north. The glaciers which removed the old soil and rock also deposited

the glacial till that covers a large part of Hastings county. Just north of Marlbank is an area of typical terminal moraine topography, marking the place where the receding ice stood for some time; fluvio-glacial deposits form much of the glacial material.

During the retreat of the ice, many dams were formed and the present drainage system had not come into existence. The three western great lakes were dammed to form an expanded great lake known as Lake Algonquin which discharged through the Trent river into Lake Iroquois, an expanded Lake Ontario. The old beach deposits may yield gravel and



Banded structure in the nepheline syenites at Egan chute.

some of the clay deposits were probably made at this time. At a still later period, Lake Ontario was invaded by sea water. During the late stages of the glaciation the present drainage lines became effective. From this summary, it may be seen that part of the topography is due to the character of the underlying rock and part to glaciation.

Description of the Rocks

For purposes of description the rocks of the county may be divided into three east-west zones, the northern, the middle, and the southern.

The northern zone, which extends from the northern boundary of the county as far south as Bancroft, is characterized by a complex group of gneisses. These gneisses have originated in several ways: Some are metamorphosed sedimentary rocks, others are probably derived from volcanic rocks, and a great part of them are formed from plutonic igneous rocks. In many places, crystalline limestones associated with the gneisses point

to the sedimentary origin of these gneisses. The gneisses of igneous origin are foliated just as are the gneisses of sedimentary origin, but they belong to the large masses of rock that came up molten from deep within the crust. These large bodies of granite or granite gneiss are called batholiths.

The heat and gases derived from the batholiths were probably, in large measure, responsible for the change of the sedimentary rocks to gneisses. The material derived from the batholiths also formed the pegmatite dikes that cut through the gneisses.

The southern boundary of the northern belt of gneisses is marked by a narrow band of rocks of a peculiar type, which are characterized by the presence of nepheline, feldspar, and dark-coloured minerals. These rocks are nepheline syenites, but on account of their unusual character, they have been given the name canadites. On a weathered surface, they have a characteristically pitted appearance, due to the weathering of the nephe-



Typical folding in the calcareous Grenville sedimentary rocks of the middle belt.

line. Some of the canadites contain corundum, which is readily seen on the weathered surface as blue, barrel-shaped crystals. The canadites are also the host rocks of the sodalite found near Bancroft.

The middle belt is underlain principally by sedimentary rocks of the Grenville series. In this series crystalline limestones and related rocks are common, but they are not of uniform character throughout the area. Those near the northern batholiths are more metamorphosed than the ones near the centre of the area. The batholiths cut through the series in the counties to the east and west of Hastings, so that here we have the least metamorphosed part of the Grenville series. Near the batholiths, the crystalline limestones are white; but away from them, as in Tudor and Lake townships, the limestones are blue. The associated rocks show corresponding degrees of metamorphism.

The amphibolites in the Grenville series contain amphibole and feldspar, are commonly dark-green, and may be derived from sedimentary rocks or from basic intrusive and volcanic rocks.

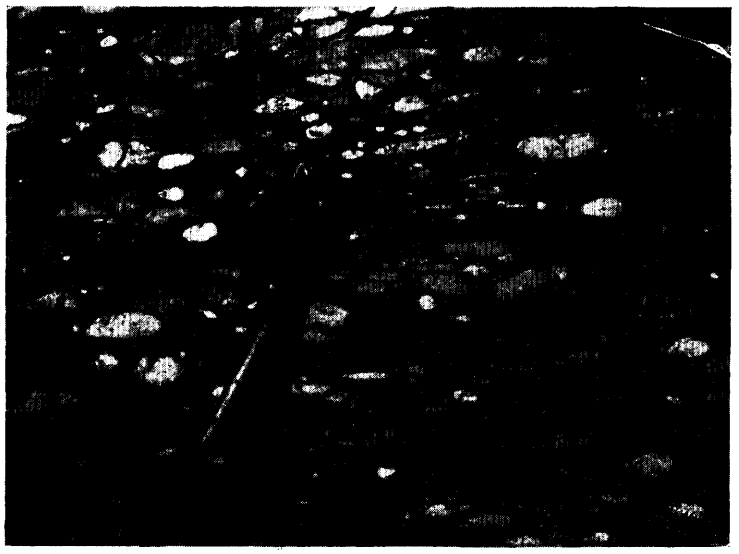
The thickness of the Grenville is unknown. Adams and Barlow estimated it at about 18 miles. In the section over which they measured it,

however, it is certainly folded; and the series is probably much thinner, possibly only a few thousand feet thick.

The Hastings series has been separated from the Grenville only in the southern part of the middle zone, and the rocks composing the two series are similar. In the southern part of the middle zone, batholithic rocks outcrop, and it is possible that a highly metamorphosed area similar to the northern zone underlies the southern zone, but is masked by the Paleozoic rocks.

Basic igneous rocks intrude the Hastings and Grenville series in several places in the middle zone. The Hole-in-the-Wall hill on the Hastings road is formed by one such mass of gabbro. These rocks contain some iron ore deposits.

The rocks of the southern zone are the limestones of Ordovician age. These are marine deposits laid down in the sea that at one time covered all



Sheared conglomerate of the Hastings series.

Hastings county. Aside from hardening, these limestones have not been changed much since they were deposited in the sea. They have not been folded nor intruded by igneous rocks and, except for the fluorspar-barite deposits, they do not contain important mineral veins.

Actinolite

One of the oldest mining industries in Ontario is near the village of Actinolite, formerly known as Bridgewater. An aggregate of fibrous minerals found at various places near the village is crushed and used in making roofing. Actinolite may be identified in the slip fibres and has given the name to the whole aggregate. The "actinolite" as mined shows considerable variation in mineralogy. The minerals are talc, amphibole, chlorite, and serpentine, and are probably formed by the action of solutions from the nearby granite on the enclosing schists. Some mineral was mined in 1927, but is still outside the mill. Only 30 tons, valued at $375, was shipped in 1929, and the highest value of any year's production in the past five was $1,075.

Elzevir Township

Erwin(1).[1]—The opening last worked for "actinolite" is on the D. Erwin farm, lot 5, concession VII. The "actinolite" forms a zone about 50 feet wide in the schists, which strike N. 30° E. and dip 65° W.

Willet(2).—There are three openings on the Willet property, which is on lot 4, concession VII. No work has been done recently and the pits are filled with water. The mineral is soft and is found in depressions below the schists.

Lot 5, Con. VI(3).—Three pits have been sunk on this property. The material mined is similar to that described above.

Asbestos

Asbestos is a "use" term. It applies to those minerals of fibrous character in which the fibres are sufficiently flexible to permit of spinning. The name was originally applied only to minerals of the amphibole group, but now by popular usage it has come to be applied to the common asbestos of commerce, the mineral name of which is chrysotile. The Eastern Townships of Quebec are a dominant factor in the world market for chrysotile.

Fibrous aggregates of amphibole are found in many places in Hastings county. Tremolite, a white variety, and actinolite, which is green, are found in the limestones and dolomites near igneous rocks. Actinolite is also formed in the metamorphism of igneous rocks. Actinolite and tremolite have no value as spinning fibre but may be used as packing or in roofing.

Marmora Township

Terryon(4).—The only occurrence of chrysotile asbestos noted in Hastings is on the farm of J. V. Terryon, lot 12, concession IX. The asbestos is of contact metamorphic origin in white crystalline limestones near their contact with a mass of granite, which outcrops to the east. Certain zones of the limestone, perhaps original dolomite beds, have been altered to serpentine. The serpentine has been altered to chrysotile along closely spaced, parallel zones giving rise to cross-fibre asbestos. A number of pits have been sunk, but the fibres were found to be short and the amount of asbestos small.

Barite

Barite is the sulphate of barium; on account of its high specific gravity, it is known as heavy spar. Ground barite is used as a filler in cloth, paper, rubber, linoleum, oilcloth, artificial ivory, and buttons. It is used in certain paints, such as lithopone, and in various barium chemicals.

In Hastings county, barite is found as a gangue mineral with calcite in lead veins. It is also found in considerable quantities in fluorite veins, which may make it of commercial importance as a by-product of the mining of lead and fluorspar.

Celestite

Celestite is the sulphate of strontium and may be used as a source for the salts of that element. The celestite in Hastings county is found in the fluorspar-barite veins described elsewhere and might be utilized as a by-product if these veins were worked. The price of celestite is low, and it probably would not pay to produce it alone, but since it is dense

[1]The numbers in parentheses, which begin on this page and appear throughout the report, are used on the accompanying map (No. 39*h*) of Hastings county to indicate the location of the mineral deposits described.

like barite and also a sulphate, a concentrate mixed with barite might be produced and marketed. Celestite has been used in the manufacture of lithopone and also as a filler.

Cement

Portland cement is the product formed by the grinding of the clinker produced by the burning of a mixture of finely ground lime-bearing rock and clay in definite proportions. The lime constituents are usually derived from limestones; formerly natural marls were used for this purpose.

Canada Cement Company.—The only operating cement plant in Hastings county is that of the Canada Cement Company at Point Anne in Thurlow township. The production is about 4,000 barrels a day. In 1929, sales from this plant were 1,552,899 barrels; there were 330 employees, and wages for the year were over $400,000. The limestone comes from the large quarry(5) in the Ordovician limestone situated near the plant, and the clay is brought in by rail from clay pits(6) about a mile north of the main Toronto-Montreal highway. The clay is worked by a steam-shovel and loaded directly into the cars. It contains about 55 per cent. silica, 23 per cent. alumina and ferric oxide, $5\frac{1}{2}$ per cent. lime, $3\frac{3}{4}$ per cent. magnesia, and 8 per cent. water.

The Rathbun Company formerly operated a cement plant at Marlbank, Hungerford township. The clay was obtained locally, and marl from a nearby lake was the source of the lime. This plant was acquired a few years ago by the Canada Cement Company and has not been operated since.

Clay

The clays of Hastings county were laid down in temporary lakes or along the flood plains of streams. None of the deposits are deep, and most of them are small and suitable only for brick-making for local use.

The Ontario Department of Mines has recently published a report by R. J. Montgomery on "The Ceramic Industry of Ontario,"[1] in which appear descriptions of the clays of the county and of the operating brick plants.

Thurlow Township

Bay of Quinte Brick Works(7).—The plant, at Belleville, operates from the middle of May to the middle of October, and has a capacity of about 10,000 red soft-mud brick a day. The clay is found in a field on the farm of Walter Lingham, lot 10, concession I, and is dug in shallow pits. In places the clay contains considerable limestone, and this appears to increase with depth.

Geo. A. Labey and Son(8).—A plant for making brick and field tile was formerly operated south of the village of Foxboro. The clay was taken from the banks of the small stream flowing into the Moira at this point. The clay has a thickness of about six feet.

Hungerford Township

Tweed Brick and Tile Works(9).—This plant is situated on lot 9, concession VIII, south of Tweed. The brick is used locally. The clay is taken from shallow pits.

Madoc Township

A small brick and tile plant was formerly operated near Madoc by the Hill Brick Company.

[1]Vol. XXXIX, pt. 4, 1930.

Fluorspar

Fluorspar, or fluorite, is a mineral of many modes of occurrence. It is found in pegmatite dikes in small amounts, and in Haliburton county attempts have been made to mine it in pegmatites of the pneumatolytic type for it. The workable deposits in Hastings county are of an entirely different type. They occupy fissures in the Ordovician limestone and extend into the pre-Cambrian rocks in some places. The deposits originated at low temperatures, much lower than those of the pegmatites.

The mineral is used in the manufacture of insecticide and hydrofluoric and hydrofluosilicic acid. It is used as a flux in the steel industry and in the refining of lead, copper, and silver, as it facilitates the elimination of silica. The fluorspar from Hastings county is very low in silica, but contains considerable calcite, which is undesirable for certain uses.

The United States is the main producer of fluorspar, and the centre of production has been the Rosiclare district in Illinois and the adjacent parts of Kentucky. These deposits closely resemble those of Hastings county.

The Madoc area was the principal fluorspar producer in Canada until 1920, but practically no work has been done since. Brief descriptions of the properties in this area, accompanied by a key map showing their location, appear in the Annual Report[1] of the Ontario Bureau of Mines for 1918.

M. E. Wilson examined the Madoc area for the Geological Survey of Canada in 1920. His summary report[2] for that year was later brought up to date and included in his report on the "Fluorspar Deposits of Canada,"[3] published in 1929.

Six companies were operating in the field in 1920, and a number of others had just ceased operations. The openings were in a much more favourable condition for examination than they are at present. The writer has, therefore, followed most of the descriptions as given by Wilson and supplemented them with a few observations of his own. The reader is referred to the more complete descriptions by Wilson for further information.

Moira Lake Group

Wilson has shown that the deposits are arranged along fissures. Moira Lake group is on a fissure that strikes about N. 57° W. and stands nearly vertical.

Huntingdon Township

Palmateer(21).—The southernmost deposit on the Moira Lake belt is the Palmateer on lot 18, concession VIII. Only a little work has been done here.

Howard(22).—This property is on lot 14, concession XI, and was opened by Stephen Wellington in 1918; some work was done in 1920, but the property was idle until 1929 when the old shafts were unwatered and deepened by W. H. Johnston, of Tweed. The shafts were full of water at the time of the writer's visit, but Mr. Johnston says that the east vein is 9½ feet wide at a depth of 28 feet. The vein is in the Ordovician limestone about 150 feet above the pre-Cambrian.

Wright.—This vein on lot 15, concession XI, is the southerly extension of the Howard.

Noyes(23).—This property, which is on lot 13, concession XII, was the largest producer in Hastings county. About 15,000 tons were pro-

[1]Vol. XXVII, pt. 1, pp. 135-138.
[2]Sum. Rept., 1920, pt. D., pp. 41-78.
[3]Econ. Geol. Series, No. 6, pp. 40-77.

duced from 1917 to 1920. The veins are found extending into the pre-Cambrian granites and have been worked to a depth of 250 feet. The vein as mined ranged from a few inches to 17 feet in width. Parts of it were high-grade, but much of it was low-grade material. No part of the vein is now visible at the surface, and the headframe over the shaft has been removed.

