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PART II. NON-METALLIC MINERALS

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## NON-METALLIC MINERALS OF MICHIGAN

### COAL\*

Coal mining began in Michigan as early as 1835 but no records of production are available before 1860, when Michigan was credited with an output of 2,320 tons. Most of the coal in the early days was obtained from veins exposed or at shallow depth in the vicinity of Grand Ledge, Eaton County, Jackson, Jackson County, and Corunna, Shiawassee County. Ten years later the production reached 28,150 tons, in 1880, 100,800 tons, and for the following two years it exceeded 100,000 tons annually. In 1883, a sharp decline began and in the following year the production fell to only 36,712 tons. It was not until 1897 that the production again exceeded the 100,000 ton mark. In that year, the Saginaw and Bay County fields were opened and the production jumped to 223,592 tons. The industry continued to grow rapidly and four years later, in 1901, the production reached nearly one and a quarter million tons. The maximum output of 2,035,858 tons was reached in 1907. Following 1907 a rapid decline set in and continued until the production for 1913 was only 1,138,699 tons. Production remained practically stationary until 1917, when it increased from 1,180,360 tons in 1916 to 1,374,805 tons, a gain of 193,445 tons. The gain was due not only to the great demand but to better car service. The shortage of freight cars as well as of labor in 1916 was an important factor in keeping down production. The car situation in 1918 is much improved but labor shortage will be an important factor in limiting production.

To meet the unprecedented demands, some new mines were opened and some old ones reopened. The Robert Gage No. 8, the Sun, the Superior, and the B. & K. are the most important. Two small mines have been reopened at Grand Ledge. There are large proven reserves of coal in Bay, Saginaw, Tuscola, and Genesee counties, which, if machinery and labor were available for development, would greatly relieve the present scarcity of coal in Michigan. At present, there is not sufficient labor to maintain the operating mines up to maximum capacity, much less to open and operate new mines.

\*For a more complete report on the coal industry in Michigan see Publication 19, Geol. Ser. 16, Mineral Resources of Michigan for 1914, pp. 247-270; also Vol. VIII, Pt. 2, Coal, by A. C. Lane.



PRODUCTION, COSTS, ETC., OF COAL MINED IN MICHIGAN IN 1917

No. men employed.	Average hours worked per day.	Average days worked per month.	Average daily wages.	Total paid in wages.	No. mines using powder.	Kegs of powder used.	Picked coal mined. Tons.	Coal mined by machine. Tons.	Total cost.	Average cost per ton.
December.....	7.7	24.2	\$3.85	\$177,062.50	13	1,550	14,096	119,183	\$248,788.62	\$1.87
January.....	7.9	25.0	3.81	192,683.30	14	1,688	18,438	123,294	266,884.26	1.86
February.....	7.9	26.3	3.81	159,461.54	14	1,418	15,166	98,629	219,324.69	1.93
March.....	7.8	25.4	4.01	199,092.87	14	1,643	19,475	119,779	254,117.69	1.82
April.....	7.8	23.5	4.27	153,800.21	14	1,182	14,564	86,590	216,460.61	2.14
May.....	7.9	22.7	4.39	170,769.09	13	1,284	15,642	99,441	250,628.54	2.46
June.....	7.9	20.7	4.25	162,260.74	12	1,127	13,054	81,432	235,378.99	2.55
July.....	7.9	21.8	4.30	176,932.75	14	1,256	13,054	91,220	255,004.96	2.45
August.....	7.9	22.5	4.24	184,357.07	15	1,362	15,915	261,594.08	261,594.08	2.34
September.....	7.8	20.9	4.39	183,202.25	18	1,298	18,078	95,762	238,229.06	2.40
October.....	7.8	23.9	4.01	222,237.96	21	1,727	20,566	99,881	327,487.74	2.72
November.....	7.7	23.5	4.97	250,690.06	20	1,825	17,360	103,522	374,249.03	3.10
Aggregate.....	.....	.....	.....	\$2,232,550.34	.....	17,360	193,156	1,200,124	\$3,148,148.26	\$2.27
Average.....1938	7.8	22.6	4.25	.....	.....	1,447	15,347	100,011	.....	.....

PYRITES

In commercial usage the term pyrites is applied to any of the common iron sulphide minerals such as pyrite, marcasite, and pyrrhotite. The term "coal brasses" is also popularly applied to pyrites occurring in coal. Pure pyrite and marcasite are identical in chemical composition and contain about 53 per cent of sulphur and 47 per cent of iron. They differ, however, principally in their manner of crystallization. Both are conspicuous by their yellow or brassy color and high specific gravity. Pyrrhotite when pure contains about 40 per cent of sulphur and 60 per cent of iron.

Pyrites is used mainly for the manufacture of sulphuric acid which in turn is widely used in the manufacture of explosives, commercial fertilizers, chemicals, etc. The enormous expenditure of explosives in the War has correspondingly increased the demand for pyrites.

Prior to the War most of the pyrites was imported from Spain but with the increasing shortage of shipping during the progress of the War, this source has gradually become more or less completely cut off. Under only the most urgent conditions have ships been spared for its importation. To meet the pressing shortage the Federal Government has sought to increase domestic production through the more extensive development of operating mines, the reopening of old ones and the discovery of new deposits.

In the summer of 1918 Prof. E. A. Holbrook of the U. S. Bureau of Mines in cooperation with the State Geological Survey made an investigation of the coal brasses of Michigan coal fields. The investigation showed that pyrites occurs in sufficient abundance and in such form in some of the coals as to make its recovery promising from a commercial standpoint, especially under present high prices. Contrary to current opinion the comparatively low sulphur coals are generally more promising than most of the high sulphur coals. This is because in the low sulphur coals, the pyrites occurs in nodules and masses of considerable size, which may be readily separated from the coal. The pyrites in the high sulphur coals is apt to occur as bands of partings interleaved with the coal and as very thin plates in the fractures. In such conditions, the pyrite is so intimately associated with the coal and the pyrite breaks up into such minute particles in the processes of concentration that it is difficult to secure a sufficiently pure product for commercial purposes. Moreover, there is a considerable percentage of finely divided pyrites lost in the tailings. Under present market requirements, the concentrate should contain at least 40 per cent of sulphur and a minimum of carbonaceous matter. In the manufacture of sulphuric

acid by the chamber process, carbonaceous pyrites may give rise to an excess of carbon dioxide, which dilutes the gases in the chambers and reduces the efficiency of the plant.

The most promising source of pyrites is in the waste piles from the washery of the Consolidated Coal Co. at Saginaw. The pyrites is largely concentrated along the refuse pipe lines and there appears to be several thousand tons of pure lump pyrites which may be readily recovered at a minimum cost. The spoil banks at some of the mines also appear to contain considerable tonnages of pyrites. None of the mines would produce more than a fraction of the amount of pyritic ore necessary to maintain in operation a 50-ton concentrating mill, but it appears probable that the combined output from a number of mines would be sufficient. The pyritic waste from the mines could be shipped to a central concentration plant. Since there is generally much coal in the pyritic waste, it would be very advantageous to combine the concentrating plant with a coal washery. The recovery of both the pyrites and the coal would make it possible to utilize much impure coal which could not be profitably treated for either product alone.

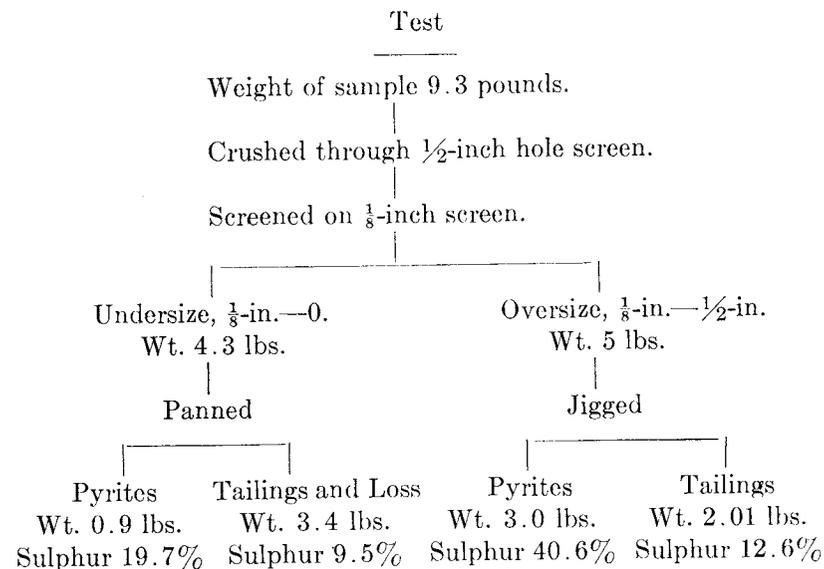
The following are the results of the analyses and tests made under the direction of Prof. Holbrook at the Mining Experiment Station, Urbana, Ill.:

#### Analyses

	Sulphur Percent.
Pure pyrite lumps. Washery of Consolidated Coal Co., Saginaw.....	47.2
Band pyrite. Wolverine Mine No. 3 (sample looks good but is light in weight).....	38.5
Heavy dark band of shale and pyrite. Wolver- ine Mine No. 3, cleanest pyrite from band...	37.6
Shale refuse.....	20.7
Separation not very satisfactory.	

A sample of refuse was taken from the elevator of the coal

washery of the Consolidated Coal Co. at Saginaw and subjected to the following treatment:



From the above it may be seen that the refuse yielded 3 pounds or over 32 per cent of pyrite analyzing 40.6 per cent of sulphur. This according to Prof. Holbrook is very satisfactory. The test indicates that the refuse probably contains about 30 per cent of recoverable pyrite of commercial grade.

#### SALT

For the past eight years the production and value of salt in Michigan has showed an annual increase, increasing from 9,452,022 barrels valued at \$2,231,262 in 1910 to the maximum of 16,078,136 barrels valued at \$6,877,202 in 1917. The increase in 1917 over 1916 was 1,158,858 barrels in quantity and \$2,264,635 in value, or respectively 7.86 and 49.09 per cent. The great gain in value was due to the much higher average price which was \$0.421 per barrel as compared with \$0.309 per barrel in 1916.

From 1880 to 1892, Michigan held first rank in production in the United States. In 1893, New York gained first rank and held it continuously, with the exception of the year 1901, until 1905 when Michigan again took the lead and continued first excepting in the two years 1910 and 1911 when New York led by a narrow margin. With the exception of 1910, Michigan has also held first rank in value since 1908.

From 1880 to 1890 Michigan produced annually from about 42 to over 49 per cent of the salt produced in the United States. The percentage declined from 43.69 per cent in 1890 to only 22.89 per cent in 1896. This was not due to a decline of the industry in Michigan but to the rapid growth of production in New York, Ohio, and other States. Since 1896 Michigan has annually produced nearly one-third of the total output and since 1880 Michigan has produced 27.3 per cent or more than one-fourth of the salt used in the United States since records of production have been kept.

Thirty years ago the center of the salt industry was in Saginaw Valley, chiefly along Saginaw River from Saginaw to Bay City. The industry was carried on in connection with the lumber mills and waste steam and fuel from the mills were utilized by more than a hundred lumber concerns in evaporating natural brines which were obtained from the Upper Marshall sandstone at depths varying from about 600 feet in Saginaw to nearly 1,000 feet in Bay City. With the decline of the lumber industry in Saginaw Valley the salt industry became relatively unimportant. In 1917 only 3 per cent of the total output of the State was produced in this district.

The war has revived the industry through the great demand for bromide from abroad. Under present conditions salt is largely manufactured in Saginaw Valley as a by-product of the bromine industry. The total output of salt for 1917 in this district was only 482,450 barrels valued at \$373,812 as compared with 561,164 barrels valued at \$1,259,539 in 1916.

At present the chief salt producing districts are in eastern Michigan along the Detroit-St. Clair rivers and in western Michigan at Ludington and Manistee. In these districts, artificial brines are used for the manufacture of salt. The brine is obtained by forcing water through casings down to rock salt beds and then back to the surface. Rock salt is mined by the Detroit Rock Salt Co. at Oakwood, a suburb on the west side of Detroit. The salt is obtained from a 20-foot bed at a depth of about 1,040 feet. The salt is crushed, screened and sized and sold for pickling, curing fish, meats, and hides, for the manufacture of ice cream, and for general refrigeration purposes. Nearly 97 per cent of the State output of salt for 1917 came from these two districts.

The salt industry in Wayne County has made a most remarkable growth. Salt was first produced in this county in 1895, the output for that year being 13,077 barrels. In 1906 the production exceeded 1,000,000 barrels and in 1917 it was 10,477,922 barrels, or 65.2 per

cent of the total for the State. The value was \$1,690,058 or only 24.6 per cent of the total.

Much of the salt produced in Wayne County is in the form of brine which is used in the manufacture of soda ash, bleach, caustic, etc., and this accounts for the low relative value as compared with other counties. The Solvay Process Co., at Delray, the Michigan Alkali Co., at Ford City and Wyandotte, and the Pennsylvania Salt Co., at Wyandotte, use great quantities of brine in the manufacture of these products.

In St. Clair County, the chief salt producing centers are Port Huron and St. Clair. The output of St. Clair County in 1917 was only 2,206,171 barrels or 13.7 per cent of the State output, yet the value was \$2,709,431 or 39.4 per cent of the total value for the State. The exceptionally high value for this county is due to the fact that much of the salt produced is of the better grades, practically 50 per cent being table and dairy salt.

In the Manistee-Ludington district, salt is made at Manistee, Manistee County, and at Ludington, Mason County. In this district, the salt industry is still largely carried on in connection with the lumber industry, waste steam and waste fuel being utilized for evaporating artificial brines. This district produced 2,911,743 barrels of salt valued at \$2,103,901. This is equivalent to 18.2 per cent of the total quantity and 30.6 per cent of the value for the State. Most of the product is packer's salt, i. e., common fine and common coarse.

The rock salt occurs in the Salina formation of Silurian age. There are three known rock salt areas, one in southeastern Michigan, a second in Alpena and Presque Isle counties, and a third in Mason and Manistee counties. South of the line from Muskegon through Kalamazoo to Trenton, Wayne County, no rock salt has been found, though wells have penetrated completely through the rock salt bearing formation at many places. The area of rock salt in southeastern Michigan so far known extends from Trenton, Wayne County, north east along Detroit and St. Clair rivers into western Ontario. The total area known to be underlain by rock salt in southeastern Michigan and western Ontario is several thousand square miles. The rock salt area extends northwest from Detroit River to and beyond Romulus and Dearborn in Wayne County, and Royal Oak in Oakland County but how far the salt area continues in this direction is unknown, since there are no wells northwest of these places deep enough to reach the salt bearing horizons. The aggregate thickness of the salt beds at Royal Oak and Dearborn is greater than to the southeast along Detroit River, thus

indicating a considerable extension to the northwest of these places. In southeastern Michigan, the salt beds are very numerous and some of them very thick. There is an upper, thick, and apparently persistent bed from 60 to 125 feet in thickness and a lower very thick and continuous bed having a maximum thickness of over 350 feet, though it probably contains partings of dolomite or shale. The average aggregate thickness of the salt beds along Detroit and St. Clair rivers is about 400 feet, but at Royal Oak and Dearborn 609 and 556 feet of salt respectively were penetrated and at the former place the bottom of the Salina apparently was not reached.

In Alpena and Presque Isle counties, the salt area although undoubtedly very large is of unknown extent. Rock salt was struck at Onaway, Grand Lake, and Alpena in great quantities, and the greatest aggregate thickness of rock salt yet penetrated in Michigan or in Ontario, Canada, is at Onaway, Presque Isle County. A test hole drilled for oil at this place penetrated over 800 feet of rock salt in a section of 1,200 feet. The lowest bed is 225 feet in thickness, and perhaps is to be correlated with the thick bed in the Detroit river region. At Grand Lake salt beds aggregating over 300 feet in thickness were penetrated in a deep well without reaching the bottom of the rock salt formation.

In the Manistee-Ludington district, the salt beds are few and thin. In the vicinity of Manistee only one bed is known. This has a thickness of 20 to 30 feet. At Ludington, however, four beds respectively 20, 12, 7, and 5 feet in thickness have been penetrated in some of the wells.

The depths to the first salt bed in southeastern Michigan varies from a minimum of 730 feet at Detroit to 1,500 and 1,600 feet at Port Huron and St. Clair, St. Clair County. In northeastern Michigan the depth at Alpena, Alpena County, is about 1,270 feet, at Grand Lake, 1,284 feet, and at Onaway, Presque Isle County, 1,630 feet.

The total area of the rock salt region in Michigan is unknown but it is undoubtedly several thousand square miles and presumably many thousands of square miles since present evidence, though not conclusive, indicates that the three known salt districts are parts of one great salt area underlying most of the northern three-fourths of the Southern Peninsula.

PRODUCTION AND VALUE OF SALT IN MICHIGAN AND UNITED STATES,  
1860-1917

Year.	U. S. Production Quantity, bbls.	Michigan production.		Per Cent. of Total Michigan.	Rank Quantity.	Value Michigan.	Michigan.	
		State Salt Inspectors* Quantity bbls.	U. S. G. S.† Quantity bbls.				Rank Value.	Price bbl.
1860		4,000						
1861		125,000						
1862		243,000						
1863		466,000						
1864		529,073						
1865		477,200						
1866		407,997				\$734,395		\$1.80
1867		474,721				840,255		1.77
1868		555,690				1,028,027		1.85
1869		561,288				786,835		1.58
1870		621,352				820,185		1.32
1871		728,175				1,063,135		1.46
1872		724,481				1,057,742		1.46
1873		821,346				1,127,984		1.37
1874		1,026,970				1,220,094		1.19
1875		1,081,856				1,190,042		1.10
1876		1,482,729				1,556,865		1.05
1877		1,660,997				1,411,847		0.85
1878		1,855,884				1,577,501		0.85
1879		2,058,040				2,099,200		1.02
1880	5,961,060	2,676,588	2,485,177	41.69	1	2,271,931		0.75
1881	6,200,000	2,750,299	2,750,299	44.35	1	2,418,171		0.85
1882	6,412,373	3,037,317	3,036,317	47.36	1	2,126,122		0.70
1883	6,192,231	2,894,672	2,894,672	46.74	1	2,344,684		0.81
1884	6,514,937	3,161,806	3,161,806	48.53	1	2,392,648		0.757
1885	7,038,653	3,297,403	3,297,403	46.84	1	2,967,663		0.900
1886	7,707,081	3,667,257	3,667,257	47.58	1	2,426,989		0.661
1887	8,003,962	3,944,309	3,944,309	49.17	1	2,291,842		0.581
1888	8,055,881	3,866,228	3,866,228	47.99	1	2,261,743		0.585
1889	8,005,565	3,846,979	3,856,929	48.17	1	2,088,909		0.541
1890	8,776,991	3,838,637	3,838,632	43.72	1	2,302,579		0.600
1891	9,987,945	3,927,671	3,966,748	39.52	1	2,037,289		0.513
1892	11,698,890	3,812,504	3,829,478	32.81	1	2,046,963		0.523
1893	11,897,208	3,514,485	3,057,898	25.70	2	888,837		0.287
1894	12,968,417	3,138,941	3,341,425	26.53	2	1,243,619		0.375
1895	13,669,649	3,529,362	3,343,395	24.46	2	1,048,251		0.315
1896	13,850,726	3,336,242	3,164,238	22.89	2	718,408		0.229
1897	15,973,202	3,622,764	3,993,225	24.99	2	1,243,619		0.313
1898	17,612,634	4,171,916	5,263,564	29.88	2	1,628,081		0.311
1899	19,708,614	4,732,669	7,117,382	36.14	2	2,205,924		0.309
1900	20,869,342	4,738,085	7,210,621	34.55	2	2,033,731	2	0.282
1901	20,566,661	5,580,101	7,729,641	37.58	1	2,437,677	1	0.328
1902	23,849,231	4,994,245	8,131,781	34.10	2	1,535,823	2	0.188
1903	18,968,089	4,387,982	4,297,542	22.65	2	1,119,984	2	0.260
1904	22,030,002	5,390,812	5,425,904	24.62	2	1,579,206	2	0.309
1905	25,966,122	5,671,253	9,492,173	35.24	1	1,851,332	2	0.196
1906	28,172,380	5,644,559	9,936,802	36.31	1	2,018,760	2	0.203
1907	29,704,128	6,298,463	10,786,630	35.39	1	2,231,129	2	0.208
1908	28,822,062	6,247,073	10,194,279	35.34	1	2,458,303	1	0.241
1909	30,107,646†	6,055,661	9,966,744	33.10	1	2,732,556	1	0.274
1910	30,305,656†	5,097,276	9,452,022	31.18	2	2,231,262	2	0.236
1911	31,183,968†		10,320,074	33.10	2	2,633,155	1	0.255
1912	33,324,808†		10,946,739	32.84	1	2,974,429	1	0.277
1913	34,393,227†		11,528,800	33.52	1	3,293,032	1	0.285
1914	34,402,772†		11,670,976	33.92	1	3,299,005	1	0.283
1915	38,231,496†		12,588,788	32.93	1	4,304,731	1	0.342
1916	45,449,329†		14,918,278	32.84	1	4,612,567	1	0.309
1917			16,078,136			6,817,202	1	0.421
Total			252,802,014			105,692,263		

\*Office of State Salt Inspector abolished in 1911.

†In cooperation with the Michigan Geological Survey after 1909.

