

COSTS, PROFITS, LOSSES AND ASSESSMENTS, MICHIGAN IRON MINES.—*Concluded*  
 Compiled by the Appraiser of Mines for the Board of State Tax Commissioners from reports of the operators

	1912. Per ton.	1913. Per ton.	1914. Per ton.	1915. Per ton.	1916. Per ton.	1917. Per ton.	1918. Per ton.
"Beyond the Mine" Cost.— <i>Con.</i>							
16. Total cost of delivery.....	\$2.59303	\$2.88015	\$2.77818	\$2.44743	\$2.53415	\$3.47076	\$4.19102
17. Royalties.....	2.51156	2.55063	2.68238	2.41592	2.50403	3.43853	4.16582
	.22255	.32380	.26407	.23872	.27134	.42668	.43584
	.21800	.33882	.25783	.23136	.26648	.42082	.43277
18. Total cost of delivery to operator.....	2.81358	3.18405	3.04225	2.68615	2.80549	3.89744	4.62686
	2.72956	2.99545	2.94021	2.64728	2.77051	3.85935	4.59859
Profit and Loss.							
19. Receipts from sale of ore.....	2.92708	3.41187	2.92249	2.79402	3.36144	4.59733	5.12394
20. Profit or loss to operator.....	.11150	.27732	.11976	.10787	.55595	.69989	.49708
	.19750	.41592	.01772	.14674	.59093	.73798	.52535
21. Total profit (operator's profit or loss plus royalty and depreciation).....	.44374	.69210	.27001	.49665	.95298	1.31471	1.15609
22. Assessed valuation per ton by Board of State Tax Commissioners*.....	.52509	.73989	.36020	.52380	.98185	1.34625	1.38106
	.....	.43561	.45237	.43546	.42923	.43439	\$0.53969

a. Total of all operations.  
 b. Total of all operations excluding non-producers.  
 Note.—All items in 1906 and 1907 figured on basis of tons shipped, tons mined not available.  
 In all other years items 1 to 9 inclusive figured on tons mined, items 10 to 17 inclusive and item 19 on tons shipped.  
 \*Assessed valuation per ton by Board of State Tax Commissioners in 1919 was \$0.55929.

PART II. NON-METALLIC MINERALS

H. M. MARTIN

## NON-METALLIC MINERAL INDUSTRY

### GENERAL REVIEW

A review of the production of non-metallic minerals in Michigan for 1918 shows an increase in production of all those minerals essential in the economy of the War, and a decrease in production of non-essentials.

The total value of non-metallic production for 1918 was \$35,769,470 as compared with \$30,975,615 in 1917 and \$23,626,879 in 1916. This increase of 12.2 percent over 1917 and 51.3 percent over 1916 represents increased prices since there was in 1918 a decrease in total quantity of production.

In 1916 the chief non-metallic minerals ranked as follows: cement, salt, brick and tile, coal, limestone, sand and gravel, gypsum, pottery, bromine. In 1918 the order was changed to salt, cement, coal, limestone, pottery, gypsum, brick and tile, sand and gravel, bromine. This comparison, however, does not show conclusively the effect of the War upon the industries i. e., bromine still remains in ninth place although its production increased 118.36 percent in quantity and 111 percent in value during 1918 alone and cement which dropped to second place decreased 24.2 percent in production during the same year; brick and tile dropped from third to seventh place. That this industry suffered more than the cement industry was due to the Government demand for cement for military roads and the cantonment at Battle Creek.

Michigan shared in the country-wide depression and stagnation in the building trades which is shown by decreases in both quantity and value in the production of cement, brick and tile, sand-lime brick, sand and gravel and a decrease in the production of gypsum. The total output of cement in spite of increased prices declined 24.2 percent reaching the lowest level since 1909. The production of brick and tile averaged more than 50 percent less in 1918 than in any year of the past twenty. Michigan retained first rank in the production of sand-lime brick although production decreased 52.9 percent reaching the lowest value since 1911 and the lowest production since 1908; the general deflation in value for the United States was 37.8 percent. Michigan ranked third in the production of gypsum although production decreased 23.69 percent; the value of gypsum decreased in many States but Michigan with New York and Oklahoma records an increase, Michigan's increase being 12.27

percent. With the resumption of imperative building operations these industries will undoubtedly very quickly resume normal conditions.