Blakely(24).—The Canada Fluorspar Company did some work on this property, which is on lot 10, concession XII, up to March, 1928, but apparently no fluorspar was shipped. A shaft was sunk 96 feet, but is now full of water. It cuts the grey and brown shales, and the Ordovician limestone. The vein is narrow to a depth of 30 feet but appears to widen below. Some high-grade fluorspar is on the dump. Sphalerite and chert were found in the lower levels of the property. The sphalerite assayed two ounces of silver a ton. A small vein nearer Moira lake strikes N. 15° W.

Perry(25).—This property is on lot 11, concession XIII. The vein, which is in almost direct line with the Noyes, is in the pre-Cambrian, and ranges in width from a few inches to 6 feet. It contains fluorspar, calcite, and barite. The property has been developed by three shafts: One is east of the Madoc gravel pit, and two are west of the railroad. Practically all the mining has been from the No. 3 or northwestern shaft, which has been sunk to a depth of 150 feet. Some of the workings are below Moira lake, and it is reported that the mining was hampered by the heavy inflow of water.

Other Properties.—The Coe(26) property, is on lot 10, concession XIII, and the South Reynolds(27) is on lot 7, concession XIII. The Rogers(28) property, lot 10, concession XIV, is probably on the Moira Lake zone from the Perry and therefore connects the Keen(29) on lot 9, concession XIV, with the main group. The Keen vein contains considerable quantities of calcite and celestite, and the fluorspar is transparent and suitable for optical purposes. Fluorspar shipped from here was obtained in the course of development work. The North Reynolds(31) property is on lot 8, concession XIV.

Madoc Township

The Bailey(30) property on lot 1, concession IV, is across the road from the Keen, but the veins on the two properties strike in different directions. Tetrahedrite was reported from this vein. The Hill(32) vein is within the village of Madoc.

The McIlroy(33) on lot 2, concession IV, the Lee Junior(34) on lot 2, concession III, and the McBeath(35) on lot 3, concession III, all belong to the Moira Lake group.

Lee-Miller Group

The veins of the Lee-Miller group strike more nearly north than the veins of the Moira Lake group, and in some places they may be traced across several lots. The fissures, however, do not appear to be as continuous as those of the Moira Lake group.

Huntingdon Township

The Herrington(36) vein on lot 2, concession XII, shows several small veins in pre-Cambrian limestone.

Madoc Township

A lens about 90 feet long and 8 feet wide yielded 800 tons of fluorspar on the Lee Senior(37) property, lot 1, concession I.

Some work has been done on the Wallbridge(38) vein on lot 1, concession I, which extends from the Lee and Herrington properties. According to G. Wallbridge one vein shows a width of 6 feet. Some fluorspar is found on the Herrington(39) property on the west half of lot 2, concession I. A 4-inch vein on the east half of the same lot is known as the Stewart(40) vein. It contains a small amount of chalcopyrite. The Ponton(41) vein, which is on lot 3, concession I, is exposed for about 160 feet. About 300 tons of fluorspar have been shipped from this property in the last three years.

Two veins have been worked on the Miller(42) property on lot 4, concession I. The east vein averages about 2 feet in width; the west vein is narrower. The last work done was in 1919. The Reynolds(43) property is on lot 5, concession I, and the Rooks(44) on lot 6, concession I. The Plain(45) property on lot 9, concession I, is the farthest north of the group.

Other Occurrences in the Madoc Area

Wilson has listed the following occurrences of fluorspar, none of which have been visited by the writer: lot 15, concession XI, and lot 11, concession XIV, of Huntingdon; the west half of lots 1 and 3, concession II, and the west half of lot 14, concession IV, of Madoc.

Origin of the Fluorspar and Galena Deposits

The origin of the fluorspar and galena deposits is uncertain. The solution of the problem is of practical importance as well as of theoretical interest. The writer believes that the galena and fluorspar veins are genetically related. In general, two modes of origin have been advanced for the deposits: The one view is that the aqueous solutions depositing the minerals came from beneath and were derived from igneous rocks. The other view is that the minerals have been deposited from solutions coming from the surface.

It would appear that the lead and fluorspar veins have the same origin because they show vein material of similar texture, they occupy fissures striking in nearly the same directions, and the minerals of the two types of veins are similar. The veins of fluorspar carry celestite, but the common minerals are barite and calcite. The galena veins show a little sphalerite, but the principal gangue minerals are calcite and barite. The sphalerite found in the fluorspar deposit is argentiferous, as it is in the galena deposits. Both the lead and fluorspar veins are more abundant in the less metamorphosed limestones or other rocks near them. The fluorspar deposits are in the Ordovician or the pre-Cambrian rocks below the unconformity. The galena deposits are in the Grenville limestone.

The evidence for deposition by solutions coming from depth is the presence of argentiferous sphalerite and tetrahedrite within the fluorspar vein, and the zoning of the galena deposits to the north and fluorspar to the south. Similar evidence[1] has been advanced to support the magmatic origin of the lead-zinc deposits of the Mississippi valley. If the evidence presented above is valid, the deposits have come from depth and are, therefore, more likely to be persistent than if they had been derived from the surface. None of the workings in Hastings county are sufficiently deep to serve as a test of the downward extension of any of the veins. Some of the smaller veins containing galena, however, have pinched out at shallow depth.

[1]W. H. Emmons, "The Origin of the Deposits of the Sulphide Ores of the Mississippi Valley," Econ. Geol., Vol. 24, 1929, pp. 221-271.

Garnet

Garnet is the name of a group of silicate minerals of complex composition. They are commonly dark-red to black, and are harder than quartz or glass. Garnet is chiefly used as an abrasive in the form of a coating on paper. It is also used as grains in glass-grinding. In wood-surfacing machines, garnet is used almost exclusively and is especially efficient on the hardwoods. It is also used to some extent in the finishing of hard rubber; but for many purposes it cannot compete with artificial abrasives.

For commercial use, garnets should be larger than a pea and easily separable from the rest of the rock. They should break to form a cutting edge, and be tough enough to hold it.

Garnets occur in a large variety of rocks, more particularly in gneisses and schists. They also occur as contact metamorphic deposits, especially in limestone. Garnet has been found in the workings of the Canadian Sulphur Ore Company, near Queensborough, and at the magnetite occurrence near Gilmour. The United States produces most of the world's supply.

The garnet occurrences of Canada have been described by V. L. Eardley-Wilmot in Part 3[1] of a report on "Abrasives," published in 1927 by the Mines Branch, Ottawa.

There was an output of 1,250 tons of garnet ore and concentrates in 1923 from Ashby township, which adjoins Hastings county to the east.

Elzevir Township

Garnets occurring on lot 2, concession II(46), have been described by Eardley-Wilmot, who indicates quite an extensive deposit; but the writer could only find an outcrop of low-grade material. The garnets noted were small.

Small garnets may be found near the old mica mine on lot 29, concession XI(47).

Mayo Township

Garnet-bearing schist was noted on the farm of Simon Bronson(48), lot 14, concession XII. Parts of the schist might average 7 or 8 per cent. garnet.

Monteagle Township

The Quirk(49) deposit is on lots 3 and 4, concession V. The garnet is so mixed with feldspar and hornblende that it could not be used for making abrasive paper, but might be used for glass-grinding.

Carlow Township

Garnets have been noted on lot 24, concession XII(50).

Graphite

Graphite is one of the forms of pure carbon. It is black and opaque. Its softness makes it possible to use it as a lubricant at high temperature and it is used for the manufacture of crucibles in the steel industry. A small amount is used in polishes and in pencils.

In Hastings county, graphite is found in limestones that have been metamorphosed, as veins cutting amphibolite, and with mica in schists.

Monteagle Township

On lots 23 and 24, concession XIII, near Graphite, a deposit of graphite is found in a silicated limestone contained within the gneisses. One wall is

[1] "Garnet," Publication No. 677.

a scapolite rock and the other is grey gneiss. The structure is complicated by a number of dikes cutting across the fold, the outcrop of which is hook-shaped. At the north end the strike is N. 80° W. and the dip 40° S. Farther south the strike is N. 58° W., and near the south end the strike is more nearly north and south. The method of mining by open pit has removed much of the graphite zone and makes the determination of the structure difficult.

The graphite occurs in the limestone as bright foils and scales. Associated with it are feldspar, scapolite, tremolite, phlogopite, and a number of other minerals. The limestone is cut by calcite veins containing pyrrho-



Pit opened for graphite on the farm of Fred Lebow, Monteagle township.

tite, molybdenite, and apatite. The molybdenite closely resembles the graphite but is slightly bluer. The width of the graphite zone varied but must have reached a maximum of 12 feet.

Virginia Graphite Company(*51*).—This company operated on the deposit described above on the farm of Fred Lebow, lot 23, concession XIII, and shipped the product to its mill near Wilberforce.

National Graphite Company(*52*).—The National Graphite Company operated on the same deposit in lot 24, concession XIII, and shipped to its mill near Harcourt.

Faraday Township

Sprague(*53*).—This property on lot 12, concession II, is owned by J. F. and A. C. Sprague, of Coehill. The graphite occurs here as veins cutting calc-schists, which strike N. 40° W. and dip 85° S. The rocks are locally silicified and pyritized, and the graphite occurs as a network of veinlets in a zone from 1 to 2½ feet wide. The general trend of the zone is N. 20° W. The graphite is lamellar, and would require concentration. The zone has been exposed over about 30 feet.

Carlow Township

William White, of Bessemer, showed the writer some graphite contained in mica schist, said to have come from concession IX. According to Mr. White the schists with graphite are 10 feet wide and may be traced for 500 feet.

Iron Pyrites

Iron pyrites (pyrite) is the sulphide of iron. The mineral is commonly confused with chalcopyrite but contains no copper. Some pyrite is used in the manufacture of metallic paint, but practically the entire output is burned to form sulphur dioxide, which is used for sulphuric acid and sulphite bleach.

A recent development is the patented invention[1] by Horace Freeman, of Shawinigan Falls, Que., of a new type of pyrite burner, which came into commercial use in 1930 at the Three Rivers plant of the Canada Power and Paper Company. The furnace, with capacity of 26 tons of pyrite a day, requires only 900 square feet of floor space, and 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. The waste heat is used for steam generation to heat the plant, and the iron oxide residue constitutes an important by-product.

Pyrite deposits are in competition with pyrite obtained as a by-product of milling operations and with native sulphur. The recent advances in the application of the flotation process to sulphide ores have made it possible to concentrate the pyrite and chalcopyrite separately. These concentrates are relatively cheap. Pyrite is sold by the unit of sulphur. A ton of concentrate containing 50 per cent. sulphur at 5 cents a unit would bring $2.50. A ton of pure pyrite at the same rate would bring $2.67. Native sulphur can be produced relatively cheaply from the deposits of the southern United States and has the advantage that it burns without residue.

A number of pyrite deposits have been exploited in Hastings county, which at one time was one of the important sulphur-producing areas in Canada. At present no pyrite is being mined. The Nichols Chemical Company use 30 tons a day at their plant at Sulphide, all of which is brought in by rail. That used in the early part of 1929 was a flotation concentrate from Eastern Quebec.

The upper parts of the pyrite ore bodies in Hastings county were covered by a capping of gossan, and several of the deposits were first operated for iron ore. The deposits have been described in various reports of the Ontario Department of Mines and of the Mines Branch, Ottawa. E. L. Fraleck's report, "Iron Pyrites in Ontario," published by the Ontario Bureau of Mines[2] is still valuable for its information. The paper by A. W. G. Wilson, "Pyrites in Canada," published in 1912 by the Mines Branch,[3] Ottawa, gives most of the available information regarding these deposits. The pyrite deposits near Queensborough are described in several reports of the Ontario Bureau of Mines.[4]

Pyrite deposits are found in zones commonly impregnating schists and amphibolites. In the opinion of the writer the mineralization is due to ease of replacement of the rocks along these "fahlbands." The Hungerford fahlband is about 5 miles east of Tweed. It strikes N. 65° E. and may be traced for about 2 miles.

Hungerford Township

The Hungerford mine(54) on lot 23, concession XII, was opened about 50 years ago for gold but was found to contain none of the precious metal.

[1]Can. Min. Jour., Dec. 12, 1930.
[2]Vol. XVI, pt. 1, pp. 149-201.
[3]Publication No. 167, pp. 62-70.
[4]Vol. XXII, pt. 2, 1913, pp. 95-103; Vol. XXV, pt. 1, p. 128.

It was operated from 1903 to 1924 as a pyrite mine by the Nichols Chemical Company.

The Canada (or Oliver) mine(55) is on lot 26, concession XII, east of the Hungerford mine.

The Hungerford Western Extension(56) is on lots 21 and 22, concession XII, and adjoins the Hungerford on the west.

The Ontario Sulphur Mines, Limited(57), is on lot 21, concession XI.

Madoc Township

The Queensborough fahlband, on which several properties have been operated, runs south of Queensborough. The Queensboro (Blakely)



Open pit on the property of the Canadian Sulphur Ore Company, Madoc township.

mine(58) on lot 11, concession XI, was the first one opened on the fahlband. The country rock is a garnetiferous schist. The surface is no longer well exposed, but the underground workings must be extensive. To the west a 2-foot vein of pyrite contains a 4-inch vein of dark-brown sphalerite.

The property of the Canadian Sulphur Ore Company(59), which is on the north half of lot 9, concession X, operated for many years and produced a great deal of pyrite. Several shafts and an open pit were sunk. The property has not been operated since 1919. Early in 1929 the dumps were trenched, and the shaft was partially unwatered for the purpose of sampling the property.

The Palmer(60) property is in lot 10, concession IX. The Farrell(61) prospect is on lot 9, concession VII. The McKenty(62) property on lot 6, concession VII, was originally opened for hematite.

Several occurrences of pyrite have been noted along the Bannockburn fahlband. The most important is Bannockburn mine(63) on lot 25, concession VI. This property was originally opened for limonite, but pyrite was found at depth. The occurrence is near a marsh and no part of the bed rock is now in view.