‡Includes production of Hawaii and Porto Rico 1909-1913, 1915-1916 and of Porto Rico 1914-1917.

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY GRADES, 1906-1917

Year.	Table and dairy.		Packers.			
	Quantity.	Value.	Common fine.		Common Coarse.	
			Quantity.	Value.	Quantity.	Value.
	Barrels.		Barrels.		Barrels.	
1906	509,905	\$362,368	2,927,478	\$757,470	2,021,287	\$618,727
1907	657,509	392,641	3,601,270	914,154	1,743,840	471,378
1908	584,452	620,647	3,454,062	968,617	2,020,956	610,286
1909	585,370	732,907	3,530,303	1,125,095	2,103,719	647,878
1910	798,434	565,653	2,216,181	734,828	1,992,465	596,301
1911	817,486	742,702	2,362,075	698,203	2,070,745	745,720
1912	905,593	920,782	2,225,337	645,692	2,086,492	835,673
1913	1,028,000	1,037,402	2,704,936	852,135	2,259,164	896,521
1914	1,092,344	1,025,164	2,668,989	911,016	2,380,378	870,715
1915	1,233,117	1,420,382	3,096,644	1,181,337	2,265,352	1,001,167
1916	1,305,950	1,461,085	3,109,857	1,221,901	2,133,600	1,064,709
1917	1,388,700	2,143,004	2,881,000	2,106,241	1,964,093	1,480,666

Year.	Packers.		Other, rock, etc.		Brine and other.*	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1906	91,098	\$33,733			4,387,043	\$246,462
1907	119,459	48,455			4,664,552	235,729
1908	134,726	53,669			3,991,083	205,084
1909	93,357	3,983			3,648,395	185,051
1910	92,426	43,942			4,104,934	211,317
1911	105,401	45,421	576,595	\$181,865	4,387,772	219,244
1912	223,866	84,638	763,908	250,680	4,737,038	236,852
1913	50,557	25,371	727,364	244,172	4,756,779	237,431
1914	†	†	712,530	252,024	4,816,735	240,086
1915	†	†	919,735	321,354	5,073,940	380,491
1916	†	†	1,012,942	368,022	7,365,927	506,850
1917	†	†	1,204,543	568,717	8,639,800	578,574

Year.	Total.	
	Quantity.	Value.
	Barrels.	
1906	9,936,802	\$2,018,760
1907	10,786,630	2,062,357
1908	10,194,270	2,458,303
1909	9,966,744	2,732,556
1910	9,452,022	2,231,262
1911	10,320,074	2,633,155
1912	10,946,739	2,974,429
1913	11,528,800	3,293,032
1914	11,670,976	3,299,005
1915	12,588,788	4,304,731
1916	14,918,278	4,612,567
1917	16,078,136	6,877,202

\*Brine only after 1910.  
†See common fine and common coarse after 1913.

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY COUNTIES, 1917

County.	Table and dairy.		Packers.		Other, rock, etc.		Brine.	
	Tons.	Value.	Common fine.		Common coarse.		Tons.	Value.
			Tons.	Value.	Tons.	Value.		
Bay	a	a	a	79,807	417,723	a	a	a
Mason	a	a	a	a	a	a	a	a
Midland	a	a	a	47,442	279,800	a	a	a
Manistee	154,394	1,811,873	82,919	61,077	84,819	a	a	a
Saginaw	33,691	262,468	49,615	26,967	340,258	a	a	a
St. Clair					182,542	a	a	a
Wayne								
Total—Tons	194,418	\$2,143,004	403,340	\$1,480,666	274,973	\$1,480,666	1,209,572	\$578,574
Bbls	1,388,700		2,881,000	1,964,093	1,204,543		8,639,800	

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY COUNTIES, 1917.—Concluded.

County.	Total.		County.		Bromine.		Calcium chloride.	
	Tons.	Value.	Quantity, Percent.	Value, Percent.	Pounds.	Value.	Tons.	Value.
Bay	270,171	1,356,231	12.0	19.7	a	a	a	a
Mason	149,996	805,835	6.7	11.7	a	a	a	a
Midland	55,019	315,647	2.4	4.6	a	a	a	a
Manistee	308,844	2,709,431	13.7	39.4	a	a	a	a
Saginaw	1,466,909	1,690,058	65.2	24.6				
St. Clair								
Wayne								
Total—Tons	2,250,939	\$6,877,202	100.0	100.0	735,654	\$405,059	22,679	\$294,693
Bbls	16,072,136							

a—Included in total.

## BROMINE AND CALCIUM CHLORIDE

The brines of the Marshall sandstone, especially near the center of the State contain appreciable quantities of bromine and considerable quantities of chlorides other than sodium chloride or salt. In the early days of the salt industry the bitters or "mother liquors" left after the precipitation of the salt were thrown away. The discovery that the bitters were rich in bromine and calcium chloride led some of the salt companies to install suitable machinery and equipment for the recovery of one or both of these products. Chemical plants were also built for the recovery of bromine and the manufacture of chemicals from the brine. Large quantities of bromine, chiefly in the form of bromides, and calcium chloride were produced. Over-production and competition with German bromine forced the price of bromine so low that for a number of years prior to the War the recovery of bromine was abandoned by all of the salt manufacturing concerns. The Dow Chemical Company of Midland, however, continued to produce large quantities of bromine and other chemicals derived from the brines. The War caused the price of bromine to advance to unprecedented figures, and revived the industry in the Saginaw Valley. In 1917 there were five producers.

Prior to the War the bromine of Michigan was marketed largely as bromides, but the increased demand has caused the marketing of a large amount in the crude state. Bromine is used in many chemical reactions, in the manufacture of disinfectants, in photography, and in drugs, and recently it has been used on a large scale in the manufacture of asphyxiating gases employed in the War.

Calcium chloride is used in large quantities for the prevention of dust, in refrigerating plants, in protective fire apparatus, in cement mixtures to prevent freezing, as a drying agent in chemical processes, as a preservative of wood, and for many other purposes. Because of its strong affinity for water a sprinkling of a solution of calcium chloride will keep a road moist and therefore dustless for several weeks under favorable conditions. It is thus extensively used in the place of crude oil for sprinkling streets.

In 1917, the quantity of bromine marketed in Michigan amounted to 735,654 pounds or 82.2 per cent of the total for the United States. The Government ordered additional wells drilled in Michigan in 1918 and the State's output for this year doubtless will be much greater. The value of bromine marketed in 1917 was \$405,059 or \$.55 per pound. The average price was less than half that of the average for the country in 1916 which was \$1.34 per pound.

The output of calcium chloride in Michigan in 1917 was 22,679 tons valued at \$294,693 or \$12.99 per ton. For a number of years there were less than three producers but in 1917 there were four.

## POTASH

Though Michigan has deposits of rock salt of great extent, they are not known to contain potash bearing salts. A small amount of potash is recovered from industrial wastes and wood ashes. In 1917 the production of potash reckoned as  $K_2O$ , amounted to 381 tons valued at \$275,215, of which 68 tons were from industrial wastes and 313 tons from wood ashes.

## CLAY

The clays\* of Michigan are of three general classes, viz.: (1) morainic or drift clays (2) lake clays and (3) river silts. Deposits of kaolin or china clays are not known in Michigan and the chances for the occurrence of commercial deposits of such clays appear to be small. Deposits of kaolin have been reported at various places in the Northern Peninsula, but these so far as investigated, have proved to be white or calcareous lake clays of the slip variety. The morainic clays, boulder and till clays, are always calcareous, some of them being very high in lime, especially in limestone regions. In such regions the clays locally approach the nature of impure marls. The results of recent tests indicate that the occurrence of deposits of relatively low lime surface clays is more common than formerly supposed. The lake clays are generally less calcareous but locally, as in limestone regions, they may contain a large percentage of lime. The river silts are the least calcareous but they are usually gritty. On account of the high content of lime, most of the clays burn white. In many surface beds, however, there is an upper portion relatively free from lime which burns red, and a lower one very high in lime which burns white or cream color. The absence of lime in the upper portion is due to leaching. In such cases, there is usually a zone of lime balls between the leached and unleached portions.

The morainic or drift clays contain pebbles, and boulders (hence the name "boulder clay,") and locally lime concretions. Screening and washing have been resorted to at some plants to separate the clay but the extra expense is generally prohibitive except in districts where good clays are wanting or where the clays possess special burning qualities. The lake clays are comparatively free from pebbles and coarse sand but some contain much very fine grit.

\*H. Reis, Vol. VIII, pt. 1, p. 48, Clays and Shales of Michigan, Geol. Surv.

These clays are generally suitable for making common brick and tile. There are inexhaustible supplies of such clays in the eastern portion of the Southern Peninsula from Arenac County south to the Ohio boundary. Large areas of lake clays also occur in Chippewa and Ontonagon counties.

The morainic or boulder clays have been developed for the manufacture of common brick and tile at many places in the State but generally on a small scale. The lake clays in the vicinity of Springwells and West Detroit have been developed very extensively for making common brick. With the growth of the city in this direction the land has become so valuable for building sites that the brick industry is being gradually forced into other localities. Important developments have also been made near Paines and West Saginaw, Saginaw County, and at numerous places in Lenawee, Monroe, and Macomb counties.

In Ontonagon County some of the clays are of the slip variety and are suitable for glazing pottery. A deposit of slip clay is also reported near Harriette, Wexford County.

Most of the surface clays in Michigan are low grade and generally the mining of such clays is merely incidental to the manufacturing of common brick and tile. Nearly all of the clay sold as clay in Michigan is slip clay. It is mined chiefly near Rockland, Ontonagon County, and shipped to potteries in Ohio and other states for glazing. The great distance of the beds from the centers of the pottery industry is a serious obstacle in promoting development. In some years, a small amount of clay is sold for medicinal purposes.

PRODUCTION OF CLAY IN MICHIGAN, 1910-1917.

Year.	Slip clay.		Brick clay.		Miscellaneous clay.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.		Tons.	
1910.....	1,363	\$3,889	60	\$105	1	\$400	1,424	\$4,394
1911.....	1,744	5,090	18	32	2	150	1,764	5,272
1912.....	2,034	6,164				9	2,043	6,173
1913.....	1,710	6,504					1,710	6,504
1914.....	1,463	4,572					1,463	4,572
1915.....	1,198	3,805	*	*	*	*	3,142	5,605
1916.....		10,509					3,454	11,193
1917.....	2,153	8,824	*	*			5,746	13,627
Total.....								\$57,340

\*Included in total.

BRICK AND TILE PRODUCTS

*Raw Materials.* Most of the surface clays (see Clay) in Michigan are of low grade and of three general classes, (1) morainic clays or drift clays, (2) lake clays, and (3) river silts. The morainic clays are usually calcareous, containing from 10 to 15 per cent or more of lime. They also contain sand, pebbles, and boulders, hence the name boulder clay. Due to their sandy or calcareous nature, most of the clays are adapted for making only common brick and tile or low grade pottery. The high lime content causes most of the clays to burn white or cream colored. In some places, leaching has removed the lime to the depth of a few feet and clay from this surface portion burns red. Recent investigations indicate that the occurrence of low lime surface clays is more common than formerly supposed.

Exposures of clay or shale beds suitable for the manufacture of fire, vitrified, and front brick, vitrified tile, fire-proofing, and other high grade products are not abundant. Near Rockland, Ontonagon County, some of the lake clays belong to the slip varieties and are used for glazing pottery. At Grand Ledge, Eaton County, Jackson, Jackson County, Corunna, Shiawassee County, near Bay City, Bay County and Flushing, Genesee County, shales belonging to the coal measures have been utilized for vitrified and front brick, vitrified tile, sewer pipe, conduits, fireproofing, etc.

Important deposits of blue gray shale occur near Ellsworth, Charlevoix County. The shale is quarried and sold for the manufacture of Portland cement, but no tests have been made to determine the suitability of the shale for clay products. Other deposits of shale occur in this vicinity but are undeveloped. Recently a deposit of high lime clay, possibly weathered shale, has been discovered west of Rogers, Michigan. Other undeveloped deposits of shale occur in Alpena, Cheboygan, Huron, Branch and Ingham counties. Some of the shales associated with the coal beds in Saginaw Valley are suitable for front brick and vitrified products.

*Production.* In 1917 the value of brick and tile products was \$2,846,264 exclusive of pottery, or \$141,210 more than in 1916. This was an increase of 5.2 per cent as compared with 20.3 per cent in 1916. The quantity of common brick, however, was only 236,612,000 or 42,563,000 brick less than 1916. This represents a decrease of 15.2 per cent in quantity. The average price of common brick in 1917 was \$7.95 per thousand as compared with \$6.65 per thousand in 1916. This was an advance in price of nearly 20 per cent. The value of drain tile increased from \$548,795 in 1916 to \$734,042, a gain of about 33.7 per cent. The gain was chiefly

through the increase in price rather than in quantity. Lack of coal curtailed the output which was much less than the demand.

The manufacture of common brick has made a great development in the vicinity of Springwells and West Detroit where extensive beds of suitable clays occur. Most of the common brick made in the State are made in this vicinity. The growth of Detroit in this direction, however, has made the land so valuable for building purposes that the brick companies are gradually being forced into other localities.

Drain tile is next in importance to common brick. Sewer pipe are made in large quantities at Grand Ledge, Eaton County, and at Jackson, Jackson County. Grand Ledge is also the chief center for the manufacture of vitrified drain tile. The manufacture of face or front brick in Michigan is in its infancy, there being but two plants in operation, one at Saginaw and the other at Grand Ledge. Another was projected at Williamston, Ingham County, but this probably will not be built until after the close of the War. Most of the front brick used in Michigan are imported from Ohio and bordering States.

ANNUAL PRODUCTION OF BRICK AND TILE PRODUCTS IN MICHIGAN, 1899-1917

Year.	Common brick.		Average price per M.	Front brick.		Average price per M.	Vitrified brick.		Fire brick.		Average price per M.
	Quantity.	Value.		Quantity.	Value.		Quantity.	Value.	Quantity.	Value.	
1899	200,144,000	\$833,176	\$4.66	4,290,000	\$58,920	\$13.73	*	*	*	*	.....
1900	180,892,000	863,250	4.77	8,421,000	48,411	5.75	*	*	*	*	.....
1901	215,836,000	1,033,550	4.77	9,476,000	64,031	6.76	*	*	*	*	.....
1902	237,254,000	1,321,753	5.57	5,476,000	42,792	7.83	*	*	*	*	.....
1903	215,791,000	1,321,572	6.10	2,225,000	19,000	8.54	*	*	*	*	.....
1904	205,196,000	1,316,714	6.41	1,080,000	7,500	6.94	*	*	*	*	.....
1905	211,558,000	1,152,505	5.45	1,693,000	5,995	3.55	6,112,000	\$81,706	13.37	13.28	\$13.00
1906	206,583,000	1,172,202	5.70	1,474,000	14,162	9.61	6,229,000	81,814	13.13	13.37	19.37
1907	200,817,000	1,181,525	5.88	3,956,000	32,116	8.12	7,911,000	94,601	11.95	11.95	10.05
1908	181,049,000	954,787	5.29	1,879,000	19,496	10.28	6,165,000	76,630	12.43	12.34	12.00
1909	219,820,000	1,329,786	5.69	2,379,000	18,654	7.84	10,473,000	129,283	12.34	12.82	.....
1910	232,551,000	1,363,306	5.86	2,209,000	27,533	12.46	9,080,000	116,446	12.82	12.82	.....
1911	252,465,000	1,303,908	5.16	2,498,000	31,572	12.64	5,597,000	78,336	13.94	13.94	18.08
1912	271,189,000	1,324,382	5.10	3,934,000	41,476	10.54	6,600,000	92,000	14.71	14.71	17.78
1913	273,571,000	1,324,286	5.04	3,505,000	5,941	11.76	8,571,000	126,062	14.71	14.71	16.41
1914	269,154,000	1,633,758	6.07	1,488,000	21,121*	14.19	7,733,000	120,562*	15.59	15.59	19.78
1915	277,399,000	1,451,588	5.23	.....	.....	11.28	5,539,000	80,915*	14.50	14.50	.....
1916	279,175,000	1,451,587	5.23	.....	.....	11.28	.....	.....	14.78	14.78	.....
1917	236,612,000	1,882,042	7.95	.....	.....	18.02	.....	.....	17	17	.....
Totals	4,367,056,000	\$25,065,669	.....	.....	.....	.....	.....	.....	.....	.....	.....

\*Concealed; less than three producers.

ANNUAL PRODUCTION OF BRICK AND TILE PRODUCTS IN MICHIGAN, 1899-1917.—Concluded

Year.	Stove linings.	Drain tile.	Sewer pipe.	Fire-proofing.	Tile (not drain.)	Miscellaneous.	Hollow building tile or blocks.	Per cent of total product in U. S.	Rank of state.	No. of firms operating.	Total Value.
	Value.	Value.	Value.	Value.	Value.	Value.	Value.				
1899.....			\$50,300	\$5,900		\$22,709		1.68	13	196	\$1,254,256
1900.....		\$140,171	57,916*	2,850		406		1.50	17	189	1,147,378
1901.....		114,747		1,880		637		1.71	14	180	1,467,369
1902.....		98,972		3,290				1.69	13	182	1,660,642
1903.....		96,645		*			\$19,138	1.58	14	178	1,662,414
1904.....		129,028		*			8,080	1.58	14	168	1,670,802
1905.....		208,048		*			3,585	1.41	16	154	1,719,746
1906.....		205,445					4,290	1.38	16	142	1,793,367
1907.....		314,098					6,386	1.39	17	136	1,786,190
1908.....		289,868		4,100		1,500		1.54	16	132	1,686,381
1909.....		327,630		*		40,100		1.44	16	122	1,697,050
1910.....		348,205		*		66,128		1.53	15	111	2,083,525
1911.....	\$3,971	373,072		*		*		1.53	15	111	1,953,442
1912.....		387,945		1,461		228,530		1.73	13	101	2,350,606
1913.....		415,543		*		235,459		1.73	13	101	2,431,242
1914.....		421,941		3,752		350,000		1.88	10	90	2,434,872
1915.....		305,156		10,850		234,280		1.79	11	82	2,248,062
1916.....		548,795		2,492		49,755		1.71	11	82	2,705,054
1917.....		734,042				216,265	4,621		13	73	2,846,264
Totals.....		\$5,763,397				79,996					\$36,878,867

\*Included under miscellaneous; less than three producers.

POTTERY

The pottery industry in Michigan has made almost uninterrupted growth since 1899 and since 1908 the growth has been rapid, particularly in the last three years. In 1899, the total value of the pottery output was \$29,741; in 1908, \$62,409; in 1910, \$112,697; in 1916, \$792,716, and in 1917, \$1,187,981. The value in 1916 increased \$270,727, or 51.8 per cent, and in 1917, \$395,265 or 50 per cent. The increases were largely due to the greatly increased output of porcelain and decorated ware and porcelain sanitary and electrical supplies.

The products are chiefly porcelain electrical supplies, decorated and white ware, and flower pots. Of eight firms, three, the Detroit Flower Pot Company, and Anton Hupprich, of Detroit, and the Ionia Pottery Company manufacture flower pots exclusively. The Jeffery-DeWitt Co. of Detroit, manufacture a variety of porcelain products,—sanitary ware, insulators, spark plugs, tumbling jars, crucibles, etc. The Mt. Clemens Pottery Company, Macomb County, manufactures decorated ware and the Pontiac Clay Pipe Novelty Co., Oakland County, clay pipes and novelty ware.

The clays used for the manufacture of flower pots are obtained from Michigan but those used for porcelain products, pipes, etc., are imported from other States and countries, for no deposits of china or ball clays are found in Michigan.

VALUE OF POTTERY PRODUCTS IN MICHIGAN, 1899-1917.

Year.	Rank of state.	No. firms.	Red earthen-ware value.	Porcelain electrical supplies value.	C. C. ware value.	Miscellaneous value.	Total value.	Gain per cent.	Per cent. of total product in U. S.
1899.....	18	4	\$29,641	.....	\$100	.....	\$29,741	.....	17
1900.....	17	4	34,317	.....	.....	.....	34,317	15.4	17
1901.....	16	5	42,485	.....	.....	\$2,400	44,865	30.2	20
1902.....	14	4	44,098	.....	.....	39,000	83,098	87.4	41
1903.....	14	4	42,007	.....	.....	6,000	48,007	-42.2	19
1904.....	17	4	40,621	.....	.....	3,000	43,621	-9.1	17
1905.....	17	5	.....	.....	.....	7,000	55,961	4.5	16
1906.....	16	6	43,510	.....	.....	7,600	51,110	11.2	16
1907.....	16	6	54,474	.....	.....	7,100	61,574	18.5	20
1908.....	13	6	54,659	.....	.....	7,750	62,409	1.5	25
1909.....	13	5	60,939	.....	.....	34,500	95,439	52.9	31
1910.....	13	6	94,450	.....	.....	13,300	107,750	18.1	33
1911.....	13	6	80,580	.....	.....	.....	130,450	58.8	38
1912.....	10	6	99,555	.....	.....	.....	160,450	49.3	53
1913.....	10	5	65,000	.....	.....	.....	224,682	20.8	59
1914.....	9	5	106,452	.....	.....	.....	252,183	33.0	75
1915.....	8	6	112,863	.....	.....	.....	529,184	96.7	1.40
1916.....	8	7	133,734	.....	.....	668,982	792,716	51.8	1.64
1917.....	.....	8	.....	.....	.....	13,722	1,187,981	49.9	.....
Totals.....	.....	.....	.....	.....	.....	.....	\$3,021,234	.....	.....