A comparison of the building operations in Michigan's largest cities Detroit and Grand Rapids, during 1916, 1917 and 1918, is interesting and apropos in this connection. In 1916 Detroit issued 16,489 permits at a total building cost of \$51,068,310; in 1917 this number was reduced to 12,109 permits at a cost of \$39,666,800 but in 1918 only 7,010 permits were issued at a total cost of \$18,226,832. These figures mean that during the War building operations in Detroit decreased 57.5 percent at a total decrease in cost of 64.3 percent. The decline in building operations during 1918 as compared with those of 1917 was 54.1 percent in cost and 42 percent in number of building permits issued. Detroit ranks third after New York and Chicago in cost of building operations. Grand Rapids issued 1,748 permits at a cost of \$3,519,245 in 1916; in 1917 the permits were reduced to 1,351 to cost \$1,817,165 and in 1918 this number was further reduced to 858 at a cost of \$1,199,985. This represents a total War-time reduction of nearly 51 percent in building permits issued and a reduction of 65.9 percent in building costs compared with 1917 the decrease was 36.5 percent in building operations and 34 percent in cost.

In spite of the high cost of labor and materials the outlook for the building trades for 1919-1920 is good, not only because of the imperative need of buildings of all kinds but because it is realized that delay in building operations is useless as there is no immediate prospect of costs being lowered. Building operations throughout the State are assuming normal proportions and both costs and operations will show an increase.

Michigan did not however share in the general decrease in the production of lime since practically all of the lime produced in Michigan is used in the chemical rather than in the building industries. The 0.8 percent decrease in production can be ascribed to labor shortage and transportation difficulties.

Limestone records an increase in both production and value; this is due directly to the War, since the greater part of the limestone is used in the chemical industries and as flux in the blast furnaces.

Although Michigan ranked 23 in coal production the State shared to some extent in the general prosperity in the coal industry. The tremendous demand which began in the last quarter of 1916 continued during 1918. Production increased beyond the limit of the railroad capacity for transportation and the demand re-

mained unsatisfied. Prices were under government control after June 1917 and coal prices for the consumer did not reach the high prices of 1916-17, but the price at the mine was higher than ever before in the coal industry of the State.

The production of salt increased but 6.75 percent although the value increased about 32 percent. Labor shortage and the closing of the factories on Mondays by the Fuel Administration early in the year caused some reduction in the salt produced. The demand for salt was good but high costs of materials and shortage of labor made it difficult for producers to fill orders. One operator reported conditions the same as in 1917 but others reported an increase of 50 to 60 percent in operating costs.

Bromine was not exactly in the "War-baby" class but the War rid the industry of the incubus of German competition so that it thrived as did none others of the non-metallic industries. Production increased nearly 213 percent above that of 1916. In that year Michigan produced approximately 70 percent of the total United States production at 72 percent of the total valuation, but in 1918 these percentages had increased to 93.08 percent and 88.2 percent, respectively. The war needs of the Allies, supplemented in 1917-18 by the needs of the United States Army caused the Government to order new wells drilled in Midland County to increase the supply. The signing of the Armistice caused a sudden decrease in the demand from abroad and by the close of 1918 the market had fallen so low that at least one company ceased the manufacture of bromine.

The pottery industry showed increased productions as well as a 66.3 percent increase in value due directly to War demands for porcelain electrical supplies.

In resume: Of the principal non-metallic mineral industries of Michigan for 1918 salt, coal, bromine, limestone and pottery show increase in both production and value; calcium chloride, grindstones, gypsum, and lime show increase in value but decrease in production; and brick and tile, sand-lime brick, cement and sand and gravel show decreases in both production and value.

Michigan ranked first among the States in the production of sand-lime brick bromine, calcium chloride and salt, second in the production of grindstones and third in the production of gypsum.