Minerals of the Pegmatite Dikes

The term "pegmatite" is usually applied to coarse-grained modifications of granite. Its meaning is often extended to include coarsely crystalline types related to other plutonic rocks such as syenite or gabbro. The pegmatitic facies occurs in dikes, veins, or segregations associated with intrusions of the normal rock type.

When an igneous body cools slowly and at a considerable depth below the surface, there are certain constituents that remain fluid after the main mass of the rock has consolidated. In addition to the principal constituents of the parent rock, small quantities of comparatively rare elements are concentrated in this residue. When crystallization finally takes place, a body of pegmatite is formed. Such pegmatitic concentrations are a frequent source of feldspar, mica, and gem stones, and they occasionally contain important quantities of tin, tungsten, lithium, beryllium, and radioactive minerals.

The only pegmatite bodies of economic importance, in the area dealt with in this report, are in the northern part of Hastings county where they are associated with intrusions of granite. These granite-pegmatites frequently contain apatite, tourmaline, zircon, and radioactive minerals.

Nepheline syenite-pegmatites are also present. These contain sodalite, pyrrhotite, magnetite, apatite, cancrinite, natrolite, and sometimes radioactive minerals.

In this area, pegmatites associated with bodies of gabbro are characterized by such minerals as phlogopite, apatite, and scapolite.

An excellent description of the pegmatites of Hastings county is found in a report of H. V. Ellsworth on the radioactive minerals in Ontario, published by the Geological Survey of Canada.[1]

APATITE

Apatite is the phosphate of calcium; it forms hexagonal brown or green crystals. Its only use is as a fertilizer, and formerly considerable amounts were produced in Canada; but production has fallen off since the discovery of the large deposits of sedimentary phosphate in the southeastern part of the United States, which can be very cheaply mined.

The mineral is found in many of the pegmatite dikes, both of the granite and the nepheline syenite. It is not being mined at present, but might be picked out as a by-product in the operation of some of the quarries.

CORUNDUM

Corundum is the crystallized oxide of aluminium. It forms six-sided, barrel-shaped crystals, which are too hard to be scratched by steel or quartz. The crystals show a tendency to part, and this determines the value of corundum as an abrasive, because the parting gives sharp cutting edges. Much of the corundum of Hastings county is brown, but some varieties are blue or pink. None are sufficiently transparent to be sapphire or ruby.

The corundum of Hastings county is associated with igneous rocks so low in silica that quartz did not form in them. Nepheline is a common constituent. In Ontario, the rocks are found in a narrow belt about a hundred miles long. Corundum is found in the normal plutonic rock, but practically the entire commercial production has been from the pegmatites of these rocks.

[1]H. V. Ellsworth, Geol. Surv. Can., Sum. Rept., 1923, pt. C1, pp. 8-16.

Corundum was first identified in Canada in 1847 by T. Sterry Hunt, who found it in a limestone from the township of Burgess. Corundum was identified by W. F. Ferrier in the pegmatites from Carlow township in 1896.

The first operations on a commercial scale were in Carlow township, where the Ontario Corundum Company started operating in 1902. The Ashland Emery and Corundum Company operated the plant from 1906, but the shipments were small and irregular. Other occurrences of corundum were exploited in Hastings, and the Canada Corundum Company went bankrupt owing to overproduction. In 1909, several of the operating companies were taken over by the Manufacturers Corundum Company, and in 1910 the Ashland Emery and Corundum Company entered this merger. The company continued operations until 1917, when the plant at Burgess Mines was moved to Jewellville in Raglan township.

Corundum is used principally as an abrasive. The industry in Ontario had almost from the beginning a serious competitor in the artificial abrasives, such as carborundum (silicon carbide) and fused alumina, an artificial oxide of aluminium made by the fusion of bauxite and even of corundum itself. This competition was the chief cause of the steady decline of production in Canada, which finally ceased in 1921.

For certain types of abrasives, it is said that corundum is superior to any of the artificial products. It seems possible that some of the larger and higher grade corundum occurrences might be worked if they were near enough to transportation and water power.

The bibliography of the corundum deposits is extensive. Much information may be found in reports by W. G. Miller,[1] published by the Ontario Bureau of Mines, and in reports by Adams and Barlow,[2] published by the Geological Survey of Canada. The most complete description available of the corundum deposits is found in the memoir on corundum by A. E. Barlow.[3] Part 2[4] of V. L. Eardley-Wilmot's report on "Abrasives," published in 1927 by the Mines Branch, Ottawa, is the most recent publication and brings the history of the corundum industry in Canada up to date.

Because of the complete details given by Barlow, it is unnecessary to describe all the corundum occurrences(64-80) shown on the accompanying map.[5] Most of the work in Hastings county was done near Burgess in Carlow township, concession XIV, lot 14, and concession XIII, lots 15 and 16. These occurrences were in the pegmatites and gave brown corundum. In places the dikes were rich, but in many places much work was required to recover the corundum. Where examined these rocks cut the hornblende granite gneiss. Dikes of the same character are found at the following places: Monteagle, concession I, lot 5; Carlow, concession I, lot 13, and concession XIV, lots 6, 7, 10, and 11; Dungannon, concession XV, lots 8 and 10.

Corundum is also found as an accessory constituent in the nepheline syenites. Corundum of this type is blue or pink rather than brown and has not been exploited as extensively as the other. Outlines of corundum crystals may be readily seen on the weathered surface. Occurrences of this type are found in Faraday, concessions XV and XVI, lots 31, 32, and 33; Dungannon, concession XI, lot 18, and concession XVI, lots 4 and 5; Monteagle, concessions I and II, lot 4.

[1] "Corundum and Other Minerals," Ont. Bur. Mines, Vol. VII, pt. III, p. 207-250; Vol. VIII, pt. II, pp. 205-240.

[2] Mem. 6, pp. 371-382.

[3] Geol. Surv. Can., Mem. 57, 1915.

[4] "Corundum and Diamond," Publication No. 699.

[5] The locations of some of the corundum deposits differ in the map by Adams and Barlow (No. 770, accompanying Mem. 6) and in the report by Barlow (Mem. 57). The text follows Barlow and the map locations are those given on map No. 770.

FELDSPAR

Feldspar is the most important economic mineral in the pegmatite dikes of Hastings county. The name feldspar is applied to a complex group of minerals. They are silicates of aluminium with potassium, sodium, or calcium, or calcium and sodium. The potassium spar is the most valuable and is called microcline. It is commonly impure and may show stringers of soda spar within it. If the stringers are visible to the naked eye it is known as perthite; if only visible under the microscope, it is known as microperthite. All the microcline examined from Hastings county is perthitic or microperthitic. The soda spar is known as albite; if it contains some of the lime spar it is known as oligoclase. The colour of feldspar shows a wide range from light to dark, pink being the commonest for the potassium spar and white for the soda spar.

Both albite and oligoclase are found in Hastings county. They occur in some of the granite pegmatites, but are especially common in the pegmatites of the nepheline syenites. The nepheline is somewhat similar in composition to the albite itself. These pegmatites contain no quartz.

A dike of nepheline syenite to the east of the York river at Egan chute is about 50 feet wide and is exposed for 200 feet. It consists of nepheline and oligoclase with small amounts of sodalite, cancrinite, apatite, and black mineral. Radioactive zircon crystals cause a radial shattering of the nepheline and albite in a few places. The nepheline is softer than quartz, having about the same hardness as albite. It is possible that the whole dike could be mined and used as an abrasive for household cleansers, where freedom from scratching by quartz is desirable.

Only one company was operating a quarry in Hastings county in 1929. Several years ago a number of quarries were opened, but large masses of quartz or graphic granite were encountered as quarrying proceeded. Good spar would probably be found in the quarries with the large masses of pure quartz, which are probably the segregated type of pegmatite. In these deposits the quartz must have been introduced after the feldspar, since it forms veins along the cleavage of the spar and cuts irregularly across it. The origin of the graphic granite and its relation to the spar is not known. In places, toward the centre of the dike, the graphic material grades into the segregated material.

Microcline is the most desirable of the feldspars for commercial use. About 85 per cent. of the feldspar produced in North America is used in the ceramic industry. For this use it should be free from mica, tourmaline, garnet, hornblende, and iron compounds. Freedom from quartz is desirable but economically impracticable because of the excessive sorting involved. No. 1 spar is practically free from quartz, No. 2 contains not more than 25 per cent., and all spar with more than 25 per cent. is classed as No. 3.

The chief use of feldspar is in the manufacture of whiteware; some is used in enamel on metals; and its use in bottle and window glass manufacture is increasing. The highest grade of spar is used in the manufacture of electrical porcelain and false teeth. Feldspar is also used as foundry facing and as an abrasive. Low-grade material may be used in the manufacture of artificial stone for stucco dash, and for chicken grits.

Soda spar has not been used extensively in the ceramic industry, but for certain purposes it may replace potash spar.

Monteagle Township

McDonald(81).—This property, on lots 18 and 19, concession VII, has been worked by the Genessee Feldspar Company, Inc., of New York, and the mine is known as Genessee Feldspar No. 1. It used to be the greatest producer of feldspar in Hastings county, but was not operated in 1929.

Most of the spar in the main dike above the level of the buildings and tram has been removed.

The main dike, which is 50 feet wide in some places, is one of the widest in the area. The country rock is an altered impure limestone with some interbanded igneous material. The walls of the dike are not so well defined as are those of some dikes in Hastings county. The country rock along the walls is shredded in a way that suggests replacement. A large open cut on top of the hill has produced considerable spar.

A part of the spar was mined by a semi-underground method, but as the mining proceeded quartz was encountered, and new openings were made



Crystals of albite and microcline at the McDonald mine (Genessee Feldspar No. 1).

at successively lower levels, each of which is north of the working above. It is possible that if still lower levels were opened to the north good microcline would be found.

The spar from the property is a pink microcline perthite of good quality. The quartz and feldspar individuals are large and well segregated, so that clean sorting of the material was possible.

The mineral association here is particularly interesting. Beside microcline and quartz, albite (and peristerite), tourmaline, hornblende, biotite, allanite, cyrtolite, fluorspar, calcite, ferriferous augite, ellsworthite, uranorthorite, rutile, magnetite, titanite, molybdenite, and pyrrhotite have been found. The radioactive minerals appear to be associated with the calcite and fluorite. The sulphides are, to some extent, intergrown with quartz and resemble the graphic granites in texture. Ellsworth[1] states that if the radioactive material had been saved here as mined, it might have been commercially feasible to extract the radium.

Two other quarries have been opened on this property, but they are not so large nor is the spar of as good a quality as that of the main dike.

Genessee Feldspar Mine No. 2(82).—The mine is on lot 14, concession VII, and was the only feldspar quarry in Hastings county operating in 1929.

[1]H. V. Ellsworth, op. cit., p. 17.

Work has been going on for about two years, and the production is about 10 tons a day.

The gneisses, which are the country rock, have been folded in a very complex manner. The calcareous members show evidence of flowage and are in part altered to granular pyroxene. The general strike of the country rock is about N. 30° W., and the dip is 30° E. The outline of the pegmatite is irregular. In part, it appears to have replaced the country rock. Inclusions are corroded and possibly drawn out. The extension of the main zone of the pegmatite to the west is almost entirely graphic granite, some of which is so fine that the mineral grains are almost invisible to the naked eye. At one place near the east end of the pegmatite the quartz and microcline are segregated, and it is here that mining has been carried on. The opening has a width of about 40 feet and a height of 25 feet; the face has been advanced about 40 feet. The irregularity of the dike makes it very difficult to ascertain its direction and width at this place. It is interesting to note that when the work started only a small amount of segregated spar was to be seen and that the larger body was opened later.

The spar has a pinkish tinge, but is discoloured by a brownish material, apparently caused by ground water along the joints. It is traversed by quartz veins, and irregular masses of quartz occur through it. The spar is much jointed, which makes it break into small pieces. As far as could be seen the quarry is free from mica and dark minerals.

A pegmatite dike(83) with much quartz and little spar is exposed at the south end of the lake west of the mine.

Woodcox(84).—The quarry, on lot 17, concession VIII, has been abandoned and is now filled with water. The dike strikes northeast. Its width is about 60 feet, but both walls are not exposed. The blocks on the dump show that much of the material was impure granitic pegmatite containing considerable allanite. Green microcline-perthite, peristerite, and some masses of coarsely crystalline white calcite were noted on the dump. This dike yielded a considerable amount of the radioactive mineral, hatchettolite, which shattered the feldspar around it for a considerable radius, and altered it to a deep red. The spar mined was of the common pink colour.

In the field to the west of this quarry and south of the farmhouse, the extension of the dike is composed almost entirely of a uniform graphic granite.

Thompson(85).—In this quarry on the farm of James Thompson, lot 11, concession VII, the dike strikes N. 70° E. and cuts granitized sediments and some granitic pegmatite dikes containing allanite and titanite. The dike is 22 feet wide and has been opened by a cut 150 feet long. The margins of the dike are composed of the granitic and graphic types of pegmatite. The middle part of the pegmatite was occupied by the segregated material, but the quartz content was high. About 50 feet west of the cut another opening has been made in the same dike, but the dike is practically entirely graphic granite. It contains some calcite and in some parts augite.

Lot 21, Concession VI(86).—An opening on this lot shows a pegmatite dike about 15 feet wide, trending N. 45° E. and cutting granite. The pegmatite is almost entirely graphic granite but shows a little pure microcline in one place on the bottom of the pit. Hornblende, titanite, and pyrite also are found in the dike. Another dike occurs a short distance to the north, but the amount of spar is small.

Lot 22, Concession VI(87).—An opening about 60 by 30 feet with a 20-foot face was made on this lot about ten years ago. The pegmatite is

principally of the graphic type, but shows some segregated microcline and albite. The dike also shows hornblende, tourmaline, pyrite, and magnetite, and a few grains of the radioactive mineral, euxenite.