\*Included in the total.  
†Included under miscellaneous.

SANDSTONE

For many years before the close of the last century the quarrying of sandstone was an important industry in Michigan. There were numerous quarries, though generally small, in Hillsdale, Jackson, Calhoun, Ionia, Eaton and Huron counties. No records, however, were kept until near the close of the century. In 1899, the production was valued at \$178,038, the largest recorded, except in 1902, when the value of the output was \$188,073. A rapid decline, though intermittent at first, began in 1900, and continued until 1911, when the industry all but ceased, the value of the output being only \$12,985. For the past four years there have been only one or two producers, hence no figures have been given.

The decline of the sandstone industry in Michigan may be ascribed to (1) the poor quality of much of the sandstone, (2) the substitution of concrete in construction work and (3) the greater use of brick and artificial stone.

Quarries formerly were operated in the sandstone of the Coal Measures near Ionia and at other places in Ionia County, and at Grand Ledge, Eaton County; and at many places in the Marshall sandstone in Calhoun, Hillsdale, Jackson, and Huron counties. Most of the sandstone in these formations upon exposure to the weather for a few years, alters more or less uniformly or in spots and streaks to an unsightly yellow color. This is due to the fact that the cementing material, especially in the Marshall, contains a considerable amount of iron carbonate, which upon exposure to the weather is oxidized to limonite. The sandstone near Ionia, though soft and friable is streaked and mottled with red, orange, and yellow and makes a pleasing appearance in buildings. Some of the stone when first quarried is reported to be so soft that great care must be used in handling to prevent breakage. After seasoning for some time, the stone becomes sufficiently hard to work and strong enough for ordinary building purposes. The only quarries operating in the Marshall at the present time are at Grindstone City and Eagle Mills, Huron County, where the gritstones near the base of the formation are quarried for grindstones and scythe-stones. Some rubble and riprap are produced incidentally to the quarrying of gritstone, at Eagle Mills by the Wallace Company of Port Austin.

The only quarry producing sawed and rough building block is near Jacobsville, Houghton County. Extensive quarrying operations have been carried on near Portage Entry for many years but now the Portage Entry Redstone Co. is the only active operator. The sandstone is known as the Jacobsville and is apparently the

equivalent of the Lake Superior or Upper Cambrian sandstone. The "redstone" or "brownstone" of the Jacobsville is well cemented, permanent in color, and pleasing in appearance, but the great distance from markets is a serious obstacle to development.

Formerly much sandstone was quarried for foundations but concrete has largely displaced stone for such purposes because of the cheapness of concrete and the rapidity and the ease of handling. Front and fancy brick are relatively cheap and a variety of artistic effects are possible through their use. Because of this they have largely displaced stone as a building material, except for foundations. Artificial stone is now displacing natural stone for foundations, especially for outside work.

Apparently the sandstone industry will not soon regain its early importance.

\*PRODUCTION AND VALUE OF SANDSTONE IN MICHIGAN, 1899-1917.

Year.	Rough building Value.	Dressed building Value.	Curbing Value.	Flagging Value.	Rubble Value.	Riprap Value.	Crushed stone.		Other Value.	Total Value.
							Road making Value.	Concrete Value.		
1899	\$102,447	\$51,682	\$109	a					\$23,800	\$178,038
1900	73,850	58,800			\$26,519					132,650
1901	128,909				27,393				19,000	174,428
1902	136,280	23,600			15,354	\$800				188,073
1903	89,931	10,365			10,657		\$2,050	\$3,450		121,350
1904	47,593	14,818			10,832		1,400	400		74,808
1905	64,056	36,035			10,403	770			12,700	123,123
1906	35,272	18,950			7,900					65,393
1907	33,561	10,918		\$528	5,190	96				53,003
1908	15,100	18,813			6,294					39,103
1909	12,985	16,805			2,505					36,084
1910	13,312	15,416			3,068					31,233
1911	5,682	2,809				1,140			286	12,959
1912	c	c			c	c			a	16,438
1913	c	c			c	3,127			c	19,224
1914	d	d			d	d				d
1915	d	d			d	d				d
1916	d	d			d	d				d
1917	d	d			d	d				d

a Included under curbing.

b Included under rubble.

c Included in total.

d Figures not given—less than three operators.

\*Exclusive of sandstone made into grindstones and scythestones.

## GRINDSTONES AND SCYTHESTONES

Michigan ranks second in the value of grindstones and scythe-stones produced, Ohio being first with a total value about six times larger than that of Michigan and West Virginia together, the nearest competitors. There are but two active quarries, both located in Huron County near the end of the "Thumb." The Wallace Company of Port Austin operates a quarry at Eagle Mills and the Cleveland Stone Company operates a quarry at Grindstone City.

The "grit" or "grindstone" occurs in the lower part of the Marshall formation which is exposed in flat low-lying benches near the shore of Lake Huron. The surface material is stripped off and the stone cut by channelling machines into square blocks eight feet or more in thickness. The blocks are split by wedges into slabs which are loaded onto cars by derricks and then taken to the mills for sawing into grindstones. The sandstone locally contains thin beds of conglomerate composed of small pebbles of white quartz. From the resemblance of the pebbles to peanuts, the stone is often called "peanut" conglomerate. The pebbles also occur scattered through the sandstone. Much waste stone results from the presence of the conglomerate and the scattered pebbles, the latter in places being sufficiently numerous to make the stone unsuitable for use.

The grindstones vary in size from small ones a foot in diameter to those seven feet in diameter having a 14-inch face. The broken stone is sawed into various grades of scythestones.

Since there are but two producers, the production and value of grindstones and scythestones cannot be given but the total value is included under Miscellaneous in the Summary Table given at the end of this report.

## SAND AND GRAVEL

The sand and gravel resources of Michigan are inexhaustible. The most important deposits occur in the form of ridges known as "hog-backs" or eskers, in irregular hills, called kames, in outwash plains, deltas, and beach ridges,—features resulting from water action during the retreat of the Wisconsin or last ice sheet, which covered much of the region north of the Ohio and Missouri rivers. There are enormous deposits of gravel in a series of old beach ridges in Presque Isle and Alpena counties but much of this gravel is composed chiefly of limestone and is of low grade.

Only a small portion of the sand and gravel deposits in the State have been developed. Most of the development has been in the southern half of the Southern Peninsula, particularly in the vicinity of the cities and near railroads, and also in river channels

and along the shores of the Great Lakes, where cheap water transportation is available. Large pits are locally developed in building State award roads. The chief producing localities and counties in order of importance are: Detroit and St. Clair rivers, and Kent, Washtenaw, Macomb, Ingham, Livingston, Manistee, Oakland, Berrien, Jackson, Kalamazoo and Calhoun counties.

The composition of gravel varies greatly in different parts of the State. In the localities where the glacial drift is thin, the gravel generally contains a considerable or even a large percentage of pebbles derived from the underlying rocks. Where the drift is thick the gravel is composed chiefly of pebbles which have been carried considerable distances by ice and water, hence the pebbles are usually of harder and more resistant rock material. In the limestone regions of Presque Isle and Alpena counties there is a broad belt of gravel ridges along the shore of Lake Huron. The gravel is composed chiefly of limestone largely derived from the underlying beds of limestone. Since many of the beds of limestone in these counties are relatively soft, much of the gravel appears to be of inferior grade. The Marshall formation underlies much of Jackson, Calhoun and Kalamazoo counties and many of the deposits in these counties contain considerable amounts of soft friable sandstone derived from this formation. This tends to make some of the gravel unfit for road building and inferior for use in concrete aggregates. There are also large deposits of gravel in the belt of limestone along the north shore of Lake Michigan and Lake Huron. These deposits contain an abundance of limestone pebbles and, since the beds of limestone in this region are generally hard, it is presumable that the gravel is of better average quality than that in the areas of softer limestones in the northern part of the Southern Peninsula. However, no tests have been made to determine which is the better grade of gravel.

In 1917, the reported production of sand and gravel in Michigan was 3,814,445 tons or 593,030 tons less than in 1916. The value of the product however was \$1,841,748 or \$546,031 more than in 1916. Most of the loss in tonnage was due to the great decrease in building sand produced which was only 782,305 tons in 1917 as against 1,234,280 tons in 1916. The amount of gravel produced for road making was 2,292,374 tons in 1917 or only 65,496 tons more than in the previous year.

Most of the producers report that lack of cars and labor was the chief cause of the decrease in production, though the curtailing of building operations through war conditions was an important factor.

## PRODUCTION AND VALUE OF SAND AND GRAVEL IN MICHIGAN, 1904-1917

Year.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.		Tons.		Tons.	
1904			167,147	\$76,299	69,656	\$30,898				
1905			19,382	13,247	263,315	148,065	5,000	\$2,500		
1906	600	\$3,000	61,387	26,108	403,199	127,937			4,000	\$400
1907	4,300	8,600	54,172	24,190	451,646	157,150	6,000	3,000	1,534	153
1908	17,000	34,000	4,584	2,892	474,238	228,395			1,991	319
1909	65,000	79,000	53,226	20,756	1,090,419	327,247	4,000	2,000	12,415	1,493
1910	16,212	25,675	93,812	24,004	1,151,588	334,336	5,000	3,000	22,270	2,172
1911			68,878	17,901	833,729	247,997			25,392	4,447
1912			152,433	40,145	902,556	294,115			18,575	4,774
1913			50,763	17,493	1,326,016	415,737	4,542	4,542	4,447	647
1914	26,035	32,593	53,400	36,583	1,088,650	360,152			6,357	1,066
1915			82,666	25,998	843,887	236,956	4,601	5,751	70,077	2,794
1916			117,200	31,978	1,234,280	350,138				
1917			147,256	52,686	782,305	433,546			4,096	1,103
Totals			1,126,307	410,281	10,915,484	3,702,669			171,154	19,368

Year.	Furnace sand.		Paving sand.		Other sand.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.	
1904						
1905					50,187	\$14,476
1906	5,000	\$2,500			51,005	12,140
1907	3,858	3,133			173,724	12,187
1908	3,329	3,828			29,187	6,850
1909	3,183	3,660			295,612	50,953
1910	3,185	4,924			372,880	57,385
1911			152,144	\$29,650	114,801	52,005
1912			68,453	16,898	130,624	54,746
1913	†	†	533,261	108,328	113,318	20,342
1914	†	†	320,322	74,866	115,291	107,392
1915			131,466	14,021	111,105	12,248
1916			154,413	38,068	228,003	103,722
1917			136,214	49,669	94,227	41,267
Totals				1,496,273	337,500	

Year.	Railroad ballast.		Gravel.		Total.		Rank.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.		Tons.	
1904					236,803	\$107,197		
1905			76,625	\$32,321	414,509	210,609	10	11
1906			72,598	25,614	597,789	197,699	12	13
1907			329,407	81,182	1,024,641	289,595	10	11
1908			312,262	94,081	842,591	370,365	8	9
1909			695,902	200,523	2,219,757	685,632	8	8
1910			1,197,791	364,841	2,862,738	816,337	7	8
1911			935,072	203,218	2,185,165	565,969	9	10
1912			1,409,180	407,925	2,681,821	818,603	9	8
1913			3,928,874	915,205	6,422,818	1,528,892	4	5
1914	7,565	\$781	2,140,359	530,338	3,757,979	1,143,771	8	7
1915			2,457,094	671,970	3,776,726	1,036,739		
1916			2,226,878	726,033	4,407,475	1,295,717		
1917	207,827	21,829	2,292,374	1,011,182	3,814,445	1,641,748		
Totals			18,074,416	\$5,309,433	35,345,257	\$10,708,873		

\*Included under other sand.

†Included under fire sand.

## GLASS SAND

Glass sand is extensively quarried near Rockwood, Wayne County, and near Steiner, Monroe County. The glass sand occurs in the Sylvania sandstone, Middle Monroe of the Silurian. The Sylvania underlies a belt which extends west from the mouth of Detroit River, then curves southwest across the southeast corner of Wayne County and through Monroe County and leaves Monroe County near the southwest corner. The belt is from three to five miles wide except in the southwest corner of Monroe County where it narrows to about one-half mile. The thickness of the Sylvania varies exceedingly. Along the Detroit River in Wayne County it is from 70 to 165 feet thick and here as elsewhere contains horizons of sandy dolomite. It thins irregularly to the southwest until near the Ohio line it is only about 35 feet thick.

The sandstone is exposed or is near the surface in three localities, viz: in the southwestern part of Whiteford township (T. 8 S., R. 6 E.) and in the vicinity of Steiner, Monroe County, and Rockwood, Wayne County. In section 28 of the Whiteford township area, the overburden is locally ten feet or less in depth. It is exposed for a considerable distance in the bed of Raisin river near Steiner in the southwest quarter of section 2, T. 6 S., R. 8 E. At this place the rock is exposed\* or covered by a few inches of soil on an area of 8 to 10 acres and on an area of 60 acres the overburden is reported to be nowhere more than two or three feet thick.

There are no natural exposures of the Sylvania in Wayne County but east of Rockwood in section 16, in the vicinity of the pits of the Rockwood Silica Company, the overburden is only from five to eight feet deep. Apparently there is an area of several hundred acres in the vicinity of Rockwood where the overburden does not exceed twenty feet.

Typically the sandstone is a remarkably pure, sparkling, snow-white aggregation of fine incoherent rounded quartz grains, very uniform in size and resembling granulated sugar. Lumps of it may be readily crumbled in the hands and when placed in water disintegrate rapidly. At the pits of the American Silica Co. east of Rockwood, Wayne County, and of the National Silica Co. near Steiner, Monroe County, the sandstone is washed down by a stream of water from a hose. At the Rockwood pit, there is a stratum of hard dolomitic sandstone which requires blasting. The material after being crushed and washed is pumped into bins where it is allowed to drain.

\*W. H. Sherzer, Geology of Monroe County; Mich. Geol. Surv. Vol. VII, pt. 1, p. 54.

Some years ago the Rockwood Silica Sand Co. drilled a well juts east of Rockwood (SE $\frac{1}{4}$  SW $\frac{1}{4}$ , Sec. 10) to the depth of 122 feet penetrating 15 feet of clay, 15 feet of dolomite, and 92 feet of glass sand rock without reaching the bottom of it. A six-inch casing was used to rock and below this a four-inch casing, through which steam under a pressure of 60 pounds per square inch was injected, forcing out water and sand. About a car-load of sand per day was obtained in this way.

Glass sand pits known as "Toll Pits" were opened many years ago near Steiner, Monroe County. These properties later were taken over by the National Silica Co. which operated them up to 1916 when its plant was burned down. The property was then sold to the Ford Plate Glass Co. of Toledo, Ohio. A new plant is now being built. The Whiteford area is undeveloped.

Immediately beneath the drift, the sandstone is more or less colored to a depth varying from a few inches to several feet, by iron from percolating surface waters. However, most of the sandstone is very free from iron and the washed product from some horizons contains only about .001 of one per cent of iron. In the quarry of the Rockwood Silica Company near Rockwood, there are numerous masses of celestite, or strontium sulphate, and native sulphur, produced by the reduction of the celestite. The masses of celestite are most numerous near the horizon of the dolomitic sandstone. Washing removes practically all of the small amount of dolomitic cement in the incoherent sandstone and also removes most of the cement from the dolomitic portions. The sand as marketed is stated to contain over 99 per cent of silica.

The following analyses are of the crude unwashed sand from the pits of the National Silica Co. at Steiner, Monroe County, and of the washed product from the pit of the American Silica Co. at Rockwood, Wayne County.

## ANALYSIS OF GLASS SAND

	Crude Per Cent	*Mashed Per Cent
Silica.....	96.50	99.70
Calcium carbonate.....	1.50	0.08
Magnesium carbonate.....	1.04	0.22
Iron oxide.....	0.00	....
Surphuric acid loss and undetermined	0.76	....
Loss on ignition.....	0.20	....

The very low percentage of iron makes the sand especially adapted for glass making, particularly for glass of the higher grades, such as plate and optical glass. Large quantities are used in the

manufacture of plate glass. Experiments by the United States Bureau of Standards show that the purest grade of the Sylvania sand of Michigan is suitable for making optical glass and now all the sand used by the Government for this purpose comes from this State. The washed sludge containing the fine grit is used for the ignition surfaces on match boxes.

There is but one producer of glass sand, hence figures of production and value are not given. The Monroe Silica Company is building a new plant near the site of the National Silica Company plant, which was burned in 1916. This plant probably will be producing toward the close of 1918.

## SAND-LIME BRICK

The manufacture of sand-lime brick was introduced into the United States in 1901, and the first plant located at Michigan City, Indiana. The industry was a "boom" and within three years nine plants were in operation. Plants were erected all over the country, the producers being under the erroneous impression that sand-lime brick satisfactory for most purposes could be made more cheaply than clay brick. But since proper investigations of the character and supply of raw material, methods of manufacture, competition from clay brick, transportation facilities and market conditions were not made and because the bricks made were of poor quality, many failures resulted and the new industry suffered. The sand-lime brick industry is adapted to those regions where sand is abundant and good brick clay scarce. The superior quality of sand-lime brick now made by many companies is overcoming the early prejudice of contractors and competition from clay-brick is being met successfully.

In Michigan, fortunately most of the early plants were started in widely separated regions, and far from large clay working industries or were located near large cities which furnished a ready market for a limited production. The industry in the State therefore did not suffer from as large a portion of failures as in some other States and has maintained a relatively steady growth. Michigan quickly attained first rank as a producer of sand-lime brick and with the exception of one year has held that rank since 1904.

The growth of the industry has been in increased production rather than in the number of plants. In 1904, ten plants were in operation and produced only 10,440,000 brick of all grades, valued at \$69,765. In 1905 twelve plants produced 26,421,000 bricks value at \$169,302. After 1905 the number of operating plants fluctuated between ten and thirteen but production and value

greatly increased. In 1916 twelve plants produced 72,004,000 brick of all grades, valued at \$499,711. This is the maximum in the history of the industry. In 1917, owing to general war time conditions as well as to the scarcity of coal, the production of sand-lime brick decreased to 47,998,000 brick of all classes valued at \$370,723. The average price of brick in 1917 was \$7.72 per thousand as compared with \$6.94 per thousand in 1916.

The improved trade conditions of 1916 did not continue during all of 1917. This was due in part to war-caused inactivity in the building trades but principally to the freight car shortage during the latter half of the year. During the early half of the year a few of the eleven producers reported business as normal or, in one instance, booming, but when in August of 1917 the car shortage became acute, business fell off rapidly and at least two plants were closed. Thus the production for 1917 was but 466,000 more than that for 1915, and but 66 $\frac{2}{3}$  per cent of that of 1916.

The production of front and fancy brick has fluctuated greatly. The production of front brick increased from 580,000 in 1904 to about 2,000,000 in 1907, then decreased in 1908 to about 900,000. The maximum production of 3,255,000 was attained in 1910. From 1911 to 1916 the production of front brick did not exceed 1,000,000 annually, falling off in 1916 to 888,000. Evidently front and fancy sand-lime brick as manufactured were not as satisfactory for outside work or could not be produced as cheaply as clay front brick. In 1917, however, the production of front brick increased to 1,019,000 valued at \$8,477. Either new methods of moulding, producing a more shapely brick, or better methods of manufacture producing a less easily crumbled brick, accounts for the increased demand.

Excepting 1906, when New York took first place, Michigan, since 1904 has held first rank among the States both in the number of plants and in the value of the output of sand-lime brick. For a number of years Michigan has produced nearly or more than twice as many sand-lime brick as any other State. In 1917 eleven plants were in operation in Michigan. Two plants are located in Detroit, and one each in Flint, Grand Rapids, Kalamazoo, Ripley (Houghton County), Rives Junction (Jackson County), Rochester, Saginaw, Sebawaing (Huron County), and Sibley (Wayne County). The plant at Menominee has been dismantled.

ANNUAL PRODUCTION AND VALUE OF SAND-LIME BRICK IN MICHIGAN AND UNITED STATES, 1904-1917.

Year.	No. of operating firms reporting - Mich.	No. of operating firms reporting - U. S.	Michigan production.						Total value Michigan.	Change per cent Michigan.	Total value United States.	Per cent of total production of U. S.	Rank.	
			Common brick.		Front brick.		Average price per thousand.	Fancy brick.					Production.	Value.
	Quantity (thou. sands).	Value.	Average price per thousand.	Quantity (thou. sands).	Value.	Average price per thousand.	Quantity (thou. sands).	Value.						
1904	10	9,886	\$64,034	580	\$5,234	\$9.02	19	\$497	\$69,765	142.7	\$463,128	15.6	1	1
1905	12	24,841	155,883	1,577	12,893	8.17	24	526	169,302	3.3	972,064	17.4	1	1
1906	11	27,281	162,879	1,796	12,022	6.69	7	20	174,921	3.3	1,170,005	15.0	1	1
1907	13	25,488	158,606	*2,000	14,234	7.17	..	..	172,840	-1.2	1,225,769	14.1	1	1
1908	10	21,997	131,827	*900	6,982	7.76	..	..	138,809	-19.7	1,029,699	13.5	1	1
1909	11	34,217	207,082	*1,600	11,144	6.97	..	..	218,226	57.2	1,150,580	19.0	1	1
1910	10	37,648	218,627	3,256	22,022	6.76	..	..	240,649	10.3	1,169,153	20.5	1	1
1911	10	32,889	192,224	2,726	17,777	6.52	..	..	210,001	-12.7	897,664	23.4	1	1
1912	11	48,129	307,106	1,163	9,626	8.27	..	..	316,732	50.8	1,200,223	26.4	1	1
1913	12	49,373	315,882	..	..	..	..	..	321,245	1.7	1,238,325	25.9	1	1
1914	12	41,456	248,113	..	..	..	..	..	255,784	-24.4	1,058,512	23.5	1	1
1915	11	46,513	281,009	888	7,845	8.83	..	..	286,948	11.8	1,135,104	25.3	1	1
1916	12	71,116	491,866	1,019	8,477	8.31	..	..	499,711	74.14	1,474,073	33.8	1	1
1917	11	46,979	362,246	..	..	..	..	..	370,723	..	..	..	1	1
Total	..	517,813	\$3,297,384	..	..	\$6.30	..	..	\$3,445,656	..	..	..	..	..