A detailed account of the non-metallic industry follows:

#### SALT

During the past nine years the production and value of salt in Michigan has increased annually, the production of 9,452,022 barrels at \$2,231,262 in 1910 increasing to the maximum of 17,-

165,179 barrels valued at \$9,048,650 in 1918. In spite of the labor shortage, high cost of fuel, the closing of the factories on Mondays by the Fuel Administration early in the year, and the increased cost in production (cooperage increased and cotton sacking tripled in 1918 as in 1917) the demand remained good and salt production was increased in 1918 by 1,087,043 barrels in quantity and \$2,171,448 in value over 1917, or respectively 6.75 and 31.57 percent. The increase in value is due to the higher average price which was \$0.52 per barrel as compared with \$0.421 in 1917 and \$0.309 in 1916—an increase of about \$0.22 or 73 percent over the pre-War price. One operator reported no change in operating expenses from those of 1917 but others report operating costs increased 26 to 25 percent in 1917 and 50 to 60 percent in 1918.

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 again led by a narrow margin. With the exception of 1910, Michigan has also held first rank in value since 1908. In the production of rock salt however New York is the largest producer in the United States and Michigan follows Kansas, and Louisiana in fourth place.

From 1880 to 1890 Michigan produced annually from about 42 to over 49 percent of the salt produced in the United States. The percentage declined from 43.69 percent in 1890 to only 22.89 percent 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 percent 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 percent of the total output of the State was produced in this district. The War revived the industry through the great demand for bromide from abroad which was further increased when the United States entered

the War.\* Under present conditions salt is largely manufactured in the Saginaw Valley as a by-product of the bromine industry. The total output of salt for this district in 1918 was only 507,807 barrels or 2.9 percent of the total for the State and was valued at \$422,646, or 4.6 percent of the total State value. This quantity represents an increase of 25,357 barrels over the production for 1917 but falls short of the 1916 production by 53,375 barrels. The maximum production for 1916 represents the great foreign demand, which decreased in 1917 when other sources of bromine production partly met the demand but increased in 1918 with the increased demand for bromine made by the United States government.

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. More than 97 percent 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 1918 it was 10,737,072 barrels, or 62.5 percent of the total for the State. The value was \$2,246,190 or only 24.8 percent 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 1918 was only 2,694,686 barrels or 15.7 percent of the State output but the value was \$3,427,061 or 37.8 percent 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 percent being table and dairy salt.

\*See Bromine page 127.

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 3,266,436 barrels of salt valued at \$92,952,753. This is equivalent to 18.5 percent of the total quantity and 32.6 percent 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, northeast 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, 1835-1913

Year.	U. S. Production Quantity bbls.	Michigan production.		Per Cent. of Total Mich-igan.	Rank Quantity.	Michigan.	
		State Salt In-p-ctors* Quantity bbls.	U. S. G. S.† Quantity bbls.			Value Michigan	Ran Value.
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		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	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	0.188
1903	18,968,089	4,387,982	4,297,542	22.65	2	1,119,984	0.260
1904	22,030,002	5,390,812	5,425,904	24.62	2	1,579,206	0.309
1905	25,966,122	5,671,253	9,49,173	35.24	1	1,851,332	2 0.196
1906	28,172,380	5,644,559	9,936,80	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	49,844,125†		16,078,136	32.25	1	6,817,202	1 0.421
1918	51,705,317†		17,165,178	33.19	1	9,048,650	1 0.520
Total			269,967,192			114,740,913	

\*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 1914-1917-8.

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY GRADES, 1906-1918

Year	Table and dairy		Packers			
	Quantity	Value	Common fine		Common Course	
			Quantity	Value	Quantity	Value
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	2,330,378	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
1918	1,612,207	2,560,439	3,181,121	2,743,657	2,514,600	2,375,831
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
1918	†	†	1,405,671	827,348	8,451,578	541,375
Year	Total					
	Quantity		Value			
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		
1918			17,165,178	9,048,650		