Near the north end of this lot an adit has been driven about 100 feet on a pegmatite, which is from 12 to 15 feet wide. The pegmatite is principally graphic granite but shows some segregated microcline and albite with pyrite, titanite, and hornblende. Part of the microcline is stained with hematite. It is said that the operations were discontinued because of the difficulty in sorting the material underground.

Lot 23, Concession VI(88).—A 12-foot pegmatite on this lot is largely graphic granite but shows a little segregated microcline and albite.

Lot 24, Concession VI(89).—Two dikes on this lot have been worked to the west of the railroad. The southern dike has been exposed and worked in places over a length of 300 feet. It has an average width of 10 feet and consists of graphic granite with some segregated spar. Black tourmaline and titanite are the accessories.

A rather unusual pegmatite dike is exposed on the hillside just to the north of the one described above. It is about 8½ feet wide, strikes N. 50° E., and dips 70° N. The walls, which are of schist, are much better defined than is commonly the case, and the pegmatite has come out free. The dike contains pink microcline-perthite and a beautiful green microcline-perthite (amazon stone), which appears to grade into the pink variety. In addition, albite showing a play of colours on the side pinacoidal section (peristerite), forms masses within the dike. Some of the albite shows twinning according to the pericline law. It may be noted that the association of amazon stone and peristerite has been found in the Woodcox dike and also at Amelia Courthouse, Virginia.

Plunkett(90).—This dike on lot 20, concession VI, is of the graphic type and is exposed for 250 feet. It is about 30 feet wide.

A number of other dikes have been opened in this vicinity, but most of them show graphic granite without much crystal spar. If graphic granite is ever mined in this area, these should become important producers because dikes of this type do not contain much black mineral.

Taylor.—A dike was opened on the farm of D. E. Taylor, lot 12, concession VIII(91), by the Consolidated Feldspar Mines, Limited, in 1926. It is over 20 feet wide but is largely graphic granite with a little segregated spar. It appears to strike toward the workings of the Genessee Feldspar quarry No. 2.

On another property owned by D. E. Taylor, south half of lot 13, concession VIII(92), the pegmatite consists of granitic, graphic, and segregated material. The relationships are difficult to determine. The whole pegmatite appears to be replacing the gneisses irregularly. The granitic pegmatite appears to be cut by the graphic and segregated varieties. Some spar was quarried from the face of the hill, but the working place has been covered by debris. An adit has been driven but no spar has been taken from it. The pegmatite contains fluorspar and calcite, with which is associated some radioactive mineral. The granitic pegmatite contains considerable allanite. Some white spar, which is untwinned but is probably albite, has been left on the dump.

Best(93).—A small outcrop of pegmatitic material on the farm of Robert Best, lot 13, concession XIII, shows pink spar containing little quartz but considerable finely disseminated black mineral.

McClure Township

A pegmatite dike on lot 14, concession XII(94), shows a little spar with quartz and mica.[1]

Dungannon Township

Cooney(95).—Float found on the land of Wm. Cooney, south half of lot 26, concession XIII, shows pink spar without quartz. No work has been done, but the volume of float suggests that a dike of some width may be concealed.

MICA

There are several varieties of mica, of which white mica, or muscovite, is the one commonly mined. Amber mica, or phlogopite, is the rarest and most valuable, and outside of Ceylon and Madagascar, the provinces of Ontario and Quebec possess the only known economic deposits. Black mica, or biotite, is the commonest and least valuable variety of mica. The fact that mica cleaves into sheets, is semi-transparent, and a non-conductor of heat and electricity determines its principles uses. Most of the mica produced is used in the electrical industry.

Muscovite is of fairly widespread occurrence, and several attempts have been made to exploit it in Hastings county. A property was operated for a time north of Bird Creek along the line of the old Hastings road.

Muscovite was mined on lot 29, concession XI, of Elzevir(96) many years ago by D. E. K. Stewart, of Madoc. A dike consisting of tourmaline, quartz, feldspar, and muscovite cuts the garnetiferous mica schist. The mica plates are small and have many iron oxide inclusions. Muscovite has been found in many of the veins exploited for feldspar, but the sheets are small and interrupted by parting so that it would not pay to sort it out.

Phlogopite occurs on the property of Robt. Bartlett(97) on lot 1, concession IX, of Monteagle. Some work was done on the property several years ago. The dike is very irregular and contains phlogopite, scapolite, apatite, salite, calcite, and titanite, with quartz and feldspar. In parts of the dike the mica is found in considerable amounts, but it is badly interrupted by partings and could be of value only as scrap.

Biotite is widely distributed. It is found in the pegmatites of the granitic rocks and also the nepheline-syenite pegmatite. The material, however, is not very valuable, its price being about the same as that of scrap muscovite.

Biotite was seen in large flakes in the old Princess sodalite quarries on the farm of Leslie Younge, lot 27, range B, of Faraday township, where the flakes were sometimes 8 inches in diameter. The pegmatite, which contains sodalite and cancrinite, is exposed in several places along the hill.

A short distance west and about one and a quarter miles north of the road a considerable opening has been made for biotite. The pegmatite contains calcite, fluorite, apatite, and minor amounts of quartz and feldspar. The biotite occurs in crystals as large as 12 inches in diameter and in books several feet thick.

QUARTZ

The granite pegmatites of the segregated type commonly contain a a large amount of very pure quartz. It is expensive to remove the quartz during mining but it is necessary to do so to mine the spar. If a market could be found for the quartz it might help some of the quarries to show a profit. The quartz occurs in large blocks and is free from sulphide. It might be used in making glass and fused quartz, and as a metallurgical flux.

[1]This feldspar deposit occurs on the property of Judson Gunter. In 1930, it was stripped for a length of 200 feet and revealed a dike 40 feet in width. The spar is said to assay 12 per cent. potash.

RADIUM AND RARE EARTH ELEMENTS

The pegmatite dikes of Hastings county contain many of the rare earth elements and radioactive minerals. Ellsworth states that if the radioactive material had been sorted from the McDonald and Woodcox dikes that an amount sufficient to pay for the recovery of the radium might have been saved.[1] No large concentration of the radium-bearing minerals was noted in Hastings in the dikes of the segregated type. A great many of the dikes yield small amounts of the radium-bearing minerals on careful search.

The granitic pegmatites contain considerable allanite. This mineral contains some of the cerium earth group and also uranium and thorium. Allanite is quite abundant in the material mined by J. F. Ferrill on lots 27 and 28, concession III, of Monteagle. It is possible that by concentrating the material, the cerium earths and radium might be recovered. The radioactive shattering around the allanite has made the rock crush easily.

Three hundred pounds of the granitic pegmatite from the Ferrill occurrence were sent to the Temiskaming Testing Laboratories for a concentrating test. The product obtained from the Wilfley table amounted to 2.15 per cent. of the whole sample. Under the microscope, it is seen to consist of allanite, titanite, magnetite, zircon, and hornblende. The concentrate was analysed in the laboratories of the Ontario Department of Mines and gave 3.74 per cent. of the rare earth elements. Cerium, thorium, and zirconium were detected spectroscopically. This would amount to about 1.6 pounds of the rare earths recoverable from a ton of the granite pegmatite. As cerium is worth less than $5 a pound, it is doubtful if the deposit is of commercial value unless the content of radium, a degradation product of the thorium, is present in larger amounts than is now estimated.

SODALITE

Sodalite is one of the unique ornamental materials found in Hastings county. The blue colour is very distinctive. The chief drawback to the use of the material is the perfect cleavage, which makes it difficult to saw and polish. The sodalite is formed as a pneumatolitic facies of nepheline syenite or by the action of pegmatitic emanations on the already solid rock.

Dungannon Township

Princess Quarries(98).—On this property, which is on lot 25, concession XIV, the monmouthite facies of the nepheline syenite has been cut by pegmatites containing nepheline, albite, biotite, pyrrhotite, apatite, and magnetite. The pegmatite is irregular in shape and extends through a zone about 30 feet wide. Part of the nepheline of the pegmatite has been altered to sodalite veined with pink natrolite, and part of the surrounding nepheline syenite has been altered to sodalite. The original texture of the monmouthite has been preserved along with the albite and dark constituents. Where the replacement is less complete, spots or veins have been developed in the rock making it a material suitable for interior decoration. The stone quarried here shatters readily due to the explosive used. It cannot be dressed or sawed into thin slabs. Some sodalite and sunstone occur on lot 24.

Cooney(99).—Some work has been done on a pegmatite dike in the nepheline syenites on the land of William Cooney, north half of lot 26, concession XIII. The sodalite is associated with a honey-yellow cancrinite and a small amount of what is probably hydronephelite. It occurs in the pegmatite and replacing the country rock. The combination of blue, yellow,

[1]H. V. Ellsworth, op. cit., p. 17.

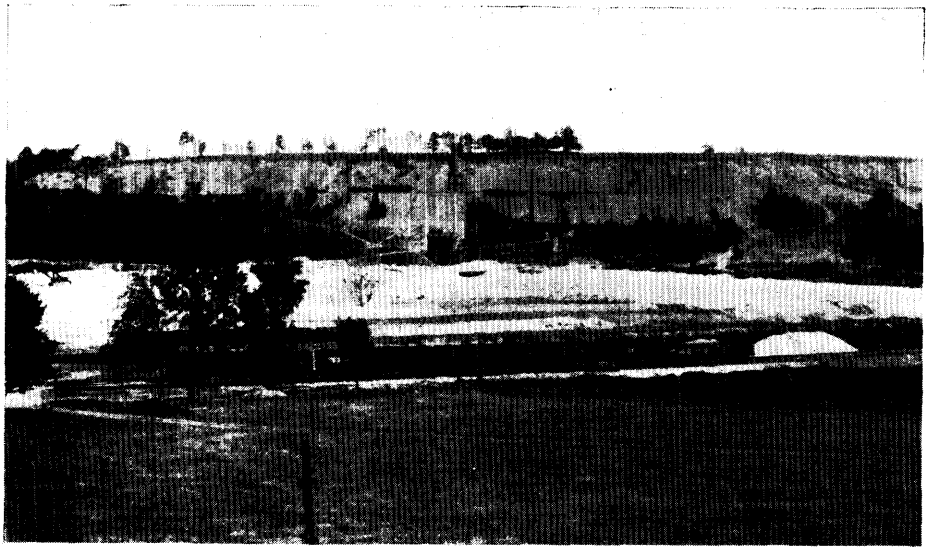
and white makes a very pleasing stone. The amount of ornamental material available here, however, is small.

Faraday Township

Younge(100).—An opening on the farm of Leslie Younge on lot 27, range B, shows white nepheline with cancrinite and sodalite. The material is highly ornamental and might be used for small ornamental objects. The opening was filled with debris, but the dike is said to be 4 feet wide.

Natural Gas and Petroleum

Up to the present no commercial production of oil or gas has been obtained in Hastings county. A very small quantity of oil was found in



View of the workings of Fuller Gravel, Limited, at Fuller.

the Ordovician limestone in the quarry at Crookston, but accumulations of oil in reservoirs cannot be expected, as the limestones are thin and broken by fissures.

The following memorandum was prepared by R. B. Harkness, Natural Gas Commissioner:—

To date, no oil or gas has been found in Hastings county in commercial quantities. So far as I know, only one well has been drilled for oil or gas; this was located at the village of Melrose in Tyendinaga township. The well was drilled 1,000 feet or more deep, and the records available show no oil or gas. It was located by some oil diviner, I believe, and carried down to the pre-Cambrian.

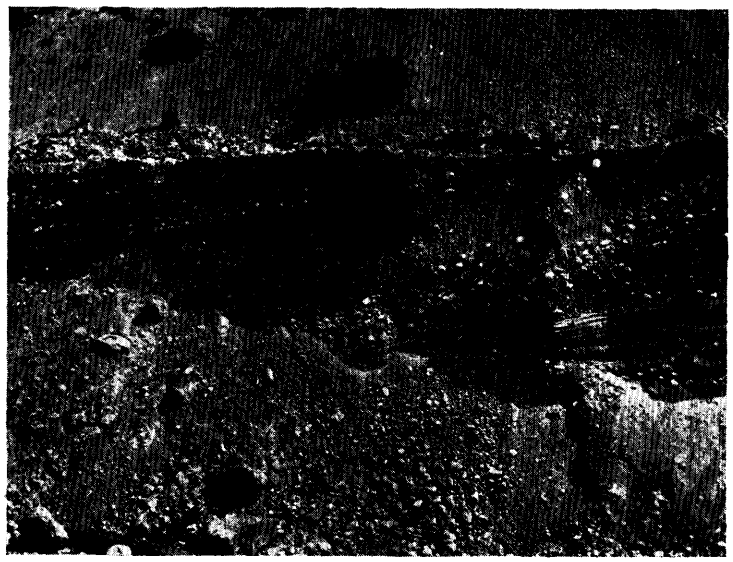
In later years, some gas was found at the village of Sterling, when a well was drilled for water in the High School yard. At about 35 feet, as I recall it, a flow of gas was encountered that blew water as high as the school roof, but apparently the gas occurred only in a pocket, for it flowed for only an hour or so. As far as my knowledge goes, this is the only occurrence of gas in Hastings county."

Sand and Gravel

The sand and gravel of Hastings county are either products of glacial outwash or of the action of post-glacial streams. The distribution of gravel throughout the county is not uniform, and its absence may be noted locally by the poor condition of the roads.

For the manufacture of concrete, sand and gravel should be free from clay, which prevents setting. Organic material is also undesirable. The deposit should not contain boulders too large to be handled readily, and a large number of limestone pebbles is undesirable for some uses.

The large esker near Trenton has provided much sand and gravel of good quality, but operations have been discontinued because the sand is used as a source of water for the town. Good gravel is found along the Trent river in Sidney township and in small amounts along the Moira river in Thurlow. Some gravel is also obtained north of Belleville. A slightly modified glacial till is used near Deseronto. Rawdon township has some gravel, but Marmora shows an almost total lack of good gravel. Madoc, Elzevir, and Hungtingdon have an adequate supply.



Lower bench in workings of Fuller Gravel, Limited, at Fuller.