\*—Estimated. †—Included in total.

## LIMESTONE\*

The growth of the limestone industry in Michigan from 1899 to 1903 was relatively slow but in 1904 a rapid growth began which has continued to the present.

During the past six years the growth has been accelerated. In 1903 the value of limestone including lime was only \$390,473. Ten years later the value, exclusive of lime, was \$1,408,703, or more than three and one-half times greater. Large gains were made in each of the succeeding years and in 1917 four years later the total value of limestone products, exclusive of lime was \$3,320,895 or about two and one-third times that in 1913. The increase over that of 1916 was \$931,132 or 38.96 per cent.

The great increases in the annual value of the output for the past three years are due not only to greater production but also to constantly increasing prices for the various products. The chief increases in 1917 were in stone for blast furnace flux, for the manufacture of soda ash and allied products, and for concrete. The output of flux stone in 1917 was 3,757,178 tons valued at \$1,633,965 as compared with 3,033,155 tons valued at \$1,207,326 in 1916. This was a gain of 542,023 tons and \$426,639, or 17.88 per cent in quantity and 35.34 per cent in value. The value of stone sold to alkali plants increased from \$438,783 in 1916 to \$787,760 in 1917, a gain of 79.5 per cent. Crushed stone for concrete increased in 1916 from 323,479 tons valued at \$155,084 to 418,403 tons in 1917, valued at \$244,648. This was a gain of 29.3 per cent in quantity and 57.8 per cent in value. Railroad ballast however decreased from 186,949 tons to 182,375 tons in 1917 and road making stone from 834,937 tons to 726,937 tons. The value of ballast stone increased from \$57,950 to \$90,560 in 1917 but the value of road making stone decreased from \$420,467 to \$344,970 in the same period.

The great increases in the output and value of flux and chemical limestone are due to the enormous demands of the War upon the iron and steel and chemical industries, which consume large quantities of limestone.

Formerly it was supposed that Michigan possessed few deposits of limestone, especially adapted for flux and chemical purposes, but in recent years many large deposits of very pure high calcium limestone have been discovered in Presque Isle, Chippewa, Mackinac, and Schoolcraft counties. A large deposit of high calcium limestone has been developed on an extensive scale near Rogers, Presque Isle County. On account of its low silica content this stone is especially

\*For a more complete report on the limestone resources of Michigan see Pub. 21, Geol. Ser. 17, Min. Res. of Mich. for 1915, pp. 103-312.

adapted for fluxing and chemical purposes and it is successfully invading the markets formerly held by stone from other States.

Most of the high calcium limestone is located in Alpena, Presque Isle, Cheboygan, Emmet, and Charlevoix counties in the northern part of the Southern Peninsula and in Schoolcraft, Mackinac, and Chippewa counties in the Northern Peninsula. Important deposits occur at Sibley, Wayne County, and Bellevue, Eaton County. An undeveloped deposit occurs about two miles northeast of Dundee, Monroe County. Small deposits of uncertain commercial importance occur near the mouth of Portage river about six miles north of Jackson, Jackson County, and about three miles northeast of Omer, Arenac County. The reserves of high calcium limestone in the northern part of the State are practically inexhaustible.

Enormous deposits of very pure high magnesian limestone or dolomite occur in the Northern Peninsula near the lake shore from Seul Choix Pt., Schoolcraft County, eastward to Point Detour, Chippewa County. This dolomite is adapted for lining open hearth furnaces and for paper making. Extensive areas of impure limestone suitable for concrete, road material, and ballast occur in the vicinity of the high grade limestone areas in the Northern Peninsula. Low grade magnesian limestone or dolomite occurs in abundance in many places in Monroe County, near Bayport, Huron County, and along the west shore of Green Bay and Little Bay de Noc, Menominee and Delta counties.

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1899-1917

Year.	Rough building. Value.	Dressed building. Value.	Paving. Value.	Curbing. Value.	Flagging. Value.	Rubble. Value.	Riprap. Value.	Crushed stone.	
								Tons.	Value.
1899.....	\$30,299	*	\$62,815			\$5,098	\$1,111		
1900.....	32,362	*	105,266		\$380	3,101	5,740		\$31,605
1901.....	47,285	*			250	710	800		56,261
1902.....	58,707	*		\$480	5,150	2,500	2,403		61,342
1903.....	36,528	*	49,000			444	1,568		58,655
1904.....	32,941	\$805	37,665			4,634	1,204		112,113
1905.....	17,071			160		4,432	1,234		78,437
1906.....	9,368	641	90,723	75		15,297	1,374		131,708
1907.....	15,120	100	56,400	300	100	2,372	3,613		182,510
1908.....	4,450	7,445	10,825			2,293	908		132,902
1909.....	7,276					350	350	\$224,307	110,184
1910.....	3,522		35,500			380	75	603,553	295,449
1911.....	9,997					3,511	610	532,511.	266,316
1912.....	8,274					1,651	6,727	505,133	242,839
1913.....	3,537		*			743	1,104	482,262	194,970
1914.....	4,262					*	*	534,215	420,467
1915.....	5,633	*				*	*	726,937	344,970
1916.....	*								
1917.....									
Total.....									\$2,843,302

\*Included in total for year.

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1899-1917.—Continued

Year.	Crushed stone.				For blast furnace flux.		To sugar factories.		To alkali works.	
	Railroad ballast.		Concrete.		Tons.	Value.	Value.	Value.	Value.	
	Tons.	Value.	Tons.	Value.						
1899.....						\$27,512				
1900.....		\$18,200				3,200				
1901.....		40,810				13,488				
1902.....		35,340				32,246				
1903.....		57,100				15,502				
1904.....		43,649				62,586				
1905.....		103,442				109,883				
1906.....		46,516				81,517	\$224,356			
1907.....		33,900				109,429	22,234			
1908.....		42,445				56,841	32,594			
1909.....		42,358				91,915	25,845			
1910.....		34,998	306,385			100,149	69,647			
1911.....	91,713	28,368	185,423		341,027	186,046	65,141		\$508,044	
1912.....	54,327	48,400	282,616		235,917	137,812	36,944		320,961	
1913.....	116,000	20,600	362,209		1,202,817	494,495	38,215		269,087	
1914.....	38,000	19,640	338,948		1,454,981	565,012	69,477		481,759	
1915.....	60,159	57,950	323,479		2,623,151	703,326	46,143		438,783	
1916.....	186,949	90,560	418,403		3,373,178	1,207,326	41,709		488,783	
1917.....	182,375					1,633,965	37,004		787,760	
Total.....		\$762,276		\$2,030,132		\$5,691,953	\$709,309		\$2,806,398	

\*Included in total.

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1889-1917.—*Concluded.*

Year.	To carbonic acid plants. Value.	To paper mills. Value.	Fertilizer.		Other purposes.	To lime burners.	Rank of state. Value.	Total. Value.
			Tons.	Value.				
1899.....					\$2,375	\$177,657	.....	\$281,769
1900.....					124,220	65,000	12	330,847
1901.....					101,399	136,173	12	429,771
1902.....					68,164	98,000	13	413,148
1903.....					4,747	132,600	14	390,473
1904.....					5,323	180,683	10	501,708
1905.....					142,790	9,380	12	544,754
1906.....					.....	.....	10	656,269
1907.....					278,297	.....	11	760,333
1908.....					253,990	.....	11	669,017
1909.....					327,571	.....	11	750,589
1910.....					299,305	.....	11	842,126
1911.....					440,857	.....	19	1,005,751
1912.....		\$12,558		\$3,003	13,596	.....	8	1,139,560
1913.....		8,150		7,447	395,874	.....	8	1,408,703
1914.....		10,723		7,048	39,523	.....	7	1,437,961
1915.....		8,307	10,907	11,104	31,529	.....	7	1,828,766
1916.....	\$53,138*	8,620	.....	11,088	39,896	.....	.....	2,389,763
1917.....	.....*	11,827	62,027	58,148	97,129	.....	.....	3,320,895
1917.....	.....*	24,097	.....	.....	.....	.....	.....	.....
Total.....		\$84,282		\$103,594	\$2,666,585			\$19,122,204

\*Included in total.

## LIME

From 1904 to 1914, the lime industry made little or no growth, the production in these years being respectively 63,601 tons and 66,507 tons. In 1915 the production increased to 81,359 tons but this was 1,749 tons less than the maximum reached in 1909. The next year there was only a slight increase, the production being 86,447 tons but in 1917 there was a large increase, the production being 135,920 tons or 57.2 per cent greater than in 1914. The value increased from \$385,341 in 1916 to \$892,682 in 1917, an increase of \$507,341 or about 1.32 per cent. The great increase in value was due not only to increased production but also to the large advance in the average price which in 1917 was \$6.72 per barrel as compared with only \$4.45 in 1916.

The absence of growth in the lime industry from 1904 to 1914 inclusive was due to several causes, chief of which were: (1) the growing scarcity of suitable wood fuel for burning lime, (2) the substitution of concrete for stone and lime-mortar in building, (3) the rapidly growing use of gypsum wall plasters and plaster substitutes, and (4) the relatively great distance of suitable limestone deposits from markets. Formerly, because of the abundance of cheap wood fuel and the lack of transportation facilities for the transportation of such bulky and unstable product as lime, lime burning flourished in many communities where limestone was available, even though the stone produced a very inferior lime.

The growth of transportation facilities and the increasing scarcity of cheap wood fuel supplies, together with the cheapness of the product combined to drive most of the local burners out of business, especially those using inferior or hard burning stone. At present no lime is burned south of Little Traverse and Thunder Bays.

The growth in 1915 and 1916 may be ascribed, though indirectly, to the war in Europe. The great increase in 1917 was due to the entrance of this country into the conflict early in 1917. A large amount of lime is used in the manufacture of many chemical materials used in the War.

## PRODUCTION AND VALUE OF LIME IN MICHIGAN, 1904-1917

Year.	Total lime burned.		Average price per ton.	No. of plants operating.	Rank of state production.
	Quantity. Tons.	Value.			
1904.....	63,601	\$256,955	\$4 04		
1905.....	48,089	192,844	4 01		
1906.....	68,133	281,465	4 13	13	
1907.....	65,822	276,534	4 20	12	16
1908.....	68,050	282,023	4 14	10	15
1909.....	83,108	354,135	4 26	12	13
1910.....	72,345	303,377	4 19	10	14
1911.....	80,709	352,608	4 37	14	14
1912.....	74,720	311,448	4 17	11	16
1913.....	77,088	331,852	4 05	10	14
1914.....	66,507	287,648	4 33	10	14
1915.....	81,359	349,979	4 29	10	15
1916.....	86,447	385,341	4 45	7	13
1917.....	135,920	892,682	6 72	7	

## CEMENT\*

## Growth of Industry

In 1895, less than 1,000,000 barrels of Portland cement were made in the United States. This was only about one-fifth of the present production in Michigan.

Prior to 1895, the kilns were of the vertical type but in that year rotary kilns, using powdered coal as a fuel, were successfully introduced. These inaugurated the present era of concrete construction. The growth of the industry from 1895 to 1907 was phenomenal, the production in 1907 reaching 48,000,000 barrels. The growth was checked by the financial depression of 1907, but it was resumed the following year and has continued almost uninterrupted up to 1917, when 92,814,202 barrels were made. The War caused relatively small decreases in production in 1914 and 1916.

## History

A vertical kiln plant was erected near Kalamazoo as early as 1878 for manufacturing cement from marl and clay. The enterprise failed in 1892, because of the high cost of manufacturing. The Peerless Portland Cement Co., in 1896, erected a vertical kiln plant at Union City, Branch County, and began the successful manufacture of Portland cement from marl and shale. By 1902, the old vertical kilns had been replaced by rotary types. In 1897, the Bronson Portland Cement Co. erected a plant at Bronson, Branch County, and, next year the Coldwater Portland Cement Co., now the

Wolverine Portland Cement Co., built plants at Coldwater and Quincy, also in Branch County.

The period between 1899 and 1901 was the "boom" years of the industry, twenty companies being organized in this period for the manufacture of Portland cement from marl and clay or shale. Extensive investigations of marl and clay deposits and elaborate plans were made by many of the companies. Only ten reached the productive stage and but five of these are still in operation. Since 1896, thirty-five different cement plants have been projected or built in Michigan. Eleven are now in operation.

A new company, the Petoskey Portland Cement Co., has been organized at Petoskey but the plant probably will not be built before 1919.

The principal raw materials used in Michigan in the manufacture of Portland cement are marl or limestone and clay or shale, though the lime refuse from a soda ash plant near Detroit is also being utilized. The early companies planned to use marl and clay or shale. Because of the greater kiln capacity and lower fuel costs, limestone has been substituted for marl wherever practical. Of eleven plants, six are reported to be using marl and clay and five limestone and shale or clay. The new company, the Petoskey Portland Cement Co., intend to use limestone and shale. The plant is to be erected on limestone deposits on Little Traverse Bay about two and one-half miles west of Petoskey. The shale will be obtained from a quarry at Ellsworth in Charlevoix County.

The following table shows that Michigan produced 4,688,899 barrels of cement in 1917 as compared with 4,919,023 barrels in 1916. This was a decrease of 220,124 barrels. Shipments decreased from 5,151,818 barrels in 1916 to 4,313,771 barrels in 1917, a loss of 838,047 barrels. The decreases are due chiefly to war conditions, which resulted in a general curtailing of building operations. The value of the cement shipped, however, shows an increase, the total value in 1917 being \$6,122,887, or an increase of \$104,976. The average price in 1916 was \$1.103 per barrel, and in 1917 the average price was \$1.419, an increase of \$.251 per barrel.

\*See Pub. 24, Geol. Ser. 17, Min. Res. for 1916, for a more detailed report.

PRODUCTION, VALUE, ETC., OF PORTLAND CEMENT IN MICHIGAN AND UNITED STATES, 1896-1917.

Year	No. of plants in operation	Michigan Rank	No. of kilns, Rotary	Daily capacity, Bbls	Michigan, cement made, Bbls	U. S. Cement made, Bbls	Michigan, per cent made	*Change per cent	Michigan cement shipped, Bbls	Michigan cement Value	U. S. Cement shipped Value	Michigan, per cent of value	Michigan, stock on hand Dec 31, Bbls	Michigan, average price per barrel	U. S. average price per barrel
1896	1	1	1	1	1,543,025	1,543,025	0.25	275.0	57,000	\$7,000	\$2,424,011	0.29	.....	\$1.75	\$1.57
1897	2	1	1	2	2,677,275	2,677,275	0.56	275.0	26,250	26,250	4,315,891	0.6	.....	1.75	1.61
1898	4	1	1	4	7,000	7,000	2.11	313.3	134,750	134,750	5,970,773	2.3	.....	1.747	1.62
1899	4	1	1	4	343,566	632,566	6.1	346.2	513,849	513,849	8,074,371	6.36	.....	1.492	1.43
1900	6	1	1	6	664,750	8,482,020	7.8	93.4	830,990	830,990	9,280,525	8.9	.....	1.25	1.09
1901	10	3	3	10	1,025,718	12,711,225	8.0	54.1	1,128,290	1,128,290	12,532,360	9.0	.....	1.10	0.99
1902	10	3	3	10	1,577,006	17,240,343	8.7	53.7	2,134,396	2,134,396	20,864,078	10.2	.....	1.353	1.21
1903	13	3	3	13	1,955,183	25,549,873	8.7	23.9	2,674,780	2,674,780	27,713,319	9.7	.....	1.367	1.24
1904	16	4	4	16	2,247,160	26,505,881	8.5	4.9	2,365,656	2,365,656	33,355,119	10.1	.....	1.052	0.88
1905	15	5	5	15	2,773,283	35,246,812	7.9	23.4	2,921,507	2,921,507	33,245,867	8.7	.....	1.053	0.94
1906	14	4	4	14	3,747,525	46,493,424	8.06	35.5	4,814,965	4,814,965	52,466,186	9.2	.....	1.284	1.13
1907	14	4	4	14	3,572,668	48,793,300	7.3	4.6	4,384,731	4,384,731	53,992,551	8.1	.....	1.227	1.11
1908	15	7	7	15	2,892,576	51,072,612	5.6	19.0	2,556,215	2,556,215	43,547,679	5.8	.....	0.883	0.85
1909	12	7	7	12	3,212,751	64,991,431	4.9	11.7	2,619,259	2,619,259	52,858,354	4.9	.....	0.815	0.813
1910	12	8	8	12	3,687,719	76,549,951	4.8	11.7	3,378,940	3,378,940	68,205,800	4.9	.....	0.916	0.891
1911	11	8	96	11	3,686,716	78,528,637	4.69	-0.03	3,024,676	3,024,676	66,248,817	4.56	506,758	0.82	0.843
1912	11	8	92	11	3,494,621	82,438,096	4.23	5.21	3,145,001	3,145,001	69,109,800	4.55	370,956	0.861	0.813
1913	11	8	83	11	4,186,236	92,097,131	4.21	19.29	4,228,879	4,228,879	88,689,377	4.77	473,563	1.036	1.005
1914	11	7	77	11	4,285,345	88,230,170	4.81	9.37	4,064,781	4,064,781	86,437,956	4.70	538,846	0.964	0.927
1915	11	5	71	11	4,765,294	95,914,907	5.55	17.37	4,454,608	4,454,608	86,891,681	5.11	569,919	0.942	0.86
1916	11	6	68	11	4,919,023	91,521,198	5.37	3.2	5,127,468	5,127,468	94,552,296	6.36	338,035	1.168	1.103
1917	11	.....	68	11	4,688,899	92,814,202	5.03	4.47	6,122,887	6,122,887	90,703,474	-4.14	713,786	1.419	1.354

\*Minus sign indicates decrease.

SHALE

Shale is quarried near Coldwater, Branch County, at Paxton, Alpena County, one mile south of Ellsworth, Antrim County, and at Bellevue, Eaton County, for use in the manufacture of Portland cement; at Grand Ledge, Eaton County, for vitrified sewer-pipe, tile and conduit and front brick; six miles north of Jackson near the mouth of Portage River, Jackson County, for vitrified sewer-pipe and tile, and at Flushing, Genesee County, for vitrified brick.

The Michigan Vitrified Brick Company of Bay City formerly mined shale from an abandoned coal mine for the manufacture of vitrified brick but this company ceased operating in 1916.

For the past three years a project has been under way to develop shale beds at Williamston for the manufacture of front brick. A large area of shale land was explored and burning tests were made of the shale, but the plant did not materialize. Probably it will not be completed until after the War.

The shale beds at Grand Ledge, Jackson, Flushing and Corunna belong to the Coal Measures. The beds vary from soft white, or light gray clay shale to compact, dark or black bituminous shale. Probably further tests will show that some of the beds are suitable for other products than those now made. The beds at Paxton belong to the lower portion of the Antrim formation of the Upper Devonian. The extent of the easily quarryable shale near Paxton is unknown but probably exploration would reveal the presence of a number of quarryable areas. Most of the shale exposed is dark brown and very bituminous but locally there are streaks of bluish to greenish gray shale and huge balls of iron carbonate and dolomite. The shale beds at Ellsworth belong to the upper part of the Antrim and are largely of soft blue gritless shale, with a few thin, dark bituminous beds. The extent of the easily quarryable areas is uncertain but apparently large. Tests probably will show that this shale is suitable for a variety of purposes. Other exposures of the Antrim shale occur in Charlevoix, Cheboygan, and Alpena counties, notably along the shore of Lake Michigan at Norwood, Charlevoix County.

Excellent exposures of shale belonging to the Coldwater formation occur at Richmondville, Sanilac County, and along the shore of Lake Huron from Forestville in the same county to Whiterock, Huron County. The Coldwater shale is also exposed or is at shallow depth in a number of places in the vicinity of Coldwater, Union City, Quincy, and Bronson, Branch County. Near Coldwater it is utilized in the manufacture of Portland cement. Exposures of the Bell shale, the base of the Traverse formation, occur near Bell,

Presque Isle County. At Rockport, the Bell shale forms the floor of the limestone quarry. The shale is soft, bluish and generally highly calcareous. Probably it will be found to be suitable for the manufacture of Portland cement though its generally high lime content probably makes it unsuitable for high grade clay products. At Charlevoix a bed of shale 10 feet thick underlies the floor of the quarry of the Charlevoix Rock Products Co., Charlevoix County. This shale has been tested and according to reports, is suitable for the manufacture of vitrified products. The burning qualities of the deposits at Ellsworth have not been investigated but its uniform fine grained and apparently low lime content makes it very promising for use in vitrified products.

Unfortunately most of the larger and more promising deposits of shale occur in the northern part of the Southern Peninsula relatively distant from markets or from means of cheap transportation.