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

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY COUNTIES, 1918

County.	Table and dairy.		Packers.				Other, rock, etc.		Brine.	
	Tons.	Value.	Common fine.		Common coarse.		Tons.	Value.	Tons.	Value.
			Tons.	Value.	Tons.	Value.				
Bay	a	a	a	a	93,070	\$637,152	a	a	a	a
Mason	a	a	a	a	a	a	a	a	a	a
Midland	a	a	13,641	\$94,776	41,955	266,333	a	a	a	a
Manistee	a	a	118,606	789,352	78,336	561,595	a	a	a	a
Saginaw	169,769	\$2,173,425	74,434	428,958	33,138	224,748	a	a	a	a
St. Clair	43,921	426,714								
Wayne										
Total—Tons	225,709	\$2,560,439	445,357	\$2,743,657	352,044	\$2,375,831	196,794	\$827,384	1,183,221	\$541,375
Ebbs	1,612,207		3,181,121		2,514,600		1,405,671		8,451,579	

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY COUNTIES, 1918.—Concluded

County.	Total.		County.		Bromine.		Calcium chloride.	
	Tons.	Value.	Quantity Percent.	Value Percent.	Pounds.	Value.	Tons.	Value.
Bay	296,900	\$1,855,455	12.3	20.6	a	a	a	a
Mason	162,877	1,157,265	6.8	12.8				
Midland	62,952	362,679	2.6	4.0				
Manistee	377,206	3,427,061	15.7	37.8				
Saginaw	1,503,190	2,246,190	62.6	24.8				
St. Clair								
Wayne								
Total—Tons	2,403,125	\$9,048,650	100.0	100.0	1,605,696	\$855,841	20,615	\$394,200
Ebbs	17,165,179							

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.

Bromine dropped in value to 25 cents and to 30 cents a pound in 1913. In 1914 when the World War cut off the supplies of German bromine France, Italy and England became largely dependent upon the United States for their supply. The price of bromine advanced to unprecedented figures, reaching the peak price of \$6.50 a pound in New York\* in the spring of 1916. The industry was revived in the Saginaw valley. In 1917 there were five producers; in 1918 the Government ordered new wells driven at Midland to increase the supply of bromine since with the entrance of the United States into the War and the increased use of asphyxiating gases the needs of the United States as well as of the Allies had vastly increased.

Prior to the War the bromine of Michigan was marketed largely as bromides but the increased demand caused the marketing of a large amount of bromine in the crude state—a heavy, reddish brown mobile liquid. Bromine is used in many chemical reactions, in separating gold from platinum and silver, in the manufacture of disinfectants, dyes and drugs. During the War because of its effects upon the eyes and throat bromine was extensively used in the manufacture of asphyxiating gases but after the Armistice was signed the large demand for this purpose naturally fell off. A demand increased by the War and one to be continued is for potassium bromide used as a depressant in the treatment of certain nervous diseases. The use of bromine in the form of silver bromide in photography is well known.

In 1918 the quantity of bromine marketed in Michigan was

\*It should be remembered that prices quoted in the New York market are much higher than those representing value of the marketed product in large lots f. o. b. at the point of shipment.

1,605,696 pounds valued at \$955,841, or 93.08 percent of the total United States production at 88.2 percent of the total United States valuation of \$970,099. The increased production over 1917 was 870,052 pounds or 118.26 percent; the increase in value was \$450,792 or 111 percent. This increase in value is due to the greatly increased production since the price of bromine dropped to \$.53 a pound. The price for the United States remained steady at about \$.75 until the Armistice was signed when the foreign demand fell off and the price dropped to \$.50; if the Government gradually places its reserve stocks of bromine on the market this price will remain fairly stable for some time.

#### *Calcium Chloride*

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. And could be used to great advantage on the hundreds of dusty summer-playgrounds. Since the playground movement is becoming so widespread and since ground treated with calcium chloride presents a hard, dry, dustless surface a few hours after treatment it is advised that greater use be made of the product to provide clean, dust-free playgrounds.

The output of calcium chloride for 1918 was 20,615 tons valued at \$394,200 or \$19.12 a ton, a decrease in output of 2,064 tons or 9.1 per cent, but an increase in value of \$99,507 or 33.7 percent.

#### CEMENT\*

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 maximum pre-War production in Michigan (4,919,123 barrels in 1916.)