In the northern townships of Hastings county the hummocky surface of the old rocks has made many basins in which the fluvio-glacial deposits of sand and gravel have been formed.

Huntingdon Township

Fuller Gravel, Limited(101).—On this property, lot 13, concessions IV and V, an esker-like ridge rises above the surrounding country. A working face about half a mile long has been opened on the north side of the hill near Fuller Station. The esker is strongly cross-bedded, and at the back of the cut there is a layer of boulder clay resembling till. The clay is thin but is found along the length of the working face and parallels the cross-bedding. Recent work has been on a new lower level instead of on the face. In former years, the presence of clay lowered the value of the sand, but the output in 1929 was free from clay.

The sand and gravel are steam-shovelled into cars and run to the washing plant. The occasional small boulders are broken in a jaw-breaker. The rock is washed and then sized by trommels. The sand is sluiced to the stock piles or directly into the cars.

Fuller Gravel, Limited, is operated by the Consolidated Sand and Gravel, Limited, which in turn is controlled by the Standard Paving and

Materials, Limited. The gravel ranges from three-eighths to 2 inches, and the daily production of sand and gravel is about 1,600 tons. In 1929, production of sand and washed gravel was approximately 20,000 tons, and total wages paid exceeded $40,000. More than forty men are employed. S. H. Pender is superintendent of the property.

Stone

Building stone has been quarried in many places in Hastings county, but most of the old quarries have been abandoned or are worked spasmodically. Some quarries supply stone for local demand only, but a number of others ship to outside points.

The building stones of Hastings county have been described by W. A. Parks in a report[1] published in 1912 by the Mines Branch, Ottawa.

GRANITE

The term "granite" is used in a broader sense by the quarryman than the geologist. In the quarry it is applied to all types of light to dark coloured igneous or metamorphic rock.

Wollaston Township

Ebonridge Quarries, Limited(102).—The Ebonridge Quarries, Limited, operated a quarry on lots 23 and 24, concession V, for granite during 1929. The stone, which is called heather granite, shows pink and grey feldspar, grey quartz, and black mica. The rock is medium-grained and has a tendency toward gneissic structure. Microscopic examination shows that the feldspars, microcline and albite, are slightly porphyritic. The matrix consists of microcline, albite, quartz, and biotite. Apatite, iron ores, and titanite are the accessory minerals. An unusual feature of the rock is the presence of carbonate. The microcline is somewhat clouded, but the rock has not undergone much alteration.

In the quarry the rock shows a faintly gneissic structure. The basic schlieren are elongated N. 40° W. and dip vertically.

The horizontal joints are parallel to the surface of the hill and strike N. 12° W. and dip 5° E. In most granite quarries these joints are farther apart at depth, but here they appear to be closer together, although the quarry has not been opened to a sufficient depth to give absolute proof. The face joints strike N. 30° W. and dip vertically. A number of pegmatite stringers less than an inch wide cut the granite. They strike N. 54° W. and dip 70° S. In one place an irregular mass of granite of coarser texture cuts the normal granite.

Farther up the hill a quarry has been opened in a dark-coloured rock (malchite), which is in contact with the granite to the north. Near its borders it contains many rounded fragments of granite and some nodules, which are probably more completely digested granite fragments. The "black granite" is cut by a pegmatite dike 3 inches wide. The jointing of the rock is irregular, but three main patterns may be recognized: N. 80° E. and vertical, N. 20° W. and vertical, and N. 35° E. and 72° W. The jointing causes the rock to break into parallel pipes and wedge-shaped pieces.

The sombre colour of the stone is relieved somewhat by the light-coloured, sporadic phenocrysts of plagioclase, the nodules derived from the granite, and the stringers of pegmatite. The joints show considerable pyrite and some is found within the rock; the stone would in time become discoloured if used in exposed places. Microscopic examination shows the phenocrysts of plagioclase set in a matrix consisting of hornblende and biotite.

[1]W. A. Parks, Report on the Building and Ornamental Stones of Canada, Vol. I, Mines Branch, Publication No. 100, Ottawa, 1912.

Considerable heather granite dimension stone was shipped from this property during the summer of 1930. Some granite blocks over 14 feet in length were moved out over the road to the station. The equipment on the property consists of gasoline compressor, steam hoist, feathering drills, etc.

Bachelor Granite Quarry(103).—This quarry is on the north slope of the hill near the Ebonridge Quarries. The granite is finer grained than the Ebonridge but is similar in mineral content even to the carbonate. The joints are more closely spaced than at the Ebonridge, and smaller blocks were quarried.

A number of other quarries near Coehill have been operated for granite.

Muffit(104).—C. E. Muffit, of Bancroft, has done some work on a band of gneissic granite cutting limestone about one mile south of Coehill station, on lots 15, 16, and 17, concession VII. The rock is much finer



Ebonridge granite quarry, Wollaston township

grained than the Ebonridge granite and a deep pink colour. It is traversed by a number of granite pegmatite dikes, and the joints are rather closely spaced so that large dimension stone could not be removed, but some of the stone might be used for monumental work. A stone in the graveyard at Coehill made from this granite has kept its colour well and has a pleasing appearance.

Hungerford Township

Courneya(105).—A granite gneiss has been quarried for local use on the farm of Felix Courneya, lot 24, concession IX. The stone is closely jointed and the foliation makes it break into small blocks. The stone is of a pinkish-brown colour and is cut by many stringers of pegmatite, which in no way detract from the appearance of the stone. The stone has been used for the Church of St. Edmunds and its presbytery at Stoco Lake. In the buildings the rock gives a rich brown tone that is very pleasing. The church, which is in the course of construction, has Crookston limestone for the trim and plinth courses. According to the masons engaged on the building, the stone works readily.

Hastings Quarry(106).—Hastings Quarries, Limited, operated two quarries next the railroad, on lot 11 or 12, concession XIV. One was for a crystalline limestone and the other for granite gneiss. The granite gneiss is well foliated and of a general pink colour. Under the microscope microcline, plagioclase, quartz, and mica may be seen. The rock shows a crushed texture. The joints are closely spaced, and the stone is only suitable for small buildings or for crushed stone.

Elzevir Township

Lots 8, 9, 10, Concession XI(107).—Along the Actinolite-Flinton road, a grey granite outcrops, which in places is massive and free from stringers of pegmatite. Several localities were noted where it might pay to test the stone. The rock is a pleasing grey colour. The microscope shows it to consist of quartz, microcline, oligoclase, and biotite. The plagioclase has been slightly altered, giving rise to sericite and epidote. Specimens examined showed no sulphides.

LIMESTONE

The term "limestone" is applied to rocks composed of calcium carbonate that have not undergone sufficient metamorphism to be recrystallized. If crystalline they may be called crystalline limestone; if they are of decorative material, they may be called marble. The limestones used for building stone in Hastings county are practically all of Ordovician age and are, therefore, restricted in occurrence to the southern part of the county.

In addition to its use as a building stone, limestone may be used for the manufacture of cement, as at Point Anne, where extensive quarries are being operated. Part of the output at Point Anne is crushed and used for ballast by the Canadian National Railways. Many roadside quarries have been opened in Hastings county for road metal. Limestone may be burned to provide quicklime for plastering or for liming fields. Small quarries and kilns are in operation to meet local requirements.

Limestone may be used as lithographic stone if it is sufficiently fine grained and uniform in texture. It must be porous enough to absorb ink and soft enough to engrave. In recent years the use of lithographic stone has fallen off because the photographic processes on zinc, copper, or steel are cheaper and more rapid. In the past, some six or seven quarries were operated in Hastings county for lithographic stone. The largest is at Crow lake(108) on lot 8, concession III, Marmora. It was operated by the American Lithograph and Asbestos Company, and had saws, rubbing beds, and planers.

Another quarry was opened along the Crow river just below the Pearce Company quarry. Some stone was shipped from the quarry on the farm of Chas. Robinson(109), on lot 8, concession V, Madoc.

The largest quarries operated for building stone are near Crookston. The Point Anne quarries are larger, but of recent years practically the entire output has been used for Portland cement, although in the past small amount of stone was used for buildings and canal work.

Huntingdon Township

Crookston Quarries(110).—The Gibson and the Quinlan, Robertson and Janin quarries are both at Crookston, on lot 10, concession IX. The Ordovician limestones are fine-grained and grey in colour but weather to a lighter shade. The beds are from 1½ to 6 feet thick, and the extensive work done here makes it possible to quarry stone from any bed. The heavy bedding and fine grain of the limestone make it suitable for use in heavy abutments for bridges and railway construction. The smaller stone

is a good building stone. Although the stone from different beds varies somewhat in shade, it is said to become more uniform on weathering.

The Quinlan, Robertson and Janin quarry was operated in 1927 for stone for the Montreal bridge.

Hungerford Township

A quarry to the north of Tweed on the farm of Frank Meraw is said to yield a stone very like that from Crookston.

Marmora Township

Pearce Quarry(111).—The basal beds of the limestone have been quarried in a number of places near Marmora. The principal quarry is that owned by the Pearce Company, Limited, of Marmora, on lot 7, concession IV, near the west end of the bridge across the Crow river. The stone is of such fine grain that it is sublithographic. The slightly weathered surface shows faintly wavy and irregular lines of stratification. The prominent joints are from 1 to 14 inches apart, but most of the stone produced has been from 5 to 12 inches in thickness. The stone as quarried has a faint brown colour but on exposure to weather it whitens. Calcite crystals, some of which are as large as an egg, detract from the appearance of some blocks. Stone from this quarry gave the highest crushing strength (37,705 pounds per square inch) of any limestone tested by Parks.[1] It is also durable, as shown by the old church at Marmora, which shows little effect of weathering, although it was built more than a hundred years ago. The principal objection to its use is its brittleness. It breaks with a conchoidal fracture, which mars the appearance of the dressed surfaces. The rock face is, however, very pleasing.

Madoc Township

McIntosh(112).—Several quarries have been opened in the outliers of Ordovician limestone north of Madoc. About 135 cords of limestone were taken from the farm of Hugh McIntosh, lot 7, concession V, for the new Albert College at Belleville. The quarry is very small.

MARBLE

Marble is the variety of crystalline limestone that is capable of taking a good polish and is suitable for use as ornamental material. In Hastings county the Grenville limestones have recrystallized near the igneous intrusions, and some of the crystalline limestone is sufficiently ornamental to be used as marble. The main occurrences lie a short distance south of the northern belt of gneisses. A number of attempts have been made to operate quarries near Bancroft. Other occurrences are found near the Moira granite close to the edge of the Paleozoic rocks.

Most marble is used in interior work, but some is used outside. If the material is exposed to the weather or moisture it must be free from iron sulphide. Some of the marbles in Hastings county show considerable iron sulphide and are therefore unsuitable for exterior work.

Most of the occurrences have been well described in the report by W. A. Parks,[2] to which the reader is referred for further information.

Dungannon Township

Ontario Marble Quarries, Limited.—The most extensive work was done by the Ontario Marble Quarries, Limited. They operated several quarries

[1]W. A. Parks, op. cit., p. 223.
[2]W. A. Parks, ibid.

and a mill for sawing and polishing the marble. The mill is on lot 30, concession X, but has not been operated by the Ontario Marble Quarries, Limited, since 1915. Later, the plant was leased by the Bancroft Marble Quarries, Limited, and operated in 1918 and 1919 for stone for the Parliament Buildings at Ottawa. Practically no work has been done since.

The Stewart quarry(113) is on lots 29 and 30, concession X. A steel derrick is standing, but no stone has been taken out for some time. White, green and white variegated, and brecciated marbles have been quarried.

The McMillan quarry(114), which is some distance to the east, was last operated for stone for the Parliament Buildings and is now filled with water. The marble is white and has a rather coarse grain. The blocks as quarried were of considerable size, but much waste was left on the ground.



Dike cutting brecciated marble in the quarry of Ontario Marble Quarries, Limited, Faraday township.

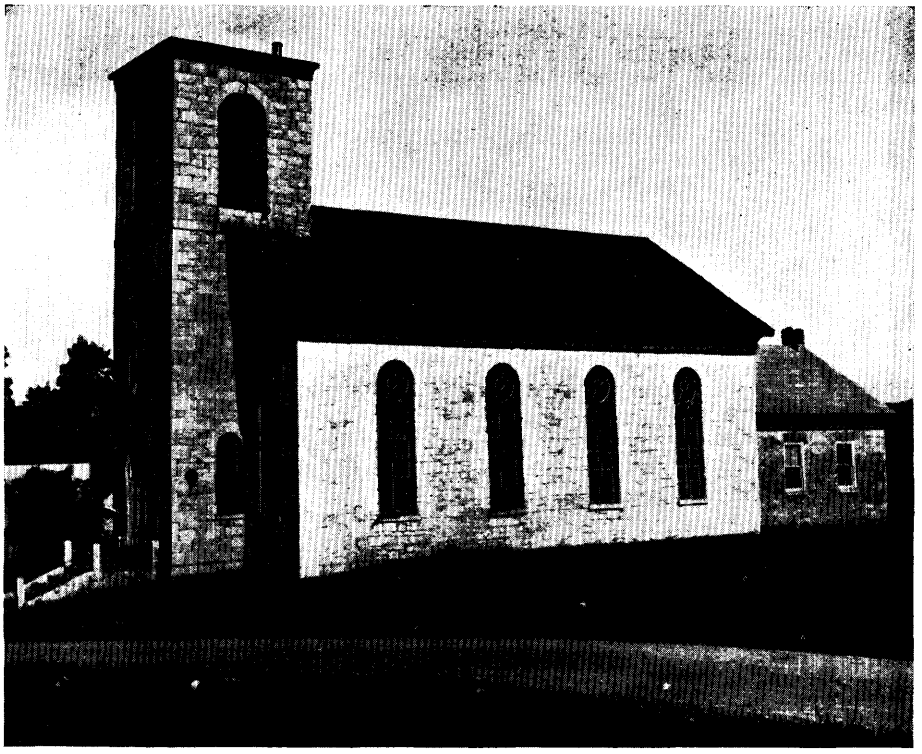
Faraday Township

Ontario Marble Quarries, Limited(115).—The quarry on lots 41 and 42, Hastings road, shows the greatest variety of marble. It has a face about 40 yards long, and about nine varieties of marble have been extracted from it. The most striking variety is a breccia composed of crystalline limestone fragments cemented by a material consisting almost entirely of black mica. Rose, variegated rose and grey, and variegated green and white marbles have been quarried. The marble is cut by two basic dikes. The quarry was last operated in 1912 when stone for the Standard Bank Building in Toronto was taken out. Some very beautiful rose and grey variegated marbles were seen on a ridge to the south of the quarry, and it is said that there are a number of varieties to the west.