#### GYPSUM

From 1868 to 1889, the annual production of gypsum in Michigan never reached 70,000 tons. The production in 1890, however, attained a maximum of 74,877 tons. The maximum value of gypsum and gypsum products for the period was attained in 1883, the value being \$377,567. The growth of the industry began in 1890. In 1892 the output reached 139,557 tons but the financial depression throughout the country during 1892-3 disorganized the industry, the production in 1895 decreasing to only 66,519 tons, or less than half that in 1892. From 1896 to 1916 the growth was almost uninterrupted, reaching the maximum production of 457,375 tons in that year, valued at \$1,066,588.

In 1916 the production increased 67,384 tons or about 17 per cent over that of 1915. This was due to the general activity and prosperity in industrial lines, particularly in the building trades. After the entry of the United States into the War in 1917, building operations, excepting for war purposes were greatly curtailed. This is reflected in the marked decrease in the production of gypsum and gypsum products for the year, the production falling from 457,375 tons to 375,803 tons, a loss of 81,572 or 17.8 per cent.

On the other hand, due largely to the great increase in prices, the value of gypsum and gypsum products marketed increased from \$1,066,599 in 1916 to \$1,568,655 in 1917,—a gain of \$502,056 or 56.4 per cent.

In the early days of the gypsum industry, four-fifths of the raw gypsum was ground into land plaster and from 1869 to 1887 more than half of the gypsum mined was ground into this product. With

the more general use of patent fertilizers, the demand for land plaster has more or less gradually decreased so that the production in 1917 was only 7,090 tons as compared with the maximum of 44,972 tons in 1873.

The growth of the gypsum industry is due largely to the invention and introduction into the building trades of gypsum plasters, plaster board, gypsum block, calcimines, and other gypsum products. Since 1887, the grinding of land plaster has become relatively insignificant in comparison with the manufacture of building products. In 1917, the value of land plaster was only \$22,903 as compared with \$1,452,002 for calcined products.

The most important of these products is mixed wall plaster; stucco is next in order of importance. In 1917 wall plaster was valued at \$949,511, or 60.5 per cent of the total value of raw and calcined products for the State. Stucco was valued at \$384,661 or 24.5 per cent of the total value. The value of these two products was 84.4 per cent of the total value for the State.

In 1917, five mines, two quarries and eight mills were in operation. Five mines, one quarry and six mills are located at Grand Rapids, Kent County, one quarry and mill at Alabaster, Iosco County, and one mill at Detroit. At least three, and probably four, gypsum beds are worked in Kent County. The two upper beds at Grand Rapids, respectively 6 and 12 feet thick, are near the surface. Formerly these were quarried but, because of the heavy overburden and water troubles which were increasing with the progress of quarrying the quarries have given place to mines. In the western part of Grand Rapids a third bed about 22 feet thick with a parting of shale one-foot thick near the center occurs about 60 feet below the surface. At Grandville an upper bed, about 11 feet thick is directly overlain by sand and gravel and is separated below from a 14-foot bed of gypsum by about four feet of hard limestone. These two beds may be equivalent to the 22-foot "split" in West Grand Rapids. The upper bed was formerly quarried but, because of heavy overburden and water, the quarries have been replaced by mines opened in the lower bed. Numerous explorations show that there are several other minable gypsum beds in the Grand Rapids-Grandville district.

In the Alabaster district the upper gypsum bed, which is extensively quarried at Alabaster is from 18 to 23 feet thick. Test holes north of Alabaster show the presence of a number of deeper gypsum beds, 5 to 25 feet thick.

In the vicinity of Turner, Twining, and the deserted village of Harmon City, Arenac County, a bed of gypsum, called the Turner

bed occurs 50 to 100 feet above the Alabaster bed. Locally, as in the vicinity of Turner, this bed is of minable thickness.

Gypsum beds occur on St. Ignace Peninsula and on St. Martins and other adjacent islands. Test holes in the vicinity of St. Ignace are reported to show beds of gypsum totalling 60 feet in thickness, three of the beds being 9, 13, and 21 feet thick respectively.

Available data indicates the presence of seven quarryable beds of gypsum in this district, but locally it is probable that water will be troublesome.

Gypsum was quarried near Pt. Aux Chenes as early as 1850. On account of various troubles, chief of which were water and a scourge of smallpox, the quarry was operated only intermittently for a number of years. Finally, when an ice-floe carried away the dock, the quarry was abandoned.

Thick gypsum beds are reported by well drillers in the vicinity of Ionia, Ionia County, and Cass City, Tuscola County, and beds 6 to 12 feet thick are known to occur at comparatively shallow depths at Bellevue, and Eaton Rapids, Eaton County. In brief, the gypsum deposits of Michigan may be said to be practically inexhaustible.

## PRODUCTION OF GYPSUM IN MICHIGAN, 1868-1917.

Year.	Ground into land plaster. Tons.	Calcined into plaster. Tons.	Sold crude. Tons.	Total mined. Tons.	Gypsum and gypsum products. Total value.	Rank.	
						Quantity.	Value.
Before 1868	132,043	14,285		146,328	\$671,022		
1868	28,837	6,244		35,081	165,298		
1869	29,996	7,355		37,351	178,824		
1870	31,437	8,246		39,683	191,718		
1871	41,126	8,694		49,820	284,054		
1872	43,536	10,673		54,209	259,524		
1873	44,972	14,724		59,696	297,678		
1874	39,126	14,723		53,849	274,284		
1875	27,019	10,914		37,933	195,386		
1876	39,131	11,498		50,629	248,504		
1877	40,000	9,819		49,819	238,550		
1878	40,000	8,634		48,634	229,070		
1879	43,658	9,070		52,728	247,192		
1880	49,570	18,920		68,490	349,710		
1881	33,178	20,145		53,323	288,872		
1882	37,821	24,136		61,957	344,374		
1883	40,082	28,410		68,492	377,567		
1884	27,888	27,950		55,847	335,382		
1885	28,184	25,281		53,465	286,892		
1886	20,373	27,370		56,748	308,094		
1887	28,794	30,376		59,170	321,392		
1888	22,177	35,125		57,302	347,531		
1889	19,823	36,800		56,623	353,869		
1890	12,714	47,163	15,000	74,877	192,019		
1891	15,100	53,600	11,000	97,700	223,725		
1892	14,458	77,599	47,500	139,557	306,527		
1893	16,263	77,327	31,000	124,590	303,921		
1894	11,982	47,976	20,000	79,958	189,620		
1895	9,003	51,028	6,488	66,519	174,007		
1896	6,582	60,352	700	67,634	146,424		
1897	7,193	71,680	16,001	94,874	193,576		
1898	13,345	77,852	1,984	93,181	204,310		
1899	17,196	88,315	39,266	144,776	283,537		
1900	10,304	86,972	33,328	129,654	285,119	2	2
1901	9,808	120,256	46,086	185,150	267,243	1	1
1902	13,022	158,320	68,885	240,227	459,621	1	1
1903	18,409	198,119	52,565	269,093	700,912	1	1
1904	18,294	185,422	34,669	238,385	541,197	1	1
1905	20,285	203,313	24,281	247,882	634,434	1	2
1906	30,220	208,715	27,517	341,716	753,878	1	2
1907	15,500	197,666	36,543	317,261	681,351	3	3
1908	11,414	192,403	40,324	327,810	401,928	1	3
1909	11,850	344,171	45,781	394,907	1,213,347	2	1
1910	7,097	240,905	64,566	357,174	667,199	2	2
1911	15,548	206,239	79,050	347,296	523,926	3	4
1912	10,103	243,656	68,819	384,297	621,547	2	3
1913	9,604	278,368	60,706	423,896	721,325	3	3
1914	9,322	240,648	61,227	393,006	705,841	3	3
1915	9,799	245,484	69,572	389,791	686,309	3	4
1916	9,072	242,109	80,298	457,375	1,066,599	3	4
1917	7,090	257,588	68,155	375,803	1,568,655	3	3
Totals...	1,258,438	4,980,816	1,146,314	8,117,545	\$21,566,874		



## MINERAL WATERS

Since 1902 there has been a steady decline in the mineral water industry in Michigan, despite annual fluctuations in amount and value of mineral and spring water produced. The principal factors affecting the production are local conditions affecting municipal water supplies, and general business conditions. When a municipal water supply becomes unpalatable or unsafe the vending of mineral waters becomes profitable, only to decline, however, when a filtration plant is installed or a new source of water supply is developed in a town.

The general business depressions of 1906, 1907 and 1914 caused the greatest decrease in production in Michigan. During the past year the increased demand for soft drinks has for a few firms occasioned a temporary increase in the sale of mineral waters used in the manufacture of "prohibition beers."

The production of 8,653,680 gallons, valued at \$275,763 in 1902, decreased to 1,069,164 gallons valued at \$105,641 in 1917. In 1916 the gain in production was .091 per cent in quantity but 50 per cent in value, the gain being due to the greater average price per gallon which was 10.9 cents in 1916 as compared to 8 cents in 1915. The value for 1917 decreased to 9.8 cents per gallon.

PRODUCTION AND VALUE OF MINERAL WATERS IN MICHIGAN, 1900-1917

Year.	Rank.		No. of Springs active.	Total.		Medicinal value.	Table value.	Average price per gal.
	Quantity.	Value.		Quantity gals.	Value.			
1900.	6	4	28	3,398,996	\$411,935			\$0.121
1901.	2	1	28	7,019,168	1,195,614			0.170
1902.	1	9	28	8,653,690	275,763			0.032
1903.	1	9	19	6,919,107	200,668			0.029
1904.	7	13	19	3,385,675	118,422			0.035
1905.	4	4	17	2,684,800	277,188	\$38,900	\$238,288	0.100
1906.	13	23	19	902,528	73,357			0.081
1907.	8	15	19	1,472,679	127,133	35,091	92,042	0.086
1908.	8	16	24	2,004,433	88,910	5,995	82,915	0.044
1909.	5	16	19	2,760,604	104,454	6,099	98,355	0.035
1910.	9	17	17	1,454,020	69,538	100	69,438	0.048
1911.	11	24	23	1,713,401	72,253	12,156	60,097	0.042
1912.	12	19	17	1,420,465	75,611	777	74,834	0.053
1913.	17	24	20	884,893	52,642	3,605	49,037	0.059
1914.	16	20	22	931,343	70,310	12,252	58,058	0.075
1915.	16	18	19	913,765	72,111	5,165	67,546	0.080
1916.	17	13	18	996,875	108,867			0.109
1917.			11	1,069,164	105,641	500	105,141	0.098
Total.				48,585,606	\$3,503,017	\$114,640	\$995,751	\$0.09

## NATURAL GAS

Although natural gas occurs in Michigan, the amount obtained is so variable, the volume and pressure so low, that its production is not an important industry in the State. Most of the gas is produced in Manistee, Alcona, and Montmorency counties, and in the southeastern part of the State in Macomb, Oakland and St. Clair counties.

The gas is obtained both from the bed rock and from the drift. The drift gas is doubtless due to leakage from the underlying bituminous and petroliferous Devonian formations as it is most abundant in belts overlying these formations. Gas given off by springs and shallow wells has occasioned unsuccessful exploration, since these wells are along the exposures of oil and gas bearing formations, therefore, they are along the line of leakage and not in the zone of accumulation. In most cases the wells yield gas sufficient for a few families only, some lasting a score or more of years, but the greater number "play out" in a few weeks or days. Farmers of Oakland and Macomb counties report that the 25 or 30 gas wells which are in use for heating and lighting purposes are rapidly declining in pressure and volume of gas.

The artesian wells around Portage Lake, Manistee County, yield some gas. The most notable yield was from a well driven in 1913 in the drift west of Onckama. In June, 1918, surface gas was struck in a well in Mikado Township, Alcona County. The mineral wells of Mt. Clemens also yield gas which is nearly sufficient for heating the boilers used for pumping. A very limited supply of gas is obtained from small drift wells in Benzie, Monroe, Washtenaw, and Wayne counties.

Many of the oil wells of the Port Huron oil field yield gas. The May and Gillette wells west of Port Huron are reported to yield from 20,000 to 40,000 feet of gas per day, when allowed to flow freely, with a gas pressure said to vary from 125 to 250 pounds per square inch. A project for utilizing the excess gas for lighting a small suburb of Port Huron seems to have been abandoned. Other wells in Port Huron yield gas sufficient for domestic and small industrial purposes.

The total production of gas is relatively insignificant, the maximum production being 2,442,000 cubic feet in 1914, dwindling to 1,184,000 cubic feet in 1917, the average annual value being less than \$1,500.

The following table shows the production of natural gas for the past seven years.

## PRODUCTION OF NATURAL GAS IN MICHIGAN, 1911-1917.

Year	No. of producers.	Domestic.		Industrial.		Other.		Total.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		M cu. ft.		M. cu. ft.		M. cu. ft.		M. cu. ft.	
1911	22	930	\$930			800	\$400	1,730	\$1,330
1912	17		1,020	900	\$450			900	1,470
1913								1,805	1,405
1914								2,442	1,442
1915	16	960	960			1,100	550	2,060	1,510
1916	12	598	598			700	350	1,298	948
1917	10	613	613			571	400	1,184	1,013

## PETROLEUM\*

Michigan has no large oil producing field but small quantities of oil have been found at many places, principally at Port Huron, Allegan and Saginaw. The most notable producing area is that of Port Huron in which are two groups of wells and several scattered wells. The wells are very small with an initial yield of from three to seven barrels per day, it is said, but the yield rapidly decreases to an average of about one-half barrel a day. Most of the wells yield gas, and many yield the gas in such quantities that it is sufficient for motive power in pumping the wells and drilling new ones. This cheap motive power added to the fact that the wells are shallow make operation profitable. The G. B. Stock Xylite Grease and Oil Company operates a group of twenty-two wells and uses the oil in the manufacture of lubricants for which it is adapted. A group of eleven wells was drilled on the Henry May and Lawrence Gillette farms near the "Oxbow" bend of the Black River about two miles west of Port Huron. The average yield of these wells when pumped is said to be similar to that of the Stock Wells. Since some of the wells yield significant quantities of gas, more than sufficient to furnish power for operating the wells and drilling new ones, it is possible to make the operation of this group profitable. But as yet the wells of the May and Gillette farms have not been put on a producing basis.

There was but one operator reporting a production in 1917, hence figures of production and value are omitted.

\*Pub. 14, Geol. Ser. 11. Occurrence of Oil and Gas in Michigan 1912. See Pub. 19, Geol. Ser. 16, Mineral Resources of Michigan for 1914 for a more complete discussion of the Port Huron field.

## MARBLE

The Kona dolomite in the Marquette iron bearing district, and the Randville dolomite in the Menominee and Crystal Falls districts are locally metamorphosed into dolomitic marble. The marble varies from coarse to fine texture and in color from white to various tones of pink, blue, green, and brown. The marble generally contains so much interbedded slate and quartzite, that few of the deposits offer commercial possibilities. Developments have been attempted but it appears that excessive waste from the interbedded slates and quartzites made operations unprofitable.

An old marble quarry in Sec. 26, T. 42 N., R. 28 W., Dickinson County, was operated by the Metronite Co. of Milwaukee, Wisconsin, until the fall of 1916 when fire destroyed the plant. Operations were resumed again in 1917. The product is ground for paint filler, whitening, etc.

Verde antique marble is now produced by the Michigan Verde Antique Marble Co. some miles north and west of Ishpeming. The marble is in a belt of altered peridotite in which the rock has been altered to serpentine and dolomite. In some places the rock is said to be almost wholly dolomite but generally it is a dolomitic serpentine, the dolomite investing the rock in an intricate system of veins and stringers. The serpentine varies in color from light to dark green with olive tones but the dolomite is generally white. The rock is firm and hard and takes a high polish. The intricate and delicate veins of white dolomite give very beautiful effects in the polished slab. The marble appears equal or superior to much of the verde antique now on the market; it is said to equal the best from Italian and Grecian quarries and can be provided in larger sections than that formerly imported from Europe.

Developments began three years ago but lack of transportation facilities, labor shortage, etc., has hindered operations. A considerable amount of stone has been quarried and stocked pending the completion of a railroad spur to the quarry. This was expected to be finished about August 1, 1918.

Other projects have been started in the past three years to develop other deposits of marble in this region but nothing came of them.

In this locality, apparently, there are several undeveloped deposits of verde antique marble which are under favorable quarrying conditions, but war conditions doubtless will prevent their immediate development. After the War it is possible that the quarrying of marble may become an important industry near Ishpeming.

## GRAPHITE

The Northern Graphite Company of L'Anse and the Detroit Graphite Company of Detroit have opened quarries in graphite slate nine miles southeast of L'Anse. The graphite rock, which is reported to contain from 32 to 35 per cent of graphite is ground and used for paint. The production is intermittent, the quarries being operated only as the crude supply becomes depleted, enough being quarried in a year to supply the needs of the companies for several years.

There was but one operator in 1917.

## MINERAL PAINTS

For some years, certain iron ores in Iron County were mined and sold for paint manufacture but production ceased in 1915. The Detroit Graphite Co. manufactures graphite paint from graphitic (see graphite) slate obtained near L'Anse, Baraga County. This company was the only producer of mineral paints in 1917.

## CELESTITE

Celestite or strontium sulphate ( $\text{SrSO}_4$ ) occurs at several horizons in the Monroe formation in southeastern Michigan. Near Maybee, Monroe County, it occurs in the Lower Monroe in scattered crystals and masses associated with native sulphur and occurs similarly in the Sylvania sandstone at Rockwood, Wayne County. Near Gibraltar, Wayne County, it occurs in disseminated crystals in Upper Monroe dolomites. In the glass sand pit of the Rockwood Silica Co., the masses are numerous in places and some of them are large. The commercial recovery of the celestite has been but partially investigated. The masses are imbedded in a friable to incoherent sandstone and can be readily separated from it.

## FELDSPAR

Deposits of potash feldspar are reported to occur near Republic, and in Sec. 22, T. 47 N., R. 29 W., Marquette County. A pegmatite dike occurs in coarse granite near the south quarter part of Sec. 8, T. 46 N., R. 41 W., Gogebic County.

According to the reports of the Commissioner of Mineral Statistics for 1902 and 1903, the deposit near Republic is of red potash feldspar. A carload from this deposit was shipped to potters in East Liverpool, Ohio, and the material was reported to be satisfactory for the manufacture of porcelain. The following analysis of the material was made by an Ohio chemist.

Silica ( $\text{SiO}_2$ )	65.25	Magnesia ( $\text{MgO}$ )	0.23
Alumina ( $\text{Al}_2\text{O}_3$ )	18.60	Sodium oxide ( $\text{Na}_2\text{O}$ )	1.99
Iron Oxide ( $\text{Fe}_2\text{O}_3$ )	0.40	Potassium oxide ( $\text{K}_2\text{O}$ )	13.40
Lime ( $\text{CaCO}_3$ )	0.38		

According to the report of the chemist there was but little free quartz in the sample. An attempt was made to develop the deposit in section 22 but apparently without success.

The pegmatite dike in Sec. 8, T. 46 N., R. 41 W., is very coarse. Many of the crystals are from four to six inches long, and some are fourteen inches in length. The feldspar appears to be pink orthoclase. The exposure is very small, being rock knob 20 to 25 paces across and between 15 and 20 feet high. Exploration would be necessary to determine the extent of the dike. It is probable that other dikes occur in this locality.

## QUARTZ

Quartz is mined near Ishpeming, Marquette County, and ground for wood filter and paint purposes by the Michigan Quartz Silica Co. of Milwaukee, Wisconsin. Some of the ground product is used in making scouring polishes. According to an analysis submitted by the company, the quartz rock is practically pure silica, there being but a trace of impurities. Mills are located at Ishpeming and Milwaukee.