Prior to 1895, the kilns used were of the vertical type but in that year rotary kilns, using powdered coal as a fuel were successfully introduced, revolutionizing cement manufacture and enabling the industry in the United States to excel that of Europe, and thus inaugurating 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 uninterruptedly up to 1917, when 92,814,202 barrels were made. The War caused relatively small decreases in production in 1914 and 1916. In 1917 there was a slight increase in production but the restrictions imposed by the Government upon fuel supplies, transportation facilities, labor, and private construction in general caused a marked decrease in output in 1918, production falling to 71,081,663 barrels, the lowest production since 1909. This was somewhat offset by the increased price of cement, \$1.596 per barrel. The total value for the entire country was \$113,153,513.

The first attempts to manufacture Portland cement in the United States were made in Michigan in 1878 when a vertical kiln plant for manufacturing cement from marl and clay was erected near Kalamazoo. 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 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 were in operation in 1918. Michigan shared with other States the general decrease in output due to War conditions. Of the ten operating plants one was closed nearly all the year and two others part of the year. Operators reported from 30 percent to 56 percent decrease in production.

The New Egyptian Portland Cement Company in April 1918 was obliged to close its plant near Fenton because of shortage of coal, scarcity of labor and government restrictions. Operation of the plant has now (July, 1919) been resumed by a syndicate which acquired the property from the Security Trust Co., receivers. The new company will manufacture cement from the marl obtained from the company's holdings of 800 acres of marl land.

A new company, the Petoskey Portland Cement Co., has been organized at Petoskey; docks are being built but the plant will probably not be in operation until late in 1920.

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

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 Petoskey Portland Cement Co., intends 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 twenty-seven miles southwest of Petoskey.

When the War caused restrictions in potash imports and the shortage of potash in the United States became acute the attention of Portland cement manufacturers was turned to the recovery of potash from cement dust. Several Michigan companies have the project under consideration and one, the Newaygo Portland Cement Company began the recovery of potash by the Cottrell process in June, 1918.

It has been estimated that nearly one-third of the annual requirements of potash are going to waste in cement dusts; production of potash by recovery from cement dusts may be maintained in the face of competition; use of the dust would rid nearby towns of an ever-present dust nuisance. These facts combined with the steady demand and high price received for potash and the proposed legislation to protect the industry would seem sufficient to cause all the cement producers to install apparatus for potash recovery from cement-furnace dusts and flue gases, and add a valuable by-product to the Portland cement industry.

The following table shows that Michigan produced 3,554,872 barrels of cement in 1918 as compared with 4,688,899 barrels in 1917 a decrease of 1,134,027 barrels or 24.2 percent. The decrease in shipments beginning in 1916 continued during 1917 and 1918; shipments decreased from 4,313,771 barrels in 1917 to 3,618,088 barrels in 1918 a loss of 695,683 barrels. As before stated decreases were chiefly due to Government restrictions induced by the War. The value of the cement shipped also shows a decrease, the total value in 1918 being \$6,078,167 a decrease of \$44,720 or 0.7 per cent. This disproportionate decrease in value is due to the increase in the average price per barrel—\$1.68, an increase of \$.261 over the average 1917 price per barrel and of \$.493 over the average for 1916—a War-caused increase of 44.6 per cent.

NON-METALLIC MINERALS

PRODUCTION, VALUE, ETC., OF PORTLAND CEMENT IN MICHIGAN AND UNITED STATES, 1896-1918.