Some of the varieties of marble obtained on this property are very beautiful and well able to compete in appearance with foreign stone, but they are not being exploited at the present time. Sufficient work has been done to show the varieties and quantity of marble available. The excessive cost of production appears to be the factor that prevents marketing the stone.

One of the most important factors is probably the lack of experienced local labor. This disability is inherent where a new industry is started. Another factor is the large amount of waste produced. At the McMillan quarry, for example, the extraction of waste must have been nearly as costly as that of the stone. The amount of waste may be expected to decrease as the quarry becomes larger and the quarrymen more experienced.

Marble is composed of crystals of calcite, a mineral with a very perfect cleavage, and if the grains are large they tend to make the marble brittle. Some of the marble from this property is coarse-grained and as tested by



United church at Actinolite, built over fifty years ago of marble from a local quarry.

the hammer, quite brittle. This is a serious defect, because the marble breaks under the dressing tools. If the marble worker is accustomed to a less brittle stone, it is easy to see that considerable breakage may result. Part of the difficulty may be overcome with practice in handling the stone.

Richie Quarry(116).—A quarry about 30 by 35 by 6 feet was opened on the farm of Wm. Goebel, on the south half of lot 2, concession XII, and a spur built from the Central Ontario railway about 1½ miles away. The marble is white and coarse-grained. It contains considerable pyrite, which renders it unsuitable for exterior use, and it is too brittle for sawing. The tracks have been removed and, so far as known, no stone has been shipped. Somewhat similar stone is found on the north half of the lot.

Madoc Township

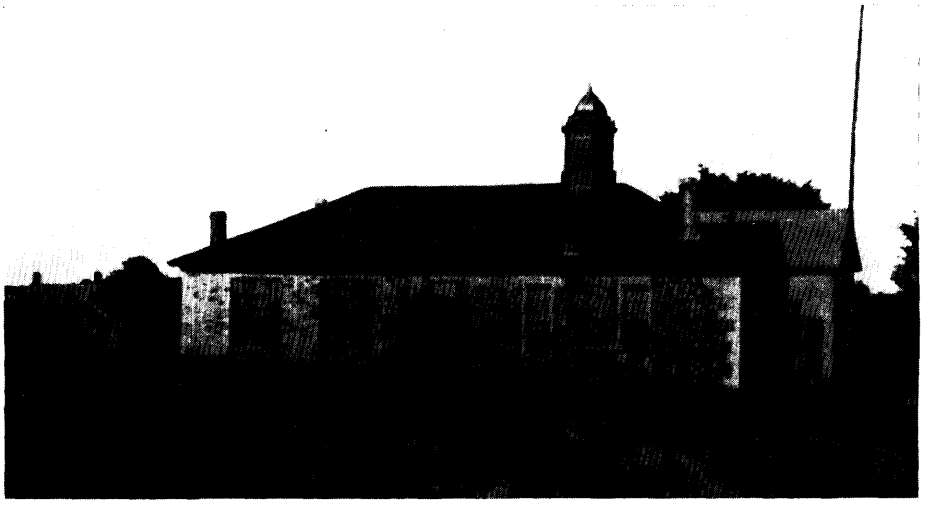
Madoc Village(117).—The black marble found on the south side of Madoc village is a unique and beautiful material. It consists of dark bands

alternating with slightly lighter bands, the whole giving a pleasing effect. The quantity of material available is practically unlimited, yet the quarry has not been operated for forty years and is now full of water. As nearly as could be ascertained the blocks extracted were not sufficiently large. Some material on the dump shows considerable pyrite, so the stone could not be used for exterior work.

Marmora Township

The following information on a property on lot 13, concession III (117a), which was not examined by the writer, has recently been received:—

On the property of D. and L. McGrath, part of lot 13, concession III, prospecting for iron was carried on in 1913 by United States interests. Diamond-drilling to a depth of 500 feet revealed marble, under a thin capping of iron ore. A core-drill was introduced and six cores



School at Actinolite built over a hundred years ago of field stone and marble from a nearby quarry.

to a depth of 130 feet were removed, disclosing a fine grade of marble remarkably free from seams and other imperfections. The marble is said to analyse 98 per cent. calcium carbonate, takes a fine polish, and in colour is white, shading to pink, green, and black.

Owing to the war and difficulty in arriving at terms with the owner, the property has lain dormant until recently. In April, 1931, calyx core drills were put to work on the deposit to check cores previously removed. This test is being carried out by C. M. Doolittle, president of Queenston Quarries, Limited, and associates. If results come up to expectations and the local market supports the effort, Mr. Doolittle hopes that actual quarry operations will be started by midsummer. The Canadian National railway runs through the property.

Elzevir Township

Actinolite Village(118).—Several marble quarries have been operated near Actinolite. One was opened by Hon. Billa Flint many years ago. The old marble church and school at Actinolite demonstrate the durability of the stone, which was quarried immediately back of the church. Some field stone was used in the construction of the school, which has withstood the weather for over a hundred years.

Feather Amphibolite

Feather amphibolite is the variety of amphibolite developed from impure dolomite in which the amphiboles form a star-shaped pattern. Much

of it would take a good polish and could be used for interior work. It is widely developed in Hastings county.

MARL

Marl is a fine-grained, compact variety of calcium carbonate, usually formed in fresh water. Part of the marl is formed by direct precipitation by bacteria and part is derived from the shells of molluscs. The marl in Hastings county is found in depressions in the glacial drift.

The deposit near Marlbank(119), which was used in the manufacture of Portland cement, is the largest. The deposit is in a lake basin lying between a terminal moraine to the north and an escarpment formed by the Ordovician limestone to the south.

The Ontario Natural Products Company did some work on a deposit of marl in a lake on lot 15 or 16, concession VII, of Rawdon(120).

Adams and Barlow[1] have noted the occurrence of marl in Blue Sea lake at the head of Beaver creek in concessions XII and XIII of the township of Limerick. They mention an occurrence[2] at Snow lake on lot 24, concession IX, of Wollaston. The writer visited this lot and could not find any marl at a depth of one foot along the south shore of the lake.

SLATE

Slate is a metamorphosed fine-grained rock that may be split into thin slabs. In general, the rocks of Hastings county have been so intensely metamorphosed as to form schists, phyllites, and gneisses. An attempt has been made to quarry slate on lot 5, concession VI, of Madoc. The slate could not be split to sufficient thinness for use as roofing and the attempt was abandoned after a pit had been carried down about 40 feet. The pit is now full of water.

STUCCO AND STUCCO DASH

Material of a desirable colour that is easily and cheaply mined may be used for stucco dash. The waste from feldspar mining and some pegmatites with granitic texture have been used. The colour most in demand is pure white, and the crystalline limestones and dolomites meet this demand.

Faraday Township

The Crystallite Stone Products, Limited(121), of Hamilton, have operated a dolomite quarry on the farm of Alfred Carfrae, west of Bancroft, since 1923. During 1928, 2,400 tons were shipped. The dolomite occurs in a 20-foot bed, striking N. 75° E. and dipping 60° S. and has amphibolite on the footwall and impure limestone on the hanging wall. It is mined from an open cut about 100 feet long with a face of 30 feet. A similar cut has been worked out. Only the paper-white dolomite is used, stone with even a faint bluish tint being discarded. A 2-inch vein of violet scapolite with phlogopite cuts the hanging-wall side of the deposit. A short distance to the south, a hornblende gabbro has been quarried for its dark minerals.

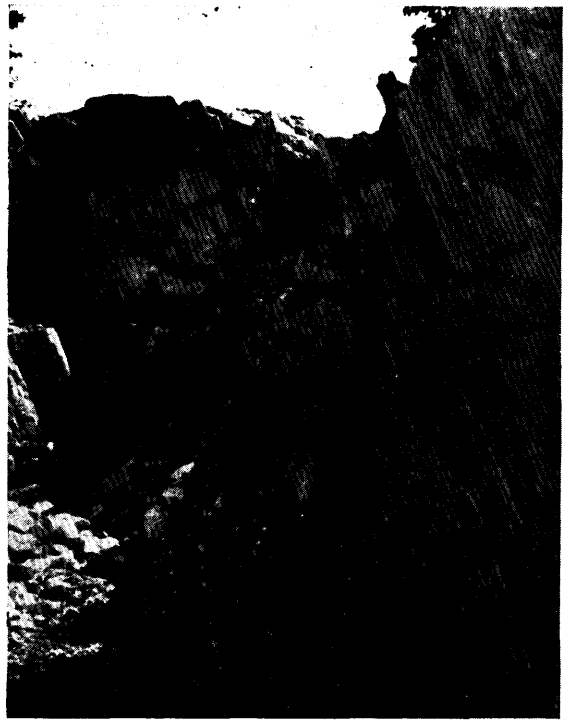
Marmora Township

A quarry on the farm of Ben Demas(122), lot 9, concession IV, has been opened by the Bonter Brothers, of Marmora. The crystalline limestone, which is cut by a number of dikes, is not as white as that from the quarry of the Crystallite Stone Products, Limited. It is intended to use a 70 h.p. engine to drive a crushing and sizing plant for stucco dust, stucco dash, and filler for artificial stone. The plant was reported in operation late in 1929.

[1]Geol. Surv. Can., Mem. 6, 1910, p. 387.
[2]Ibid.

Monteagle Township

J. F. Ferrill(123) has worked a body of granite pegmatite on lots 27 and 28, concession III. The pegmatite, which strikes N. 30° E. and dips 30° E., has an exposed thickness of 30 feet. Similar material is found in the ridge to the north. The pegmatite contains quartz and feldspar with augite, titanite, and allanite. The radioactive allanite has shattered the light minerals, making the rock much easier to mine and crush. The extraordinarily high content of allanite suggests that this dike might produce



Dolomite quarry of the Crystallite Stone Products Company in Faraday township.

other radioactive minerals and some of the rare earth minerals. About 15 cars have been shipped to Hamilton.

R. W. Best has shipped a coarse-grained limestone from lot 23, concession XIII.

Herschel Township

An abandoned stucco-dash quarry just west of Baptiste station has yielded green and yellow material from a band of serpentinous limestone.

Dungannon Township

D. J. Molloy has shipped a tremolitic limestone from lot 28, concession III; and a coarse pink calcite has been shipped from a quarry south of the McMillan.

Talc

Talc is a hydrous silicate of magnesium. It is extremely soft and tends to cleave into thin flakes; these properties make it valuable as a lubricant.

It is chemically inert and is not affected by the common acids, which enables it to be used for such articles as table-tops. Its white colour and softness make it valuable for talcum powder.

The occurrences of talc near Madoc were known over a hundred years ago, and a road was built from Marmora to Moira lake to bring out the talc, which was used for lining iron furnaces. Alexander Murray, in the Report of Progress of the Geological Survey of Canada, for the year 1852-53, mentions the occurrence of talc schists a short distance north of Madoc village, but no systematic attempts to exploit the talc were made until 1896. It is said that the talc on what is now the Henderson property was known from 1880. Operations from 1896 till 1905 were spasmodic, but since then the Henderson mine has been worked continuously.

The talc mined at Madoc is far from pure, but for many years it brought a higher price than that mined in the eastern part of the United States.



View of the Henderson mine, Huntingdon township, showing shafthead at the left.

The mineral impurities, of which dolomite is the chief, are not disadvantageous for many uses. Various methods for eliminating the dolomite have been devised, but none of them have proved to be commercially feasible. Tremolite and quartz are less common in the talc at Madoc than in many other localities.

The writer noted several occurrences of talc in the tremolitic dolomites. One such zone, north of Coehill, is about 4 feet wide. The talc contains much tremolite and carbonate. Another occurrence in concession XI of Lake township is back of B. G. Airhart's mill. The talc is of very low grade.

The talc deposits of Hastings county have been described in the various reports of the Ontario Department of Mines. The report by H. S. Spence on "Talc and Soapstone in Canada," published in 1922 by the Mines Branch,[1] Ottawa, gives a great deal of information on the occurrence of the mineral and its uses. The most complete descriptions of the geology of the talc deposits are to be found in a report by M. W. Wilson, entitled "Talc Deposits of Canada," published in 1926 by the Geological Survey of Canada.[2]

[1]Publication No. 583.
[2]Economic Series No. 2.

Production of talc in the Madoc area during the past five years has ranged from 13,614 tons in 1925, to 15,463 tons in 1929. The total value of ground talc marketed in 1929 was $180,492. From 40 to 60 men are employed in the industry, and wages paid range from $40,000 to $50,000 a year.

Huntingdon Township

Henderson Mine(124).—This property is situated in lot 14, concession XIV, and is the oldest talc mine in Hastings county. It is owned by the Geo. H. Gillespie Company, who have operated it since 1918.

The country rock is highly contorted tremolitic dolomite, crystalline limestone, and quartzite. Parts of the tremolitic dolomite have been altered



Talc grinding mill of the Geo. H. Gillespie Company, Madoc.

to talc. The talc is itself folded and dikes of a tourmaline rock, called madocite by Wilson, have been folded with it. The madocite has slickensided contacts against the talc and is itself broken.

The deposit is 900 feet long and, in places, 65 feet wide, the average width being 30 feet. The talc along the margins is hard and contains impurities. Since the mine was visited by Wilson in 1924, the shaft has been deepened and another level opened. The talc on this level is the same grade as that on the higher levels.