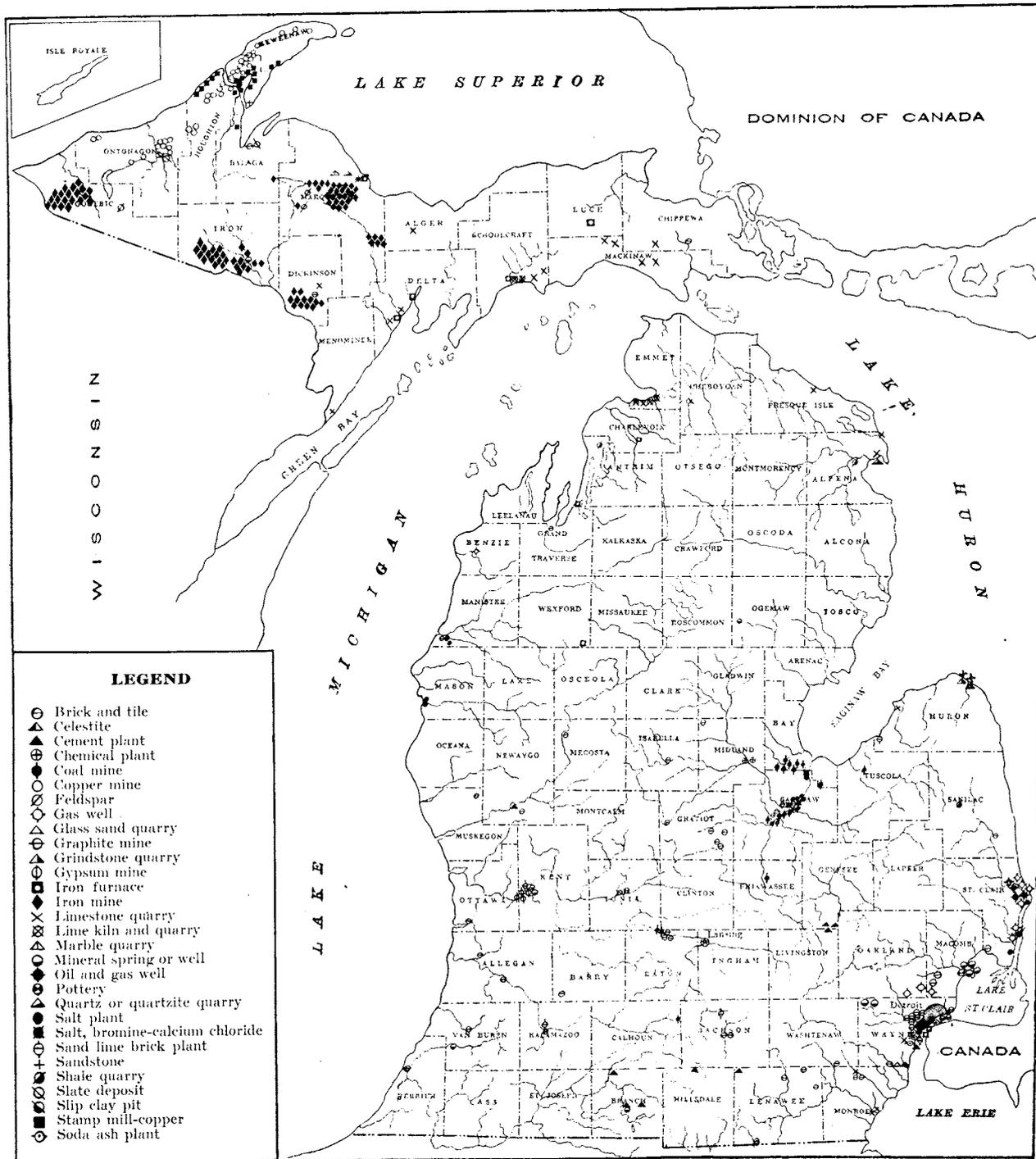
The above company was the only producer in 1917.

## TRAP ROCK

There are inexhaustible resources of trap rock in the western half of the Northern Peninsula, chiefly in the iron and copper bearing districts. Trap rock is quarried at Marquette and Negaunee, Marquette County. Large quantities of amygdaloidal trap are produced incidentally to the mining of copper. The trap rock from Marquette County is harder, tougher, and less altered than that from the copper mines. The inferior wearing qualities of the amygdaloidal trap, however, is partially compensated by superior cementing power.

Most of the quarry product and considerable amounts of fieldstone or "hardheads" are crushed for road material and concrete. In some years, a small amount has been sold for rip-rap. The great distance from markets is a serious obstacle to the development of the trap rock industry of the State. Car and labor shortage is reported to be the chief cause of the decrease in 1917.





ISLE ROYALE

LAKE SUPERIOR

DOMINION OF CANADA

W I S C O N S I N

M I C H I G A N

LAKE

H U R O N

L A K E

CANADA

LAKE ERIE

**LEGEND**

- ⊕ Brick and tile
- ▲ Celestite
- ▲ Cement plant
- ⊕ Chemical plant
- ⊕ Coal mine
- ⊕ Copper mine
- ⊕ Feldspar
- ⊕ Gas well
- ⊕ Glass sand quarry
- ⊕ Graphite mine
- ⊕ Grindstone quarry
- ⊕ Gypsum mine
- ⊕ Iron furnace
- ⊕ Iron mine
- ⊕ Limestone quarry
- ⊕ Lime kiln and quarry
- ⊕ Marble quarry
- ⊕ Mineral spring or well
- ⊕ Oil and gas well
- ⊕ Pottery
- ⊕ Quartz or quartzite quarry
- ⊕ Salt plant
- ⊕ Salt, bromine-calcium chloride
- ⊕ Sand lime brick plant
- ⊕ Sandstone
- ⊕ Shale quarry
- ⊕ Slate deposit
- ⊕ Slip clay pit
- ⊕ Stamp mill-copper
- ⊕ Soda ash plant

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APPENDIX

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DIRECTORY OF THE PRODUCERS OF NON-METALLIC  
MINERALS IN MICHIGAN, 1917

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## BRICK AND TILE MANUFACTURERS, 1917

Operator.	Office.	Works.
<i>Allegan County:</i> Allegan Brick Works (Fish & Fish)..... Zeeland Brick Co. ....	Allegan..... Zeeland.....	Allegan. Zeeland.
<i>Barry County:</i> Leonard, Wm.....	Delton.....	Delton.
<i>Bay County:</i> Michigan Vitrified Brick Co. ....	Bay City.....	Bay City.
<i>Berrien County:</i> Mamer Brick Co. ....	Benton Harbor.....	Benton Harbor.
<i>Charlevoix County:</i> East Jordan Clay Products Co. ....	East Jordan.....	East Jordan.
<i>Chippewa County:</i> Rudyard Brick Works.....	Rudyard.....	Rudyard.
<i>Dickinson County:</i> Vulcan Brick Works.....	Vulcan.....	Vulcan.
<i>Eaton County:</i> American Sewer Pipe Co. .... Baker Clay Co. .... Grand Ledge Clay Products Co. ....	Broad St., Akron, Ohio..... Grand Ledge..... Grand Ledge.....	Grand Ledge. Grand Ledge. Grand Ledge.
<i>Emmet County:</i> De Arment, C. A. ....	Petoskey.....	Petoskey.
<i>Genesee County:</i> Gale Bros. .... Scholl, L. J. & C. E. .... McCann, Fred'k W. .... Sharp, Frank.....	Atlas..... Ohio..... Gaines..... R. D. No. 1, Linden.....	Atlas. Ohio. Gaines. South Mundy.
<i>Gratiot County:</i> Ashley Tile Co. .... Stevenson & Sons, David..... Lee, Chas. .... Peet, C. D. .... Lyle G. Smith & Fred Bernard..... Riverside Brick & Tile Co. ....	Ashley..... Ashley..... North Star..... North Star..... St. Louis..... Sumner.....	Ashley. Ashley. North Star. North Star. St. Louis. Sumner.
<i>Hillsdale County:</i> Jerome Brick & Tile Co. ....	Jerome.....	Jerome.
<i>Ingham County:</i> Clippert, Spaulding & Co. ....	Lausling.....	Lausling.
<i>Ionia County:</i> Van Der Heyden, Fred H. ....	Ionia.....	Ionia.
<i>Isabella County:</i> Mt. Pleasant Brick & Tile Co. ....	Mt. Pleasant.....	Mt. Pleasant.
<i>Jackson County:</i> Warden Michigan State Prison..... American Sewer Pipe Co. ....	Jackson..... Akron, Ohio.....	Jackson. Jackson.
<i>Kent County:</i> Grand Rapids Brick Co. .... Blanchard, Addison H. ....	Mieh. Ave. and Fuller St., Grand Rapids..... Sparta.....	Grand Rapids Sparta.
<i>Lenawee County:</i> Britton Pressed Brick Co. .... Atkin, Wm. T. .... Ruff, Lewis..... Ellis, G. D. .... American Brick & Tile Co. .... Comfort, Albert A. ....	Ann Arbor..... Deerfield..... Jasper..... Macon..... Morenci..... R. D., Tecumseh.....	Britton. Deerfield. Jasper. Macon. Morenci. Tecumseh.
<i>Macomb County:</i> Hartsig, Jacob..... Hacker, Frank G. .... Gass, East..... Warren Brick & Tile Works..... New Baltimore Brick & Tile Co. ....	Warren..... Mt. Clemens..... R. D. No. 2, Washington..... Warren..... New Baltimore.....	Centerline. Clinton. Davis. Warren. New Baltimore.

BRICK AND TILE MANUFACTURERS, 1917.—*Concluded.*

Operators.	Office.	Works.
<i>Manistee County:</i> Kujawske, Joseph.....	Oakhill.....	Oakhill.
<i>Mecosta County:</i> Nehmer, Wm. F.....	Big Rapids.....	Big Rapids.
<i>Midland County:</i> Rilett & Herwig, J. W.....	R. D. No. 3, Coleman.....	Coleman.
<i>Monroe County:</i> Meyer Bros..... Maybee Brick & Tile Co..... Angerer Clay Products Co.....	Azalia..... Maybee..... Scofield.....	Azalia. Maybee. Scofield.
<i>Muskegon County:</i> Muskegon Brick & Tile Co.....	Muskegon.....	Holton.
<i>Newaygo County:</i> Stevens & Sons, Wm.....	R. D., Grant.....	Grant.
<i>Ottawa County:</i> Zeeland Brick Co.....	Zeeland.....	Zeeland.
<i>Saginaw County:</i> Parker-Lohmann Brick & Tile Co... Day, James..... Day, Thomas..... Saginaw Paving Brick Co..... Saginaw Plate Glass Co.....	R. D. No. 10, Saginaw, W. S... R. D. No. 8, Saginaw..... R. D. No. 3, Saginaw..... 1850 S. Jefferson Ave., Saginaw Saginaw.....	Saginaw, W. S. Saginaw. Saginaw. Saginaw. Saginaw.
<i>St. Clair County:</i> Schriner Brick Co..... St. Clair Brick Co.....	Marine City..... Detroit.....	Marine City. St. Clair.
<i>Sanilac County:</i> Croswell Brick Co..... Sandusky Brick & Tile Co.....	Croswell..... Sandusky.....	Croswell. Sandusky.
<i>Tuscola County:</i> Hall, Chas.....	Cass City.....	Cass City.
<i>Wayne County:</i> Daniel & Bro. Brick Co., Jacob... Haggerty, John S..... McDonald & Son, John C..... Bunte Bros. Tile Co..... Clippert & Bro. Brick Co., Geo. H... Clippert, Wm..... Mercier, Bryan, Larkins Brick Co... Lonyo Bros..... Porath Bros..... Springwells Brick Co..... Pewabic Pottery & Tile Co.....	291 Clippert Ave., Detroit... 1815 Dime Sav. Bk. Bldg., Detroit..... 707 Hammond Bldg., Detroit... Flat Rock..... 1960 Michigan Ave., Detroit... 1960 Michigan Ave., Detroit... Michigan Ave. and Lonyo Road, Detroit..... 613 Campbell Ave., Detroit... 306 Free Press Bldg., Detroit... 1009 Hammond Bldg., Detroit... 2164 Jefferson Ave., Detroit...	Detroit. Detroit. Springwells. Flat Rock. Springwells. Springwells. Springwells. Springwells. Springwells. Springwells. Springwells. Springwells. Springwells. Springwells. Springwells. Springwells. Detroit.

SAND-LIME BRICK PRODUCERS, 1917

Operator.	Office.	Works.
<i>Genesee County:</i> Flint Sandstone Brick Co.....	Flint.....	Flint.
<i>Houghton County:</i> Lake Superior Stone Brick Co.....	Calumet.....	Ripley.
<i>Huron County:</i> Sebewaing Sandstone Brick Co.....	Sebewaing.....	Sebewaing.
<i>Jackson County:</i> Jackson-Lansing Brick Co.....	Rives Junction.....	Rives Junction.
<i>Kalamazoo County:</i> South Michigan Brick Co.....	Kalamazoo.....	Kalamazoo.
<i>Kent County:</i> Grande Brick Co.....	Kalamazoo Ave., Grand Rap- ids.....	Grand Rapids.
<i>Oakland County:</i> Rochester Brick & Sand Co.....	Rochester.....	Rochester.
<i>Saginaw County:</i> Saginaw Brick Co.....	321 N. Hamilton St., Saginaw.	Saginaw.
<i>Wayne County:</i> Michigan Pressed Brick Co..... Flood & Hall.....	Cor. Lawton Ave., and M. C. R. R., Detroit..... Foot of Jean St., Detroit.....	Detroit. Detroit.

CEMENT PRODUCERS, 1917

Operator.	Office.	Works.
Huron Portland Cement Co..... Burt Portland Cement Co..... Peninsular Portland Cement Co..... Michigan Portland Cement Co..... Wolverine Portland Cement Co.....	1525 Ford Bldg., Detroit..... Bellevue..... Cooley Block, Jackson..... Chelsea..... Coldwater.....	Alpena. Bellevue. Cement City. Four Mile Lake Coldwater and Quincy.
New Aetna Portland Cement Co..... Omega Portland Cement Co..... Newaygo Portland Cement Co..... Peerless Portland Cement Co..... Wyandotte Portland Cement Co..... Egyptian Portland Cement Co.....	412 Union Trust Bldg., Detroit Jonesville..... Grand Rapids..... Union City..... 1525 Ford Bldg., Detroit..... Fenton.....	Fenton. Mosherville. Newaygo. Union City. Wyandotte. Fenton.

LIST OF MICHIGAN COAL MINES, LOCATION BY COUNTY, NAMES OF MANAGERS AND SUPERINTENDENTS

Name of mine.	County.	Manager.	Address.	Superintendent.	Address.
Robert Gage Coal Co. No. 6.	Bay	Chas. Coryell	Bay City	H. C. Lewis	Bay City
Robert Gage Coal Co. No. 7.	Bay	Chas. Coryell	Bay City	John Corvell	Bay City
Beaver Coal Company	Bay	Chas. Coryell	Bay City	John Corvell	Bay City
Wolverine Coal Mining Company No. 3.	Bay	R. M. Randall	Saginaw	Alex Liddle	Bay City
Wolverine Coal Mining Company No. 2.	Bay	R. M. Randall	Saginaw	Alex Liddle	Bay City
Sun Coal Company	Bay	O. L. Callahan	Bay City	Alex Jeffreys	Bay City
What Cheer Coal Mining Company No. 1.	Bay	E. B. Foss	Bay City	Alex Jeffreys	Bay City
B. & K. Coal Mining Co.	Calhoun	W. A. Knapp	Albion	Alex Jeffreys	Bay City
American Sewer Pipe Co.	Eaton	Clyde H. Earl	Grand Ledge	Alex Jeffreys	Bay City
New Riverside Coal Co.	Eaton	Horner Pickens	Grand Ledge	Alex Jeffreys	Bay City
What Cheer Mining Company No. 2.	Genesee	A. N. Fancher	Bay City	Thos. M. Jenkins	Bay City
Cedar River Coal Mining Company	Ingham	Thos. M. Jenkins	Williamston	Richard Jenkins	St. Charles
Robert Gage Coal Company No. 2.	Saginaw	Chas. Coryell	Bay City	Richard Jenkins	St. Charles
Robert Gage Coal Company No. 3.	Saginaw	Chas. Coryell	Bay City	Richard Jenkins	St. Charles
Robert Gage Coal Company No. 8.	Saginaw	Chas. Coryell	Bay City	Richard Jenkins	St. Charles
Bliss Coal Mining Company	Saginaw	C. E. Linton	Saginaw	John E. Evans	Saginaw
Banner Coal Mining Company	Saginaw	Wm. B. Carmichael	Saginaw	John E. Evans	Saginaw
Consolidated	Saginaw	R. M. Randall	Swan Creek	Jos. Skillcorn	Swan Creek
Pere Marquette Coal Company No. 3.	Saginaw	R. M. Randall	Saginaw	R. Johnston	Saginaw
Chappell and Fordney No. 2.	Saginaw	R. M. Randall	Saginaw	Tim Hollis	Saginaw
Corunna Coal Mining Co.	Shiawassee	Julius Amaika	Corunna	Tim Hollis	Saginaw
Superior Coal Co.	Shiawassee	J. E. Evans	St. Charles	John Morris	Owosso
Akron Coal Mining Company No. 2.	Tuscola	Chas. Handy	Bay City (W. S.)	John Morris	Akron

Hon. Duncan A. Reed, State Coal Mine Inspector, Flint, Michigan.

CLAY MINERS, 1917

Operator.	Office.	Mine.
<i>Barry County:</i> Leonard, Wm.	Delton	Delton.
<i>Ontonagon County:</i> Emmond, Wm. F. Robinson Clay Products Co.	Rockland 1010 E. Market St., Akron, Ohio.	Rockland. Rockland. Rockland.
Vogtlin, W. P.	Rockland	Rockland.
Jefts, F. A.	Rockland	Rockland.
<i>Wayne County:</i> Geo. H. Clippert & Bro. Brick Co.	Detroit	Springwells.

COKE PRODUCERS, 1917

Operator.	Address.	Location of plant.	No. of ovens.	County.
Michigan Alkali Co.	Wyandotte	Plant No. 2	30	Wayne.
Semet-Solvay Co.	Syracuse, N. Y.	Detroit	175	Wayne.

NATURAL GAS PRODUCERS, 1917

Operator.	Address.
<i>Benzie County:</i> Gordon & Conklin	Beulah.
<i>Hillsdale County:</i> DeWitt, C. M.	Osseo.
<i>Macomb County:</i> Hanekow, Mrs. Wm. H. Hartsig, Wm. L. Jacobs, Edward and Otto. Elwart, Franz.	Warren, R. F. D. No. 2. Warren, R. F. D. No. 2. Warren, R. F. D. No. 2. Warren, R. F. D. No. 2.
<i>Oakland County:</i> McClelland, James	Redford.
<i>St. Clair County:</i> Haas, H. G. Michigan Central Oil, Gas and Mineral Co. Michigan Development Co. Stevens, H. Leroy Stock Co., G. B., Xylite Grease and Oil Co. Mason, F. H. Howe, Geo. W. Lawrence, Gillett May, Henry Rowe, John A.	Port Huron, 1615 Griswold St. Port Huron. Port Huron. Port Huron. Port Huron. Port Huron, 2478 Military St. Port Huron, 4008 Military St. Port Huron. Port Huron. Marysville.
<i>Washtenaw County:</i> Harmon, H. E.	Willis.
<i>Wayne County:</i> Bicht, Wm. F. Chavre, Louis W.	Redford. Detroit, 21 Linsdale Ave.

## GRAPHITE PRODUCERS, 1917

Name.	Address.	Quarry.
Detroit Graphite Co. ....	10, 12th St., Detroit...	L'Anse.
Northern Graphite Co. ....	L'Anse.	L'Anse.

## GRINDSTONE AND SCYTHESTONE PRODUCERS, 1917

Operator.	Office.	Quarry.
<i>Huron County:</i> Cleveland Stone Co. ....	Cleveland, Ohio. ....	Grindstone City.
The Wallace Co. ....	Port Austin. ....	Eagle Mills.
Cleveland Stone Co. ....	Cleveland, Ohio. ....	Port Austin.

## PRODUCERS OF GYPSUM PRODUCTS, 1917

Operator.	Office.	Name of plant.	Location of mine.
United States Gypsum Co. ....	Chicago, Ill. ....	Alabaster. ....	Alabaster.
United States Gypsum Co. ....	Chicago, Ill. ....	Midland. ....	Grand Rapids.
Acme Cement Plaster Co. ....	St. Louis, Mo. ....	Mill No. 5. ....	Beverly.
Michigan Gypsum Co. ....	Grand Rapids. ....	Grand Rapids. ....	Grand Rapids.
American Cement Plaster Co. ....	Lawrence, Kas. ....	Grand Rapids. ....	Grand Rapids.
Grand Rapids Plaster Co. ....	427 Mich. Trust Bldg., Gd. Rapids	Eagle Mill. ....	Grand Rapids.
		Grandville. ....	Grandville.

## LIMESTONE AND LIME PRODUCERS, 1917

Operator.	Office.	Quarry.
<i>Alger County:</i> The Munising Co. ....	11th Fl. Rockefeller Bldg., Cleveland, Ohio. ....	Eben.
<i>Alpena County:</i> Michigan Alkali Co. ....	Wyandotte. ....	Wyandotte.
Great Lakes Stone and Lime Co.	Alpena. ....	Rockport.
<i>Arenac County:</i> McDonnell, Jas. (lime) ....	Twining. ....	Omer.
<i>Charlevoix County:</i> Northern Lime Co. (lime) ....	Petoskey. ....	Bay Shore.
<i>Cheboygan County:</i> Campbell Stone Co. (also lime) ..	Indian River. ....	Afton.
Cheboygan Limestone Products Co. ....	Mackinaw City. ....	Mill Creek.
<i>Chippewa County:</i> Scott Quarry Co. ....	Sault Ste. Marie. ....	Trout Lake.
<i>Delta County:</i> Delta Contracting Co. ....	Escanaba. ....	Escanaba (Hyde).
Biehler Bros. ....	Gladstone. ....	Pine Ridge.
Biehler, John. ....	Groos. ....	Groos.
Berkman, Andrew J. ....	Gladstone, R. F. D. No. 1. ....	Gladstone, R. F. D. No. 1, Escanaba Twp.
<i>Dickinson County:</i> Metronite Co., The. ....	Milwaukee, Wis. ....	Felch.
<i>Emmet County:</i> Antrim Lime Co. (also lime) ..	912 Mich. Trust Bldg., Grand Rapids. ....	Petoskey.
Emmet Co. Rd. Comm'rs. ....	Brutus. ....	Petoskey.
Northern Lime Co. (also lime) ..	Petoskey. ....	Petoskey.
Petoskey Crushed Stone Co. ....	Petoskey. ....	Petoskey.
<i>Huron County:</i> Wallace Stone Co. ....	Bayport. ....	3 mi. E. of Bayport.
<i>Jackson County:</i> Lime Products Co. ....	Jackson. ....	Jackson.
<i>Mackinac County:</i> Ozark Stone Quarry. ....	Ozark. ....	Ozark.
Union Carbide Co. ....	42nd St. Bldg., New York, N. Y. ....	Hendricks Quarry.
Fiborn Limestone Co. ....	Sault Ste. Marie, Ontario, Can.	Fiborn Quarry.
<i>Marquette County:</i> City of Negaunee. ....	Negaunee. ....	Negaunee.
<i>Menominee County:</i> Menominee Co. Road Commrs. Spencer, Henry. ....	Menominee. ....	Menominee.
<i>Monroe County:</i> Shore Line Stone Co. ....	Monroe. ....	Frenchtown.
The France Stone Co. ....	1800 Second National Bank Building, Toledo, Ohio. ....	Monroe.
Morris, Sam W. ....	Monroe. ....	Monroe, S. part of City.
Angerer, Jr., Chas. ....	Maybee, R. D. No. 1. ....	Schofield.
<i>Presque Isle County:</i> Michigan Limestone and Chem- ical Co. ....	55 Liberty St., New York, or Rogers City, Mich. ....	Calcite.
<i>Schoolcraft County:</i> The White Marble Lime Co. (Also lime). ....	Manistique. ....	Blaney, Manistique and Marblehead.
Boylett, D. T. ....	Crystal Falls. ....	Blaney.
Fredun, Gust. ....	Whitedale (Gulliver P. O.) ..	Manistique.
Delta Contracting Co. ....	Escanaba. ....	Manistique.
<i>Wayne County:</i> Solvay Process Co. ....	Syracuse, N. Y. ....	Trenton and Sibley.
Dunbar Stone Co. ....	Detroit or River Rouge. ....	Mouth of Detroit River.