Year	No. of plants in operation	Michigan Rank	No. of kilns	Daily capacity, Bbls.	Michigan, cement made, Bbls.	U. S. Cement made, Bbls.	*Change per cent	Michigan cement shipped, Bbls.	Michigan cement shipped, 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	8	96	22,400	4,000	1,543,023	0	3,651,094	\$7,000	\$2,244,011	0.29	.....	\$1.75	\$1.57
1897	2	8	92	19,450	15,000	2,677,775	256	3,228,979	26,250	4,315,891	0.6	.....	1.75	1.61
1898	2	8	83	19,900	77,000	3,692,284	2,114	4,228,879	134,750	5,970,773	2.3	.....	1.75	1.62
1899	4	4	77	19,100	343,566	5,652,266	6,346	4,757,729	513,849	8,074,371	6.36	.....	1.492	1.43
1900	6	2	71	20,800	664,750	8,482,020	7,893	5,127,768	830,990	9,280,525	8.9	.....	1.25	1.09
1901	10	3	68	20,650	1,025,718	12,711,225	8	4,313,731	1,128,290	12,532,360	9	.....	1.10	0.99
1902	10	3	68	20,550	1,577,006	17,230,644	54	3,618,088	2,134,396	20,864,078	10	.....	1.353	1.21
1903	13	3	68	19,100	1,955,183	22,342,973	7,23	.....	2,674,780	27,713,319	9.7	.....	1.367	1.24
1904	16	4	71	20,800	2,247,160	26,505,881	5	.....	2,365,656	33,245,119	10	.....	1.052	0.88
1905	16	5	71	20,800	2,773,283	35,246,812	9	.....	2,921,507	33,245,119	10	.....	1.053	0.94
1906	14	4	68	20,650	3,747,525	46,463,424	6	.....	4,814,965	52,466,186	9.2	.....	1.284	1.13
1907	14	4	68	20,650	3,572,688	48,785,390	3	.....	4,384,751	53,992,551	8.1	.....	1.227	1.11
1908	15	7	68	20,650	2,892,576	51,072,612	6	.....	2,556,215	43,547,679	8	.....	0.883	0.85
1909	12	7	68	20,650	3,212,751	64,991,431	6	.....	2,619,259	52,858,354	4.9	.....	0.815	0.813
1910	12	8	68	20,650	3,687,719	76,549,951	4	.....	3,378,940	68,205,800	4.9	.....	0.916	0.801
1911	11	8	68	22,400	3,686,716	78,528,637	4	.....	3,024,676	66,248,817	4.56	506,758	0.82	0.843
1912	11	8	92	19,450	3,494,621	82,458,096	4	.....	3,145,091	69,106,800	4.55	370,956	0.861	0.813
1913	11	8	83	19,900	4,186,236	92,097,131	4	.....	4,228,879	89,106,907	4.74	473,563	1.035	1.005
1914	11	7	77	19,100	4,285,345	88,230,170	4	.....	4,064,781	80,118,475	5	538,846	0.964	0.927
1915	11	5	68	20,800	4,765,294	85,914,907	5	.....	4,454,608	74,756,674	5.95	569,919	0.942	0.86
1916	11	6	68	20,650	4,919,023	91,521,198	3	.....	6,017,911	104,258,216	5.77	338,035	1.168	1.103
1917	11	6	68	20,550	4,688,899	92,814,202	5	.....	6,122,887	122,775,088	4.98	701,919	1.419	1.354
1918	10	8	49	22,160	3,554,872	71,081,663	5	.....	6,078,167	113,153,513	5.37	635,447	1.680	1.596

\* Minus sign indicates decrease.

## 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 (cement dust and Steffens water from beet sugar manufacture) and wood ashes. In 1918 the production of potash reckoned as  $K_2O$ , amounted to 404 tons valued at \$100,647, of which 196 tons were from industrial wastes and 206 tons from wood ashes.

When the shortage of potash became acute due to the restrictions in imports caused by the War, attention was turned to the development of all possible domestic sources, particularly to the recovery of potash from former manufacturing wastes. Several Portland cement companies considered the project of recovering potash from cement dust. In June Newago Portland Cement Company began the recovery of potash by the Cottrell process, investigation showing that it was possible to recover about three tons of potash in the manufacture of 2,000 barrels of cement. During a four-month trial mechanical difficulties developed, however, which rendered the recovery of potash unprofitable. It is possible that when the mechanical difficulties are overcome the Newago Portland Cement Company will again open its potash recovery plant.

## 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.

The increased production in 1916 was due to the general activity and prosperity in industrial lines, particularly in the building trades. After the entry of the United States in 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 1917 and 1918, the production falling from 457,375 tons to 375,803 tons in 1917 and to 286,768 tons in 1918, a decrease of 17.8 percent in 1917 and 89,035 tons or 23.69 percent in 1918, a total decrease in production of 170,607 tons or

37.3 percent following the entry of the United States into the War. The percentage decrease for Michigan in 1918 corresponds to the average decrease for the entire United States.