Connolly Mine(125).—This property, which is directly east of the Henderson mine on lot 15, concession XIV, is owned by the Canada Talc Company, Limited, formerly known as the Asbestos Pulp Company. Roy Taylor is manager.

The zone of high-grade talc is a direct continuation of that from the Henderson mine, and the madocite, tremolitic dolomite, and quartzite of the Henderson mine are also found here. The width of the deposit ranges from 5 to 25 feet. The workings have been deepened to 400 feet, and the talc is of the same character as that on the higher levels. Five men are employed underground.

The mill, which is near the shaft collar, produces about 25 tons a day in six sizes: 100, 125, 150, 175, 200, and 325 mesh. According to Henry Taylor, 25 per cent. of the production is used in toilet preparations. About

7 per cent. of the production is sent to Europe, and 65 per cent. to the United States. The talc contains about 6 per cent. CaO.

Lot 16, Concession XIV(126).—Occurrences of talc have been noted here, but no large bodies have yet been found.

Madoc Township

Eldorado Mining and Milling Company(127).—This property on lots 20 and 21, concessions IV and V, has been held by several companies. The latest work was done in 1920 by the Eldorado Mining and Milling Company. The country rock is similar to that of the Madoc area, and there are several granite dikes. No madocite has been found. The property was developed by two shafts, which are now inaccessible. The surface shows low-grade talcose material, which was ground for roofing. The mill is in bad repair.

Lot 15, Concession XI(128).—Impure talc outcrops a few hundred yards east of the farmhouse on this lot.

Grimsthorpe Township

An occurrence of remarkably pure talc on lot 9, concession V(129) has been described by Spence,[1] and Wilson.[2] The locality was not visited by the writer. The talc is light-green and lamellar, forming a vein from 10 to 14 inches wide cutting a serpentine rock.

[1]Op. cit., p. 25.
[2]Op. cit., pp. 90, 91.

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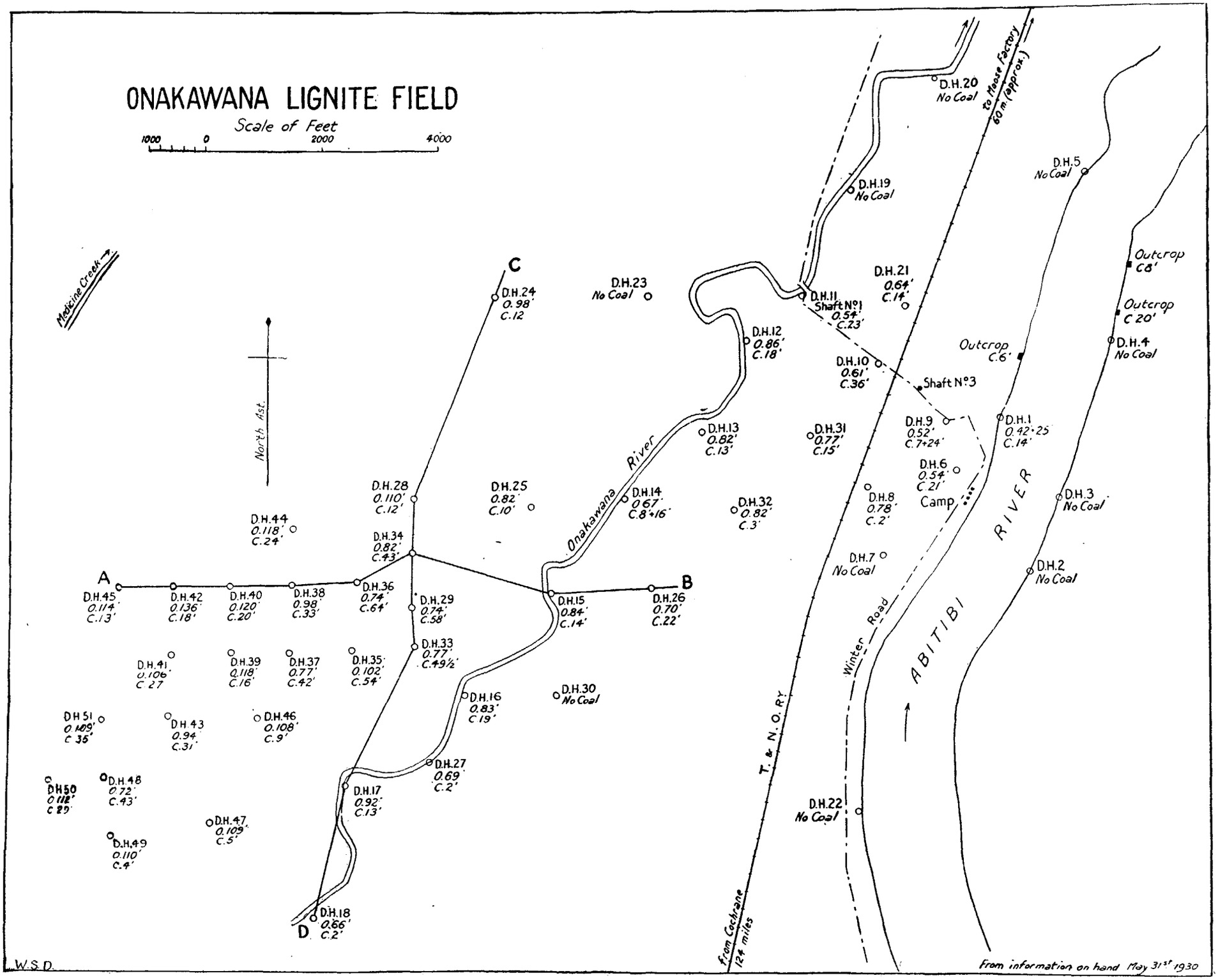


Fig. 3—Plan showing positions of drill holes and shafts, also thickness in feet of overburden (*O*) and lignite (*C*) at each drill hole.

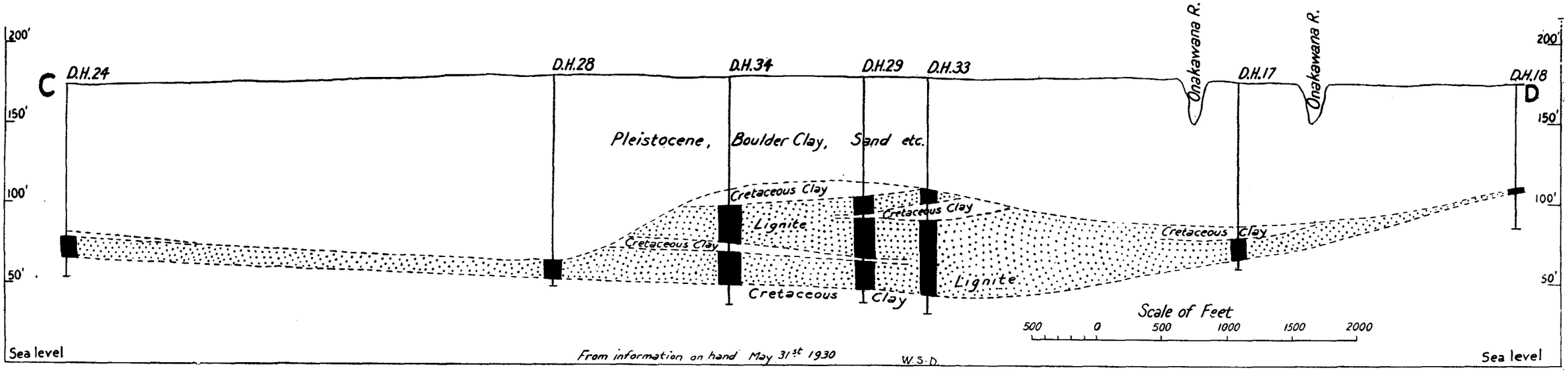


Fig. 4—Section CD through Onakawana lignite field between drill holes 24 and 18.

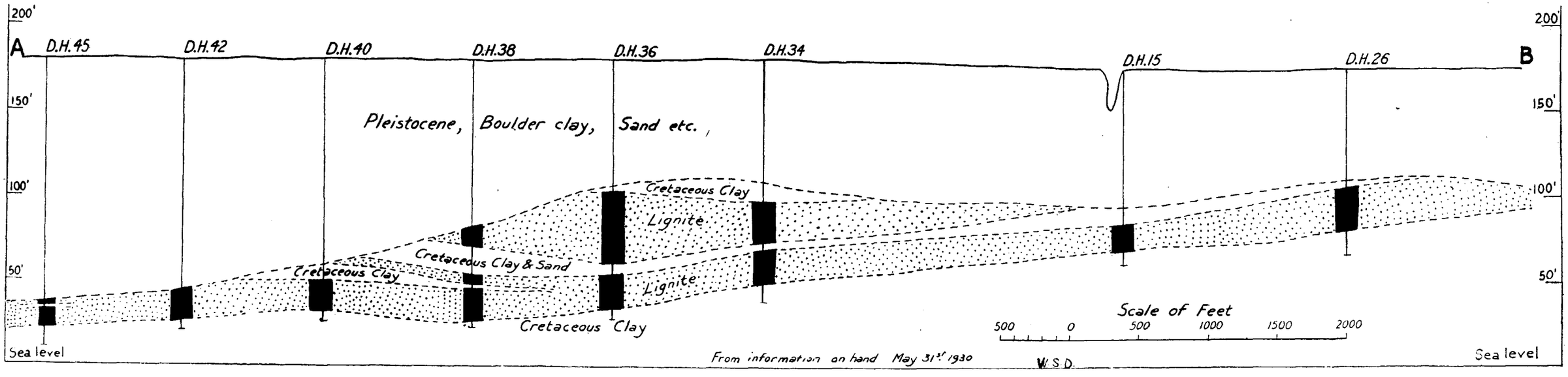


Fig. 5—Section AB through Onakawana lignite field between drill holes 45 and 26.

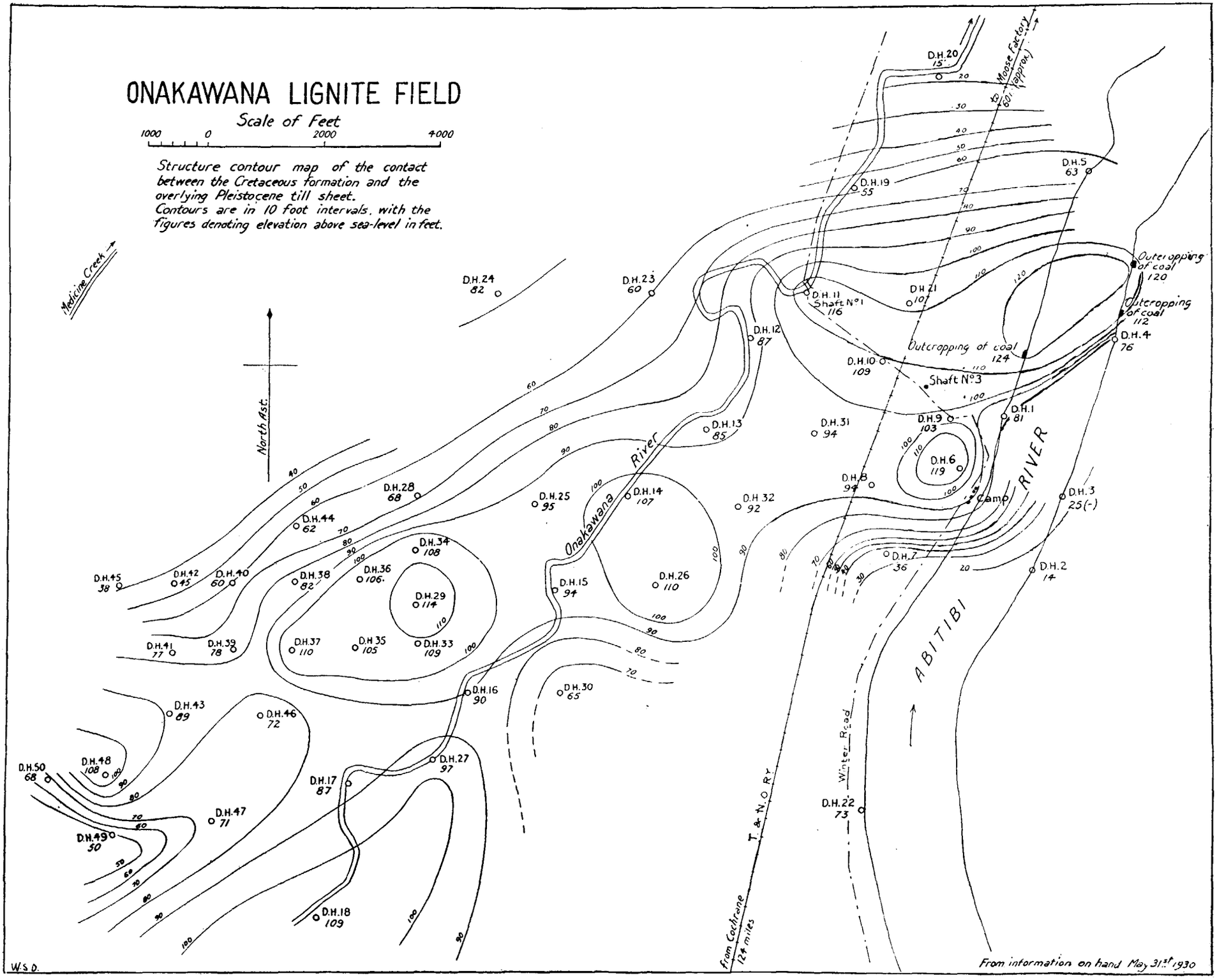

ONAKAWANA LIGNITE FIELD
Scale of Feet
1000 0 2000 4000
Structure contour map of the contact between the Cretaceous formation and the overlying Pleistocene till sheet.
Contours are in 10 foot intervals, with the figures denoting elevation above sea-level in feet.
Medicine Creek
North Ast.
Onakawana River
Camp
ABITIBI RIVER
T & N O R Y
Winter Road
Moose Factory (approx.)
Outcropping of coal 120
Outcropping of coal 112
Outcropping of coal 124
Shaft No. 1
Shaft No. 3
D.H.1 81
D.H.2 14
D.H.3 25(-)
D.H.4 76
D.H.5 63
D.H.6 119
D.H.7 36
D.H.8 94
D.H.9 103
D.H.10 109
D.H.11 116
D.H.12 87
D.H.13 85
D.H.14 107
D.H.15 94
D.H.16 90
D.H.17 87
D.H.18 109
D.H.19 55
D.H.20 15
D.H.21 101
D.H.22 73
D.H.23 60
D.H.24 82
D.H.25 95
D.H.26 110
D.H.27 97
D.H.28 68
D.H.29 114
D.H.30 65
D.H.31 94
D.H.32 92
D.H.33 109
D.H.34 108
D.H.35 105
D.H.36 106
D.H.37 110
D.H.38 82
D.H.39 78
D.H.40 60
D.H.41 77
D.H.42 45
D.H.43 89
D.H.44 62
D.H.45 38
D.H.46 72
D.H.47 71
D.H.48 108
D.H.49 50
D.H.50 68
From Cochrane 124 miles
From information on hand May 31st 1930
W.S.D.