## MINERAL AND SPRING WATER PRODUCERS, 1917

Operator.	Office.	Spring.
Artic Spring Water Co. ....	412 Ottawa Ave., Grand Rapids. ....	Artic.
Bailey Marvel Springs Co. ....	Bellaire. ....	Alden.
Willis, J. L. ....	Bangor. ....	Beaver.
Bromo-Hygeia Mineral Water Co.	Coldwater. ....	Bromo-Hygeia.
Crystal Spring Water, Fuel & Ice Co. ....	35 No. Division St., Grand Rapids. ....	Crystal Spring.
Israelite—House of David. ....	Benton Harbor. ....	
Deep Springs Water Co. ....	Northville. ....	
The Pugh Stoves Co. ....	365 E. Illinois St., Chicago. ....	Eastman.
Ogemaw Spring Water Co. ....	Bay City. ....	Ogemaw.
Dewitt, C. M. ....	Osseo. ....	Osseo.
Ponce de Leon Co. ....	Grand Rapids. ....	Ponce de Leon.
Pike, Lute H. ....	Topinabee. ....	Sanitas.
Shorkey, Chas. ....	Mt. Clemens. ....	Victory.
Ypsilanti Mineral Water & Bath Co. ....	Ypsilanti. ....	Moorman Well.
Magnetic Spring Water Co. ....	Saginaw, W. S. ....	Andrew's Magnetic Mineral.
Beard Hill Mineral Spring Co. ....	105 E. Bancroft St., Toledo, Ohio. ....	Avoca.
Charbeneau, Jno. H. ....	Mt. Clemens. ....	Maple Leaf Springs.
Preussel, Frank W. ....	47 Crocker Ave., Mt. Clemens. ....	Panacea.
Wall, R. I. ....	South Haven. ....	Crystal.
Jackson, Roger. ....	Crystal Falls. ....	Sterling.
Sutton, Geo. ....	Hartford. ....	Sultana.
Silver Springs Water Co. ....	Detroit. ....	Northville.
McAisfer Mfg. Co. ....	Mt. Clemens. ....	Eureka.

## PETROLEUM PRODUCERS, 1917

Operator.	Address.
Michigan Central Oil & Mineral Co. ....	807 Pine St., Port Huron.
Stock Xylite & Oil Co., G. B. ....	Port Huron.

## PIG IRON PRODUCERS, 1917

Operator.	Office.	Name of furnace.	Location of furnace.
Mitchell-Diggins Iron Co. ....	Cadillac. ....	Cadillac. ....	Cadillac.
Detroit Furnace Co. ....	1069 Jefferson Ave., Detroit. ....	Detroit. ....	Detroit.
Detroit Iron & Steel Co. ....	149 Jefferson Ave., Detroit. ....	A & B. ....	Detroit.
East Jordan Furnace Co. ....	East Jordan. ....		East Jordan.
Cleveland Cliffs Iron Co. ....	Cleveland Ohio. ....	Pioneer No. 1. ....	Gladstone.
Cleveland Cliffs Iron Co. ....	Cleveland, Ohio. ....	Pioneer No. 2. ....	Near Marquette.
Antrim Iron Co. ....	Antrim. ....	Antrim. ....	Antrim.
Pioneer Iron Co. ....	Marquette. ....	Carp River. ....	Near Marquette.
Stephenson Charcoal Iron Co. ....		Stephenson. ....	Wells.
Charcoal Iron Co. of America. ....	Detroit. ....	Chocolay. ....	Chocolay.
Charcoal Iron Co. of America. ....	Detroit. ....	Boyne City. ....	Boyne City.
Charcoal Iron Co. of America. ....	Detroit. ....	Manistique. ....	Manistique.
Charcoal Iron Co. of America. ....	Detroit. ....	Newberry. ....	Newberry.
New Metals Process Co. ....	Marquette. ....		Marquette.

## POTTERY PRODUCERS, 1917

Operator.	Office.	Works.
<i>Ionia County:</i> Ionia Pottery Co. ....	Ionia. ....	Ionia.
<i>Kalamazoo County:</i> Kalamazoo Sanitary Mfg. Co. ....	Kalamazoo. ....	Kalamazoo.
<i>Macomb County:</i> Mt. Clemens Pottery Co. ....	Mt. Clemens. ....	Mt. Clemens.
<i>Oakland County:</i> Pontiac Clay Pipe & Novelty Co.	Pontiac. ....	Pontiac.
<i>Wayne County:</i> Jeffery-Dewitt Co. ....	Detroit. ....	Detroit.
Hupprich, Anton. ....	2161 Michigan Ave., Detroit. ....	Detroit.
Pewabic Pottery & Tile Co. ....	2161 Jefferson St., Detroit. ....	Detroit.
Hygeia Filter Co. ....	338 Denton Ave., Detroit. ....	Detroit.

## QUARTZ PRODUCERS, 1917

Operator.	Office.	Mine.
<i>Marquette County:</i> Michigan Quartz Silica Co. ....	Milwaukee, Wis. ....	Ishpeming.
Marquette Trap Rock Co. ....	Marquette. ....	Marquette.

## SALT PRODUCERS, 1917

Operator.	Office.	Works.
<i>Bay County:</i>		
Hine Lumber Co. ....	Sta. A., Bay City .....	W. Bay City.
Biglow-Cooper Co. ....	Bay City .....	Bay City.
<i>Isabella County:</i>		
Van Schaack & Sons, Peter. ....	118 Lake St., Chicago, Ill. ....	Mt. Pleasant.
<i>Manistee County:</i>		
Filer & Sons, Vacuum Pan Salt Works. ....	Filer City .....	Filer City.
The Buckley & Douglass Lumber Co. ....	381 River St., Manistee .....	Manistee.
Sands Salt & Lumber Co., Louis. ....	Manistee .....	Manistee.
<i>Mason County:</i>		
Morton Salt Co. ....	Ludington .....	Ludington.
Stearns Salt & Lumber Co. ....	Ludington .....	Ludington.
<i>Midland County:</i>		
The Dow Chemical Co. ....	Midland .....	Midland.
American Bromine Co. ....	Maywood, N. Y. ....	Midland.
<i>Saginaw County:</i>		
Mershon, Eddy, Parker & Co. ....	Saginaw .....	Carrolton.
Bliss & Van Auken Lumber Co. ....	Saginaw, W. S. ....	Saginaw.
Eastman Salt Products Co. ....	Saginaw, W. S. ....	Saginaw.
Estate of Edward Germain. ....	Holland Ave., near Genesee St., Saginaw, E. S. ....	Saginaw.
Saginaw Plate Glass Co. ....	Saginaw, W. S. ....	Saginaw, W. S.
Saginaw Salt Co. ....	430 Shearer Bldg., Bay City .....	St. Charles.
Strable Lumber & Salt Co. ....	Saginaw .....	Saginaw.
Saginaw Chemical Co. ....	Saginaw .....	Saginaw.
<i>St. Clair County:</i>		
Michigan Salt Works. ....	Marine City .....	Marine City.
Morton Salt Co. ....	717 Ry. Ex., Chicago, Ill. ....	Port Huron.
Diamond Crystal Salt Co. ....	St. Clair .....	Port Huron.
<i>Wayne County:</i>		
Inland Delray Salt Co. ....	Detroit .....	Delray.
Solvay Process Co. ....	Detroit .....	Delray.
Detroit Rock Salt Co. ....	Scranton, Pa. ....	Detroit.
Mulkey Salt Co. ....	610 Equity Bldg., Detroit .....	Oakwood.
Kay Salt Co. ....	Charleston, W. Va. ....	Ecorse.
Worcester Salt Co. ....	168 Duane St., New York, N. Y. ....	Ecorse.
Michigan Alkali Co. ....	Wyandotte .....	Wyandotte.
Pennsylvania Salt Mfg. Co. ....	115 Chestnut St., Philadelphia, Pa. ....	Wyandotte.
Wolverine Salt Co. ....	Detroit .....	Ecorse.

## SANDSTONE PRODUCERS, 1917

Operator.	Office.	Quarry.
<i>Houghton County:</i>		
Portage Entry Redstone Co. ....	Jacobsville .....	Jacobsville.
<i>Huron County:</i>		
Cleveland Stone Co. ....	Cleveland, Ohio .....	Grindstone.
Wallace Co. ....	Port Austin .....	Grindstone City.

## APPENDIX.

## SAND AND GRAVEL PRODUCERS, 1917

Operator.	Office.	Pit.
<i>Alcona County:</i>		
Jas. Bell & Co. ....	Greenbush .....	Greenbush.
Huron Shore Gravel Co. ....	Greenbush .....	Greenbush.
<i>Allegan County:</i>		
Sutler, Fred W. ....	Byron Center .....	Burnips Corners.
Wiest, Peter .....	Dorr, R. F. D. 2 .....	Dorr.
Terpstra, Geo. ....	Dunningville, R. F. D. 1 .....	Dunningville.
Kool, Henry .....	New Richmond .....	New Richmond.
Pierce, Myron .....	Otsego .....	Otsego.
Powell, J. C. ....	Plainwell .....	Plainwell.
Craine, W. C. ....	Douglass .....	Douglass.
Hilaski, Stanley .....	Hopkins, R. F. D. 3 .....	Hilliards.
Fry, W. G. ....	South Haven, R. F. D. 6 .....	South Haven.
Purdy, P. ....	Fennville .....	Saugatuck.
Gray, Tom C. ....	Fennville, R. F. D. 2 .....	.....
Dendel, Martin .....	Allegan, R. F. D. 5 .....	Monterey.
Stuby, J. F. ....	Moline .....	Wayland.
Clawson, Jacob .....	Martin .....	Martin.
Dean, Mrs. John .....	Shelbyville .....	Shelbyville, 3 1/2 mi. E. of.
<i>Alpena County:</i>		
Riley & Monkman .....	501 State St., Alpena .....	Alpena.
<i>Antrim County:</i>		
Sissons, F. E. ....	Central Lake, R. F. D. 1 .....	Central Lake.
Campbell, Wm. G. ....	Mancelona .....	Mancelona.
Swan, Guy .....	Mancelona .....	Mancelona.
Burch, A. O. ....	Central Lake .....	Central Lake.
Harvey, M. L. ....	Eastport .....	Eastport.
<i>Arenac County:</i>		
Daniels, Wm. ....	Sterling, R. F. D. ....	Sterling.
Mayor of Omer City .....	Omer .....	Omer.
<i>Barry County:</i>		
Woolston, Chas. ....	Hastings .....	Hastings.
Renkes, Fred .....	Hastings .....	Hastings.
Dunham, P. O. ....	Nashville .....	Grove Center.
Clever, Daniel .....	Nashville .....	Nashville.
Hinckley, C. G. ....	Hastings .....	Hastings.
<i>Bay County:</i>		
Hayward, R. ....	Bay City, R. F. D. 3 .....	Bay City.
Schabel, A. J. ....	Munger .....	Munger.
Whitney, Geo. A. ....	Bentley .....	Bentley.
<i>Benzie County:</i>		
Huddleston, Wm. ....	Bendon, R. F. D. 1 .....	Bendon.
Betsey River Orchards, Ben Newhall & Co. ....	840 Ohio Bldg., Chicago or Thompsonville, Mich. ....	Thompsonville.
Rice, James R. ....	Benzonia .....	Sec. 15, Joyfield.
<i>Berrien County:</i>		
Edgecombe, Geo. W. ....	439 Main St., Benton Harbor .....	Benton Harbor.
Warren, Paul C. ....	Lakeside .....	Lakeside.
Benton Harbor Sand Co. ....	Benton Harbor .....	Benton Harbor.
American Sand & Gravel Co. ....	Benton Harbor .....	Benton Harbor.
Garden City Sand Co. ....	Riverside .....	Riverside.
Kerlikowske Bros. ....	St. Joseph .....	St. Joseph.
Brewer, Frank .....	Galien .....	Galien.
Thar, Anton .....	Coloma, R. F. D. 3 .....	Riverside.
Broderick Bros. ....	Riverside .....	Riverside.
Brant, Mrs. Rebecca .....	Bridgeman .....	Bridgeman.
Andrews, C. ....	Galien .....	Galien.
Mettger, Henry .....	Berrien Springs .....	Oronoka.
Warren, E. K. ....	Three Oaks .....	New Buffalo.
Ireland & Lester .....	Benton Harbor .....	Benton Harbor.
<i>Branch County:</i>		
Werner, Jake F. ....	Bronson .....	Bronson.
Barnes, Mrs. J. M. ....	Montgomery .....	Kinderhook.
Brehm, Jno. H. ....	Kinderhook .....	Kinderhook.
Wilkins, W. H. ....	Coldwater, R. F. D. 3 .....	Kinderhook.
Holcomb, Preston .....	Bronson .....	Bronson.
Graham, Herbert A. ....	Elkhart, Ind. ....	Union City.
Bretz, John D. ....	Ray, Ind. ....	Ray, Ind.

## SAND AND GRAVEL PRODUCERS, 1917.—Continued

Operator.	Office.	Pit.
<i>Calhoun County:</i>		
Abbott, L. N.	Albion	Albion.
March, Andrew	Union City, R. F. D. 5.	Union City.
Young, Willard A.	Albion	Albion.
Blowers, N. A.	Athens	Athens.
Punk, F. J.	Battle Creek, R. F. D. 2.	Battle Creek.
Hiscock, Seth	Battle Creek	Battle Creek.
Grosbeck, Fred	Burlington	Burlington.
Adrian, John	323 Hamblin Ave.	Battle Creek.
Crystal Sand & Gravel Co.	12 E. Main St.	Battle Creek.
Brownlee Park & Material Co.	Battle Creek	Brownlee Park.
Michigan United Traction Co.	Jackson	Marshall.
Phillips, L. W.	Burlington	Burlington.
Van Sickles, Elmer	Albion	Albion.
<i>Cass County:</i>		
La Grange Twp.	Cassopolis	Cassopolis.
Crandall, Lester	Cassopolis	Cassopolis.
Blanchard, A. G.	Niles	Niles.
Graham, H. A.	Elkhart, Ind.	Union.
<i>Charlevoix County:</i>		
Ward, E. B.	Charlevoix	Charlevoix.
Charlevoix Lumber Co.	Charlevoix	Charlevoix.
<i>Cheboygan County:</i>		
Charpointiar, Jos.	Cheboygan, R. F. D. 2.	Cheboygan.
<i>Chippewa County:</i>		
Belanger, Louis	Sault Ste. Marie	Sault Ste. Marie.
Rye, Jas.	409 Maple St., Sault Ste. Marie	Sault Ste. Marie.
Taylor, F. H.	Pickford	Pickford.
<i>Clare County:</i>		
Littlefield, J. L.	Farwell	Farwell.
<i>Clinton County:</i>		
Parmenter, Geo.	Shepardsville	Shepardsville.
Gleason, S. B.	Ovid	Ovid.
Allen, Frank	Elsie	Elsie.
Keys, Hiram	St. Johns	St. Johns.
Wilhelm, Noah	Bath, R. D.	Bath.
Mich. United Traction Co.	Jackson	DeWitt.
Stowell, Elmer	Ovid	Ovid.
Coats, Lewey	Ovid	Ovid.
<i>Delta County:</i>		
Potvin, Louis	Garden	Garden.
Chicago & N. W. R. R.	Chicago	Escanaba.
Escanaba Stone & Gravel Co.	Escanaba	Escanaba, Flat Rock.
Jorgensen, Adolph	Escanaba	Escanaba.
Bereman, Andrew	Gladstone	Gladstone.
Romean, A.	Bark River	Bark River.
<i>Dickinson County:</i>		
Chicago & N. W. R. R.	Chicago	Iron Mountain and Loretto.
Chicago, Milwaukee & St. Paul Ry.	Iron Mountain	Dickinson.
Vulcan Brick Works	Vulcan	Vulcan.
Miench, Anton	107 E. Fleisheim St., Iron Mountain	Iron Mountain.
<i>Eaton County:</i>		
Palmiter, S. J.	Bellevue, R. F. D. 4	Bellevue.
Hull Bros.	Dimondale	Dimondale.
Johnson, A. C.	Eaton Rapids	Eaton Rapids.
LaRock, Hiram	Grand Ledge	Grand Ledge.
Gates, Burton	Grand Ledge	Grand Ledge.
Kent, V. M.	Grand Ledge	Grand Ledge.
Saier, H. E.	Lansing, R. F. D. 6	Millett.
Wells, C. E.	Vermontville	Vermontville.
Markwood, Geo. W.	Grand Ledge	Grand Ledge.

## SAND AND GRAVEL PRODUCERS, 1917.—Continued

Operator.	Office.	Pit.
<i>Genesee County:</i>		
Burns, Ed	Duffield	Duffield.
Farnham, Henry	Farnham, R. F. D. 3	Fenton.
Flint Sandstone Brick Co.	Flint	Flint.
Reid, Alfred	Flint	Flint.
Scott, F. D.	Genesee	Genesee.
Boston, H. W.	Goodrich, R. F. D. 1	Goodrich.
Miner, Frank	Flint	Fenton.
Goodrich, Ford	Grand Blanc	
Stine, Martin	Goodrich	Goodrich.
Bowles, E.	Linden	Linden.
Hogan, Daniel	Linden	Linden.
Brown, D.	Duffield	Duffield.
Horning, A.	Montrose	Montrose.
Johnson, Ernest	Swartz Creek	Swartz Creek.
Knox, Wm.	Linden	Argentine.
Goodrich, Wm. P.	Goodrich	Goodrich.
Bigelow, Elma H.	Grand Blanc	Grand Blanc.
City of Flint	Flint	Otisville.
<i>Gladwin County:</i>		
Wixom, F. L.	Sanford	10 mi. S. of Beaverton.
Butman, L. V.	Butman	Butman.
<i>Grand Traverse County:</i>		
Koch, John	Mayfield	Mayfield.
<i>Griati County:</i>		
Church, I. H.	Alma	Alma.
Dexter, Jas.	Shepherd, R. D. 2	Summerton.
Sawvel, Robert	Breckenridge	Breckenridge.
Lippert, Jacob	Elwell	Elwell.
Curtis, C.	Ithaca, R. F. D. 6	Ithaca.
Haas Bros.	Northstar, R. F. D. 3	Northstar.
Tomlin, A. E.	Sumner	Sumner.
Wiles, Wm.	Sumner, R. F. D. 2	Sumner.
Church, E.	Alma	Alma.
<i>Hillsdale County:</i>		
Zeiter, Geo.	Reading	Camden.
Michigan Central R. R. Co.	Jonesville	Jonesville.
Schofield, H. C.	Pittsford	Pittsford.
Thompson, L. W.	Waldron	Waldron.
Wolcott, C. Nelson E.	Hillsdale	Hillsdale.
Kline, H. N.	Camden	Camden.
Howald, Geo.	Camden	Camden.
<i>Huron County:</i>		
Conkey, Sam	Caseville	Caseville.
Merrick Gravel Co.	Pigeon	Pigeon.
Wallace Co., The	Port Austin	Port Austin.
James Conley—J. C. Gorey	Port Austin	Port Austin.
<i>Ingham County:</i>		
Artz, Joe	Leslie	Sec. 23, Bunker Hill Twp.
Atkinson, Mr.	Mason	S. W. Cor. Sec. 16, Vevay Twp.
Bell, O. E.	Mason or Lansing	Sec. 36, Delhi Twp.
Bunker, Chas.	Leslie or Stockbridge	Sec. 35, Bunker Hill Twp.
Bunker, Chas.	Leslie or Stockbridge	Sec. 35, Bunker Hill Twp.
Burwell Sand & Gravel Co.	S. Wash. Ave., Lansing	Lansing.
Corwin, W. L.	Williamston	Sec. 2, Wheatfield Twp.
Couch, Chas.	Mason	Sec. 25, Aurelius Twp.
Curtis, Bert	Williamston	N. E. Cor. Sec. 21, Wheatfield Twp.
Potts, W. S.	Mason, R. F. D. 1	Mason.
Dubois, D. D.	Leslie	Sec. 28, Bunker Hill Twp.
Frost, A. J.	Williamston	Sec. 22, Wheatfield Twp.
Frost, J. F.	Williamston	Sec. 26, Wheatfield Twp.
Holbrook & Skinner	Lansing	Lansing (Holt).
Linn, Lew	Williamston	Sec. 15, Wheatfield Twp.
Saier, H. E.	Lansing, R. F. D. 6	Lansing.
Stockman, F. M.	Lansing	Lansing.
Campbell, Hugh	1516 6th St., Bay City	Mason.