On the other hand, due 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 percent, and to \$1,761,149 in 1918 a further gain of \$192,494 or 12.27 percent, producing a total increase of 65.11 percent over pre-War prices, despite the 37.3 percent decrease in production from the maximum (1916) pre-War production.

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 1918 was only 5,892 tons as compared with the maximum of 49,570 tons in 1880. The Gypsum Industries Association of Chicago, Ill., has launched a campaign to induce greater use of gypsum as land plaster and as a deodorizer and fixative of ammonia in manure about stables. This campaign may have some effect in increasing production of ground gypsum in Michigan since its use will prevent the present wastage of fertilizer value of stable refuse caused by the evaporation and consequent loss of much of the ammonia content.

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 1918, the value of land plaster was only \$23,876 as compared with \$1,629,711 for calcined products.

The most important of these products is mixed wall plaster; gypsum board and stucco are next in importance. In 1918 wall plaster was valued at \$931,725, or 52.9 percent of the total value of raw and calcined products for the State. Stucco was valued at \$330,761 or 18.7 percent of the total value. The manufacture of gypsum board and tiles is increasing rapidly, the 1918 production exceeding that of 1917 by 73.5 percent in quantity and 401.7 percent in value. The value of the product in 1918 was \$339,901 or 19.3 of the total value of the State, compared with a value of \$67,741 or 4.3 percent of the State total in 1917.

In 1918, 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, 1868-1918

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		68,499	349,710		
1881	33,178	20,145		53,323	298,872		
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	329,392		
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	192,099		
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	67,633	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	24,289	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	3	3
1909	11,890	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	206,299	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	69,372	389,791	686,309	3	4
1916	9,072	292,109	80,298	457,375	1,066,599	3	4
1917	7,090	257,588	68,155	375,803	1,568,655	3	3
1918	5,892	207,059	46,608	286,768	1,761,149	4	4
1919							
Totals...	1,264,330	5,187,965	1,192,922	8,404,313	23,328,023		

PRODUCTION OF GYPSUM IN MICHIGAN, 1911-1918

YEAR	Gypsum sold crude.									
	Crude gypsum mined.		To Portland cement mills.		As land plaster.		For other purposes.		Total sold crude.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1911	Tons.		Tons.		Tons.		Tons.		Tons.	
1912	347,296	\$69,497	63,489	\$15,706	15,548	\$52	13	\$52	79,050	\$85,255
1913	384,297	52,420	10,103	9,375	10,103	50	5	50	63,819	61,845
1914	423,696	*	9,604	10,222	9,604	9,011	10,320	9,011	60,706	55,969
1915	363,006	*	9,322	10,761	9,322	*	*	*	61,227	51,242
1916	389,701	*	9,799	9,894	9,799	9,894	*	*	69,572	63,236
1917	457,375	92,874	9,072	16,658	9,072	16,658	*	*	80,298	90,973
1918	375,808	105,621	7,090	22,903	7,090	22,903	*	*	68,155	116,653
	286,768		40,314	23,876	5,892		*	*	46,608	131,438

Gypsum sold calcined.

YEAR	As mixed wall plaster.				As plaster of Paris, etc.				As stucco.				As boards, tile, etc.				To plate glass works.			
	Quantity.		Value.		Quantity.		Value.		Quantity.		Value.		Quantity.		Value.		Quantity.		Value.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1911	146,920	\$381,362	47,989	\$88,168	82,010	\$168,434	19,158	\$67,741	33,253	\$339,901	11,370	\$19,031	6,214	\$8,078						
1912	146,099	368,676	47,937	3,229	95,402	202,675														
1913	166,711	437,720	*	*	83,780	173,172														
1914	163,972	475,638	*	*	80,172	177,317														
1915	155,861	426,432	*	*	87,405	279,597														
1916	193,816	668,795	224	1,325	85,426	384,661														
1917	147,371	949,511	*	*	52,132	330,761														
1918	117,902	931,725	*	*																

\*Included in total.