Fig. 6

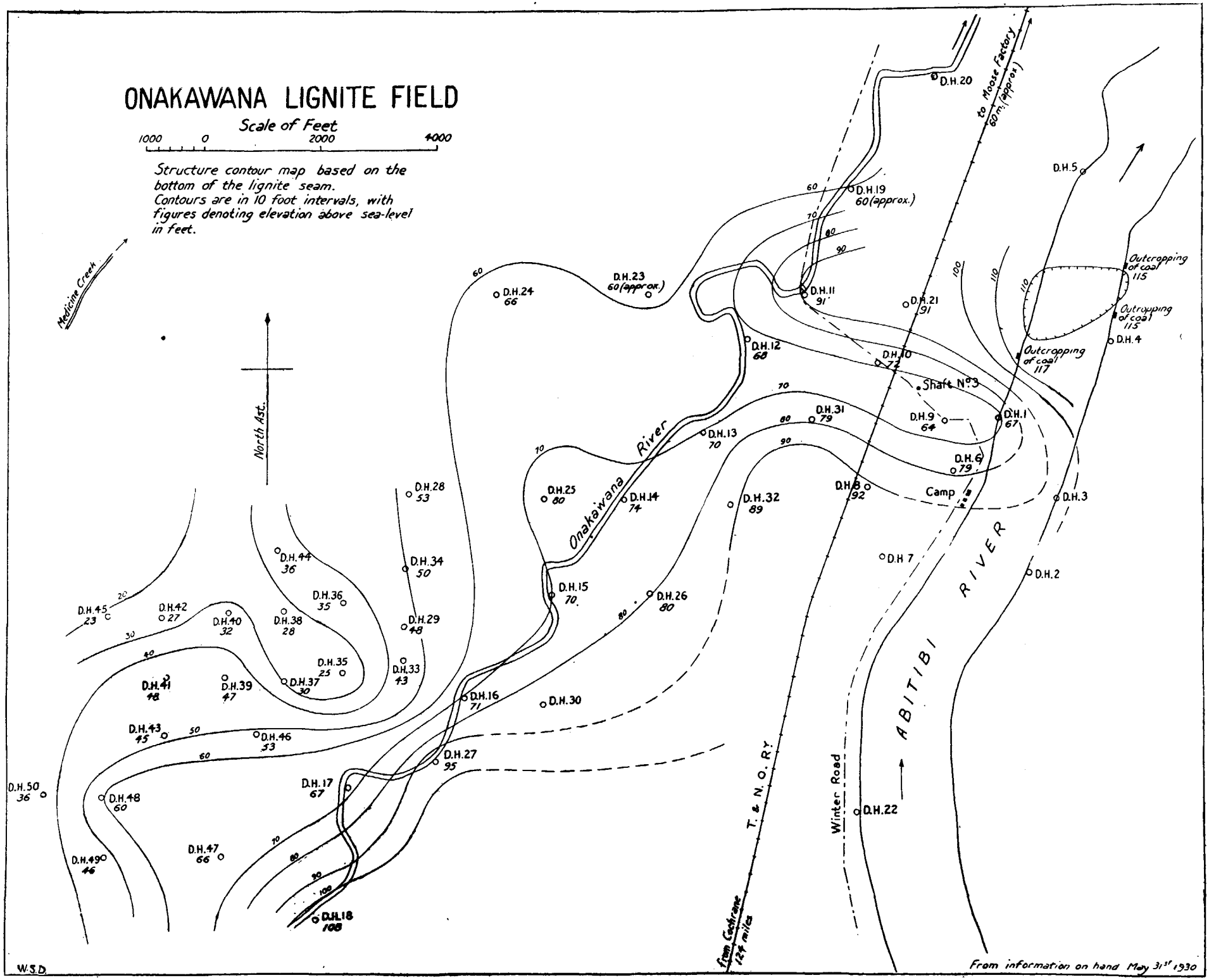

ONAKAWANA LIGNITE FIELD
Scale of Feet
1000 0 2000 4000
Structure contour map based on the bottom of the lignite seam.
Contours are in 10 foot intervals, with figures denoting elevation above sea-level in feet.
Medicine Creek
North Ast.
Onakawana River
ABITIBI RIVER
T. & N. O. RY.
Winter Road
to Moose Factory 60 m. (approx.)
from Cochrane 124 miles
Shaft No 3
Camp
Outcropping of coal 115
Outcropping of coal 115
Outcropping of coal 117
D.H.1 67
D.H.2
D.H.3
D.H.4
D.H.5
D.H.6 79
D.H.7
D.H.8 92
D.H.9 64
D.H.10 72
D.H.11 91
D.H.12 68
D.H.13 70
D.H.14 74
D.H.15 70
D.H.16 71
D.H.17 67
D.H.18 108
D.H.19 60(approx.)
D.H.20
D.H.21 91
D.H.22
D.H.23 60(approx.)
D.H.24 66
D.H.25 60
D.H.26 80
D.H.27 95
D.H.28 53
D.H.29 48
D.H.30
D.H.31 79
D.H.32 89
D.H.33 43
D.H.34 50
D.H.35 25
D.H.36 35
D.H.37 30
D.H.38 28
D.H.39 47
D.H.40 32
D.H.41 48
D.H.42 27
D.H.43 45
D.H.44 36
D.H.45 23
D.H.46 53
D.H.47 66
D.H.48 60
D.H.49 46
D.H.50 36
W.S.D.
From information on hand May 31st 1930

Fig. 7

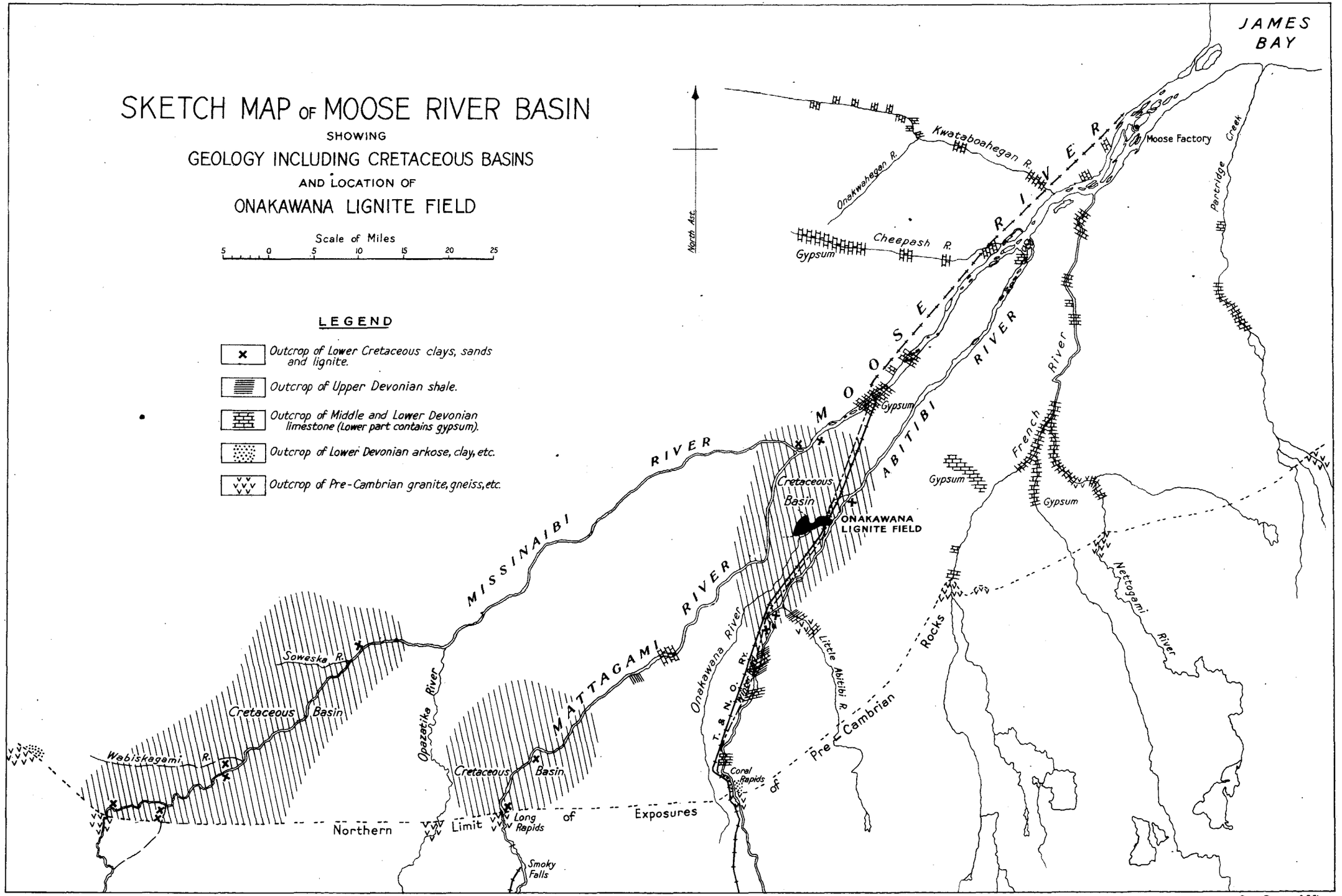
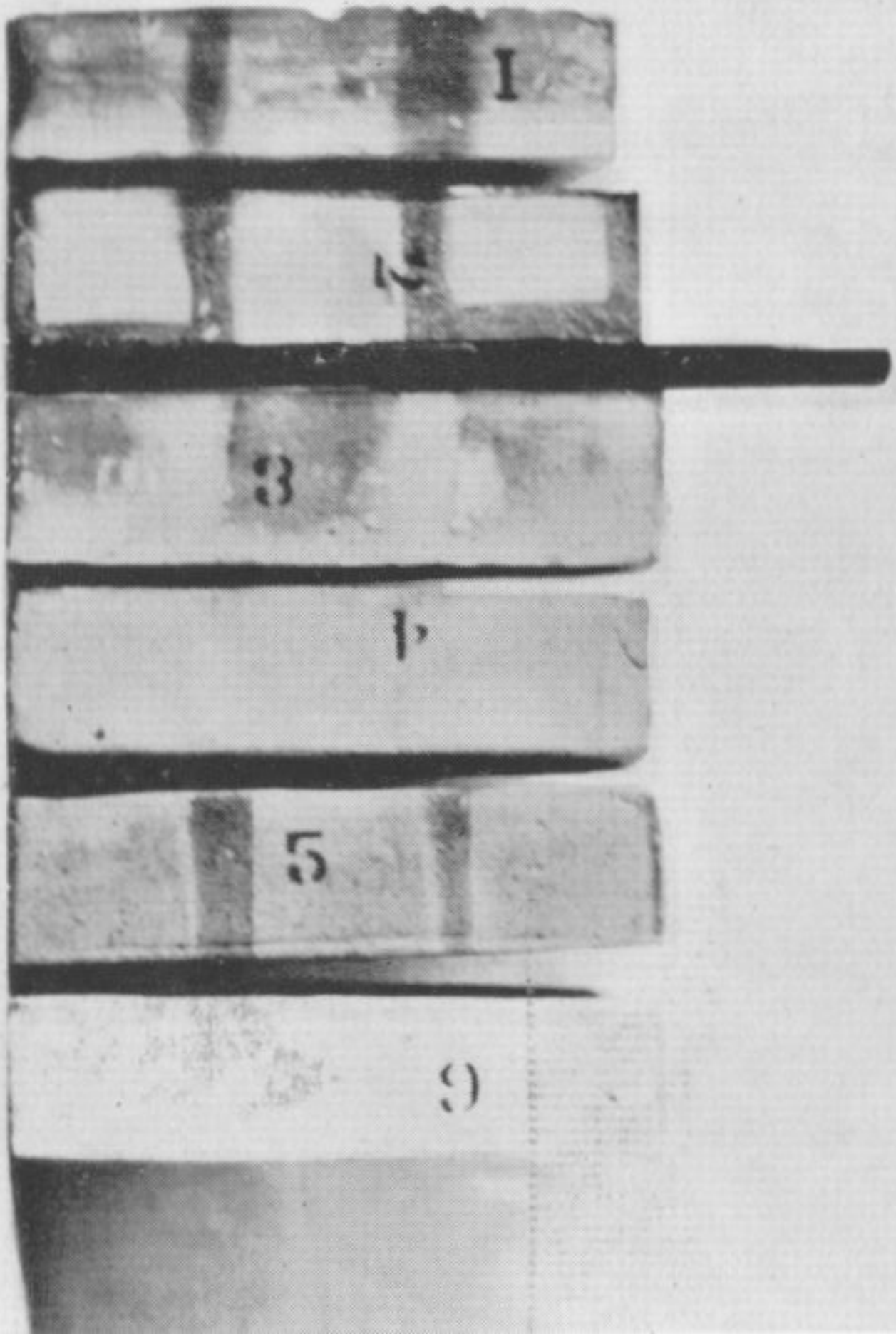


Fig. 2

Ont. Dept. of Mines




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