## SAND AND GRAVEL PRODUCERS, 1917.—Continued

Operator.	Office.	Pit.
<i>Ingham County:—Continued.</i>		
Nice, Geo.	Mason	Sec. 6, Vevay Twp.
Okobock, Dennis	Mason	Sec. 5, Vevay Twp.
Rappe, A.	Lansing or E. Lansing	Sec. 16, Meridan Twp.
Porter	Williamston	Sec. 34, Williamston Twp.
Sheltraw, A. E.	Saginaw	Mason.
Smith, Geo.	Mason	Sec. 10, Vevay Twp.
Stevens, F. B.	Mason	Sec. 5, Vevay Twp.
Victory, Ward	Leslie or Stockbridge	Sec. 36, Bunker Hill Twp.
Michigan United Traction Co.	Jackson	Sec. 25, Delhi Twp., Mason and Haslett.
Warner, Mr.	Mason	N. W. Cor. Sec. 36, Aurelius Twp.
Williams, C. W.	Williamston	Sec. 35, Williamston Twp.
Winters, J. P.	Leslie or Stockbridge	Sec. 25, Bunker Hill Twp.
Hunter, DeWitt	Lansing	Lansing.
<i>Ionia County:</i>		
Glick, Cephas M.	Lowell, R. F. D.	Saranac.
Ionia Cement Products Co.	Ionia	Ionia.
Miller, Henry	East Main St., Ionia	Ionia.
Knapp, A. M.	Ionia, R. F. D. 7.	Ionia.
Trowbridge, Forest P.	Ionia	Ionia.
Elvert, Forest P.	Muir, R. F. D.	Muir.
Hazelitt, J. I.	Ionia, Star Route.	Palo.
Dansinger, Samuel	Saranac, R. F. D. 1.	Saranac.
Gilmore, Niel	Shiloh	Shiloh.
Fellows, Jas. M.	Lake Odessa	Lake Odessa.
Hauserman, Herman	Lake Odessa, R. F. D.	Lake Odessa.
Millard, Seymour	Palo	Palo.
Ronald, Twp. Gravel Pit	Palo	Palo.
Grieves, Mrs.	Saranac, R. F. D. 12.	Saranac.
Keyser, Chas.	Saranac, R. F. D. 10.	Saranac.
Dusman, Sam	Saranac	Saranac.
<i>Iosco County:</i>		
Boomer & Son, Jno	Tawas City	Tawas City.
<i>Iron County:</i>		
Ross, D. M.	Crystal Falls	Crystal Falls.
Chicago, Milwaukee & St. Paul R. R.	Chicago	Crystal Falls.
<i>Isabella County:</i>		
Dexter, James	Shepherd	Shepherd.
Merrill, D. R.	Shepherd, R. F. D. 5, Box 15.	Shepherd.
<i>Jackson County:</i>		
Greenville Gravel Co.	Greenville, Ohio	Ackerman Lake, 3 mi., S. of Jackson.
Cooper, Fred B.	Horton	Horton
Kimball, D. G.	Jackson	Napoleon.
Winters, J. P.	Jackson	Jackson.
Blake, Wm.	Jackson, R. F. D. 6.	Jackson.
Emmons, Wm. P.	123 Clinton St., Jackson	Jackson.
Watts, C. R.	Jackson, R. F. D. 2.	Jackson.
Mich. Central R. R. Co.	Detroit	Bloomerville.
Mich. United Traction Co.	Jackson	Michigan City.
Hunn, G. L.	Parma	Parma.
<i>Kalamazoo County:</i>		
Mich. United Traction Co.	Jackson	Augusta.
Miller, J. B.	Augusta	Augusta.
Balch, Wm. A.	Kalamazoo	Kalamazoo.
Buurma, Sam'l H.	Kalamazoo	Kalamazoo.
Haas Bros.	Kalamazoo	Kalamazoo.
Huff, Archie	Kalamazoo	Kalamazoo.
Kalamazoo Gravel & Sand Co.	Kalamazoo	3 or 4 mi. N. of Kalamazoo on G. R. & I. siding.
Klepper, Jacob	Kalamazoo	Kalamazoo.
Molhock, Peter	Kalamazoo	Kalamazoo.
Owens, Michael	Kalamazoo	Kalamazoo.
Russell, Jas. T.	Kalamazoo	Kalamazoo.
So. Mich. Brick Co.	Kalamazoo	Richland Twp.
Mich. United Traction Co.	Jackson	Augusta.
Gunn, J. W.	Watervliet	Williams.
Kalamazoo County Road Comm.	Kalamazoo	Kalamazoo.

## SAND AND GRAVEL PRODUCERS, 1917.—Continued

Operator.	Office.	Pit.
<i>Kalkaska County:</i>		
Anderson, Lynn	Kalkaska	Kalkaska.
Hayward, W. F.	South Boardman	South Boardman.
<i>Kent County:</i>		
Holt, C. E.	Ada, R. F. D. 42	Ada.
Deiss, Jos.	Ada, R. F. D. 17	Alpine.
Read, Percy	Alpine	Alpine.
Brewer, Earl	Byron Center, R. F. D.	Byron Center.
Battjes Fuel & Bldg. Mat. Co.	Grand Rapids	Grand Rapids.
Bunker Co., G. W.	Grand Rapids	Grand Rapids.
Harrison Land Co., Ltd.	Grand Rapids	Grand Rapids.
Carpenter Construction Co.	Grand Rapids	Grand Rapids.
Valley City Stone & Gravel Co.	Grand Rapids	Grand Rapids.
Ide, D. K.	Grandville	Grandville.
Maloney, Pat.	Harvard, R. F. D. 40	Harvard.
Kruger, M.	Kent City	Kent City.
Farnam, Reuben	Sand Lake	Sand Lake.
Standard Builders Supply Co.	Grand Rapids	Grand Rapids.
Sargeant, John	Lowell	Lowell.
Trumm, C. C.	Kent City	Tyrene Twp.
Mich. Railway Co.	Jackson	Grand Rapids.
<i>Lake County:</i>		
Chicago, Milwaukee & St. Paul Ry. Co.		Bristol.
<i>Lapeer County:</i>		
Hallock, Roy P.	Almont	Almont.
Miteen, Fred	Goodrich	Sec. 18, Hadley.
Caley, M.	Metamora	Hunters Creek.
Broecker, August W.	Goodrich, R. F. D. 2.	Hadley.
<i>Leelanau County:</i>		
Bronson, Mrs. Margaret	Maple City, R. F. D. 1.	Maple City.
<i>Lenawee County:</i>		
Shannon, F. J.	Adrian	Adrian.
Smith, Porter C.	Clinton	Clinton.
Fuller, Charles	Hudson	Hudson.
Lockwood, Sam.	Hudson	Hudson.
Lowe, Frank	Hudson	Hudson.
Evans, Geo.	N. Morenci	N. Morenci.
Gillispie, R. P.	Tecumseh	Tecumseh.
Wilson, Ira	Tecumseh, R. F. D. 3.	Tecumseh.
Tecumseh Gravel Co.	Tecumseh	Tecumseh.
Baldwin, V. E.	Morenci	Morenci.
<i>Livingston County:</i>		
Ohio & Michigan Sand & Gravel Co.	1025 Nicholas Bldg., Toledo, Ohio.	Chilson.
Coles, Ben.	Fowlerville	Fowlerville.
Arnold, O. B.	Gregory	Gregory.
Butler, Dwight	Hamburg	Hamburg.
Hosby, E. B.	Howell	Howell.
Thomas, Henry	Oak Grove	Oak Grove.
<i>Macomb County:</i>		
Blay Bros.	Mt. Clemens	Clinton River.
Horning Gravel Co.	412 Weadock Building, Saginaw	Armada.
Chapman, Jas.	Memphis	Memphis.
Lake Side Ice & Coal Co.	Mt. Clemens	Mt. Clemens.
Harder, Henry	Richmond	Richmond.
Wacker, H. Jacob	Mt. Clemens	Mt. Clemens.
Clark, Chas.	Utica, R. F. D. 2.	Utica.
Detroit Sand & Gravel Co.	34 McGraw Bldg., Detroit	Utica.
Superior Sand & Gravel Co.	Detroit	Utica.
Ruff, Michael	Lennox, R. F. D.	Richmond.
United Fuel & Supply Co.	Free Press Bldg., Detroit	Utica, Rochester.

## SAND AND GRAVEL PRODUCERS, 1917.—Continued

Operator.	Office.	Pit.
<i>Manistee County:</i>		
Hubbell Sand Co. . . . .	Manistee . . . . .	Manistee.
Summerfield, Porter M. . . . .	Manistee . . . . .	Manistee.
Farr, M. A. . . . .	Onokama . . . . .	Onokama.
McMartin, Chas. . . . .	Chief, R. F. D. 2. . . . .	Chief.
Johnson, John. . . . .	Chief. . . . .	Chief.
<i>Marquette County:</i>		
Chicago & N. W. R. R. . . . .	Chicago . . . . .	Michigamme.
Champion Sand & Gravel Co. . . . .	Marquette. . . . .	Champion.
<i>Mason County:</i>		
Szymanski, Geo. . . . .	Freesoil, R. F. D. 2. . . . .	Freesoil.
Wahr, John. . . . .	Freesoil, R. F. D. 2. . . . .	Freesoil.
Beaune, Oliver. . . . .	Ludington, Box 68. . . . .	Ludington.
Clark, Henry. . . . .	Ludington. . . . .	Ludington.
Lorentz, Ferdinand. . . . .	Ludington. . . . .	Ludington.
Dodge, C. C. . . . .	Tallman. . . . .	Tallman.
Edmonson, James. . . . .	Tallman. . . . .	Tallman.
Hubbell Sand Co. . . . .	Manistee. . . . .	Ludington.
<i>Mecosta County:</i>		
Conklin, Wm. . . . .	Big Rapids, R. F. D. 5. . . . .	Big Rapids.
Riley, J. E. . . . .	Millbrook, R. F. D. 2. . . . .	Millbrook.
Main, W. J. . . . .	Millbrook. . . . .	Millbrook.
Stone, C. E. . . . .	Hersey. . . . .	Hersey.
<i>Menominee County:</i>		
Capt. Nels Olsen. . . . .	Menominee. . . . .	Menominee.
Schoen, Jno. W. . . . .	Wilson. . . . .	Wilson.
County Road Comm'rs. . . . .	Menominee. . . . .	Menominee.
<i>Midland County:</i>		
Crane, H. A. . . . .	Midland. . . . .	Hope.
Gehoski, Mike. . . . .	Midland, R. F. D. 1. . . . .	Midland.
Schukofski, G. T. . . . .	Midland, R. F. D. 1. . . . .	Near Midland.
<i>Missaukee County:</i>		
Pickering, O. L. . . . .	Lake City. . . . .	Lake City.
Reeves, Kary D. . . . .	McLean, Ill. . . . .	McBain.
<i>Monroe County:</i>		
Falmstock, Emerson. . . . .	Carlton. . . . .	Carlton.
National Silica Co. . . . .	Steiner. . . . .	Steiner.
<i>Montcalm County:</i>		
Belknap Cement Products Co. . . . .	Greenville. . . . .	Greenville.
Boezwinkle, Wm. . . . .	Pierson. . . . .	Pierson.
Matz, Chas. . . . .	Pierson. . . . .	Pierson.
Tissue, Leonard. . . . .	Stanton, R. F. D. 1. . . . .	Stanton.
Sinkey, Mrs. L. M. . . . .	Carson City. . . . .	Carson City.
Anderson, Holgen. . . . .	Greenville, R. F. D. 3. . . . .	Greenville.
Williams, E. O. . . . .	Edmore. . . . .	Edmore.
<i>Muskegon County:</i>		
Bettis, Philo F. . . . .	Ravenna, R. F. D. . . . .	Ravenna.
Homer, Wm. . . . .	Ravenna, R. F. D. . . . .	Ravenna.
Valley, Edw. . . . .	Twin Lakes. . . . .	Twin Lakes.
Barlow, John C. . . . .	Muskegon. . . . .	Casnovia.
<i>Newaygo County:</i>		
Wentland, Mrs. Johanna. . . . .	Woodville. . . . .	Woodville.
Raymond, R. J. . . . .	Grant. . . . .	Grant.
<i>Oakland County:</i>		
Park & Son, A. H. . . . .	Birmingham, R. F. D. 2. . . . .	Birmingham.
Ely, C. . . . .	Farmington. . . . .	Farmington.
Rice, E. J. . . . .	New Hudson. . . . .	New Hudson.
Campbell, John. . . . .	Ortonville, R. F. D. 2. . . . .	Ortonville.
Detroit-Oxford, Gravel & Stone Co. . . . .	Oxford. . . . .	Oxford.
Bartlett, C. S. & A. S. . . . .	Pontiac. . . . .	Pontiac, 2 miles E.
Kemp, W. R. . . . .	Pontiac. . . . .	Pontiac.
Rockwell, C. L. . . . .	Pontiac. . . . .	Pontiac.
Standard Gravel Co. . . . .	Pontiac. . . . .	Pontiac.
Heal, Geo. . . . .	669 Baker St., Detroit. . . . .	New Hudson.
Rochester Sand & Brick Co. . . . .	Detroit. . . . .	Rochester.
Boomer Sand & Gravel Co. . . . .	520 Forest St., E., Detroit. . . . .	Rochester.

## SAND AND GRAVEL PRODUCERS, 1917.—Continued

Operator.	Office.	Pit.
<i>Oakland County—Continued.</i>		
Thompson, W. R. . . . .	100 Beaubien St., Detroit. . . . .	Goodison.
Adams & Cummings. . . . .	1105 Kresge Bldg., Detroit. . . . .	New Hudson.
United Fuel & Supply Co. . . . .	Detroit. . . . .	Oxford.
Ward Sand & Gravel Co. . . . .	Penobscot Bldg., Detroit. . . . .	Clifford.
<i>Oceana County:</i>		
Aldrich, A. O. . . . .	Hart. . . . .	Crystal Valley.
Twp. Board of Newfield. . . . .	Hesperia. . . . .	Hesperia.
Cartright, Thos. . . . .	Rothbury, R. F. D. 1. . . . .	Rothbury.
Wheeler, Frank. . . . .	Rothbury, R. F. D. 1. . . . .	Rothbury.
<i>Ogemaw County:</i>		
Brooks, H. F. . . . .	Rose City. . . . .	Rose City.
Harvey, D. . . . .	West Branch, R. F. D. 1. . . . .	West Branch.
<i>Osceola County:</i>		
Carmichael, Ed. . . . .	Ewart, R. F. D. 1. . . . .	Ewart.
Stone, Chas. E. . . . .	Hersey, R. F. D. 1. . . . .	Hersey.
Marvin, Seymour. . . . .	Tustin, R. F. D. 1. . . . .	Tustin.
Marquette Gravel Co. . . . .	Saginaw. . . . .	Ewart, 4 mi. W. of Hersey.
Hale, C. H. . . . .	Hersey. . . . .	Hersey.
<i>Ottawa County:</i>		
Holtrop, Jno. . . . .	Ferrysburg. . . . .	Ferrysburg.
Graham, Mrs. T. . . . .	West Olive. . . . .	Grand Haven.
Walsma Van Toll Co. . . . .	Grand Haven. . . . .	Bass River.
Van Weelden & Co., J. . . . .	609 Fulton St., Grand Haven. . . . .	Grand Haven.
<i>Presque Isle County:</i>		
Kroll, Andrew. . . . .	Posen. . . . .	Posen.
<i>Roscommon County:</i>		
Campbell Gravel Co. . . . .	Roscommon. . . . .	Roscommon.
<i>Saginaw County:</i>		
Moiles & Donely. . . . .	336 Howard St. . . . .	Saginaw River.
<i>St. Clair County:</i>		
Armitage, Sidney. . . . .	Atkins, R. F. D. 1. . . . .	Atkins.
Kinney, Chester. . . . .	Atkins, R. F. D. 1. . . . .	Atkins.
Snyder, Wm. . . . .	Atkins, R. F. D. 1. . . . .	Atkins.
Kitchen, Cyrenius. . . . .	Smiths Creek. . . . .	Goodells.
McGennet, Jas. . . . .	Smiths Creek. . . . .	Smiths Creek.
Westrick & Son, C. A. . . . .	Marine City. . . . .	Marine City.
Caldwell Transit Co. . . . .	1805 Dime Bk. Bldg., Detroit. . . . .	St. Clair River and Lake.
United Fuel & Supply Co. . . . .	Foot of 1st St., Detroit. . . . .	Algonac.
Marine Contracting Co. . . . .	211 Quay St., Port Huron. . . . .	Port Huron.
James Co., R. C. . . . .	Port Huron. . . . .	Port Huron.
Superior Sand & Gravel Co. . . . .	726 Dime Bank Bldg., Detroit. . . . .	Marine City.
Thompson Co., W. R. . . . .	Detroit. . . . .	Port Huron.
<i>St. Joseph County:</i>		
Hill, S. . . . .	Colon. . . . .	Colon.
Kerlikowske Bros. . . . .	St. Joseph. . . . .	St. Joseph.
<i>Sanilac County:</i>		
Buck, C. J. . . . .	Marlette. . . . .	Marlette.
Gilbert, Geo. . . . .	Melvin, R. F. D. 6. . . . .	Melvin.
Mills, Henry. . . . .	Minden City. . . . .	Minden City.
Carney, Chas. . . . .	Sandusky. . . . .	Sandusky.
Lloyd, T. . . . .	Deckerville. . . . .	Deckerville.
<i>Shiawassee County:</i>		
Gilmore, Edw. . . . .	Durand. . . . .	Lennon.
Ackerman, Clarence. . . . .	Durand. . . . .	Durand.
Darling, E. R. . . . .	Carland. . . . .	Carland.
Schultz, A. A. . . . .	Laingsburg. . . . .	Laingsburg.
Hibbard, Joseph. . . . .	Byron. . . . .	Byron.
Barnes, O. L. . . . .	Byron, R. F. D. 1. . . . .	5 mi. from Byron.

SAND AND GRAVEL PRODUCERS, 1917.—*Concluded*

Operator.	Office.	Pit.
<i>Tuscola County:</i>		
Hile, Tom.....	Caro, R. F. D. 2.....	Caro, S. W. of Caro in Juanita Twp.
Baker, Gilbert.....	Kingston.....	Kingston.
Whittaker, Benson.....	Kingston.....	Kingston.
Hill, Elmer A.....	Unionville.....	Silverwood.
<i>Van Buren County:</i>		
Bennett & Son, Warren.....	Hartford.....	Hartford.
Burger, F. A.....	Bangor.....	Bangor.
Hoppin, A. D.....	Bangor.....	Bangor.
Shine, John.....	Bangor.....	Bangor.
Sherburn, John.....	Decatur.....	Decatur.
Otis, L. L.....	Kibbie.....	Kibbie.
Wright, J. E.....	Lawrence.....	Lawrence.
Fry, W. G.....	South Haven.....	South Haven.
Funk, Merrifield.....	South Haven.....	Lakeside.
<i>Washtenaw County:</i>		
City Concrete & Coal Co....	1015 Dime Bank Bldg., Detroit.....	Delhi.
Eddie, Geo.....	Ann Arbor, R. F. D. 8.....	Ann Arbor.
Fiegel, Fred.....	Ann Arbor, R. F. D. 3.....	Ann Arbor.
Graves, Mrs. Margaret.....	Ann Arbor, 219 Murray Ave.....	Saline.
Finkbeiner, Bros.....	Saline, R. F. D.....	Saline.
Stuart, Milton.....		Ypsilanti, 1 mi. from.
Washed Clean Sand & Gravel Co.....	Ann Arbor.....	Dexter.
Cadillac Sand & Gravel Co....	1452 Penobscot Bldg., Detroit.....	Ann Arbor.
<i>Wayne County:</i>		
Detroit United Fuel & Sup- ply Co.....	Detroit, Free Press Bldg..	Utica and Detroit.
Thompson, W. R.....	Detroit, 606 Kress Bldg..	Detroit.
Rockwood Silica Co.....	Detroit, 933 Dime Bank Bldg.....	1 ½ miles E. of Rockwood.
<i>Wexford County:</i>		
Selma Twp. Pit.....	Cadillac.....	Boon.
Fewless, John.....	Manton, R. F. D. 3.....	Manton.

## TRAP ROCK PRODUCERS, 1917

Operator.	Office.	Quarry.
<i>Houghton County:</i>		
Winona Copper Co.....	Winona.....	Winona.
<i>Marquette County:</i>		
Durocher, T. L.....	Marquette.....	Marquette.
The Park Cemetery Stone Co.	Marquette.....	Marquette.
City of Negaunee.....	Negaunee.....	Negaunee.
Marquette Trap Rock Co....	Marquette.....	Marquette.
<i>Ontonagon County:</i>		
Blumgren, J. E.....	Norway.....	Bergeland.

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