PRODUCTION OF GYPSUM IN MICHIGAN, 1911-1918—Concluded

YEAR	Gypsum sold calcined.										No. mines and quarries	No. mills		
	For other purposes.		Total sold calcined.		Total value.		Kettles in mills.		Daily capacity.				Shifts run by mills during year.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	No.	Size.	24 hrs.	Total No.			Hrs. in shift.	
1911	Tons.		Tons.		Tons.									
1912	8,393	\$10,073	206,299	\$488,671	206,299	\$488,671	29	8x10	2,200	1,850	11	8		
1913	9,897	15,830	243,656	559,702	243,656	559,702	28	8x10	2,340	1,368	11	6		
1914	1,811	5,432	278,368	665,356	278,368	665,356	28	8x10	1,785	2,043	11	8		
1915	*	*	249,648	654,599	249,648	654,599	28	8x10	1,860			7		
1916	*	*	245,484	623,073	245,484	623,073	26	8x10				8		
1917	*	*	292,109	975,626	292,109	975,626	26	10x12				8		
1918	*	*	257,588	1,452,002	257,588	1,452,002	26					7		
			207,059	1,629,711	207,059	1,629,711						7		

\*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 percent 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, fireproofing, 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 1918 the value of brick and tile products was \$1,708,736, exclusive of pottery,\* or \$1,137,525 less than in 1917. This was a decrease of 39.9 percent as compared with the 5.2 percent increase in 1917 and the 20.3 percent increase in 1916. The quantity of common brick was 94,746,000 or 141,866,000 brick less than in 1917 and 184,429,000 less than the pre-War production of 1916. This represents a decrease of 59.6 percent in quantity during 1918 and a decrease of 66.6 percent from the pre-War maximum of 1916. The value of common brick was \$915,599 or an average

price of \$9.65 per thousand as compared with \$7.95 per thousand in 1917 and \$6.65 in 1916. This was an advance in price of nearly 20.3 percent in 1918 and an advance of 45.1 percent above the pre-War figures. The value of drain tile, however, decreased from \$734,042, to \$565,398, a loss of about 23 percent. During 1917 the decrease in manufacture was due largely to a lack of coal which decreases the output, but in 1918 the general stagnation in the building industries due to the War and the withdrawal of men from the industry in to the Army accounts for the greatly decreased output. One operator reports decreased production due to a decreased demand for drain tile due to the dry season of 1918.

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. In 1917 another plant was projected at Williamston, Ingham County, but this will not be built until post-War time developments permit profitable operation.

\*See Pottery, value \$1,976,436.

ANNUAL PRODUCTION OF BRICK AND TILE PRODUCTS IN MICHIGAN, 1899-1918

YEAR.	Common brick.		Average price per M.	Front brick.		Average price per M.	Vitrified brick.		Average price per M.	Drain tile.	Sewer pipe.
	Quantity.	Value.		Quantity.	Value.		Quantity.	Value.			
1899	200,144,000	\$933,176	\$4.66	4,290,000	\$58,920	\$13.73	*	*	\$12.42	\$140,171	\$50,300
1900	180,892,000	863,250	4.77	8,421,000	48,411	5.75	*	*	11.42	98,747	57,916
1901	215,836,000	1,095,254	5.07	9,476,000	64,031	6.76	*	*	12.30	98,972	*
1902	237,254,000	1,331,752	5.61	5,684,000	42,792	7.53	*	*	12.26	96,645	*
1903	215,791,000	1,231,572	5.80	2,225,000	19,000	8.54	*	*	13.27	129,028	*
1904	205,196,000	1,116,714	5.44	1,080,000	7,500	6.94	*	*	13.28	208,088	*
1905	211,558,000	1,152,504	5.45	1,693,000	5,995	8.65	*	*	13.37	205,445	*
1906	206,583,000	1,178,202	5.70	1,474,000	14,162	8.61	*	*	13.13	314,098	*
1907	200,817,000	1,094,522	5.48	3,956,000	32,116	8.12	*	*	11.96	289,868	*
1908	181,049,000	1,250,757	6.89	1,856,000	19,496	10.28	*	*	12.43	327,630	*
1909	219,820,000	1,263,316	5.76	2,379,000	18,654	7.84	*	*	12.43	289,868	*
1910	232,551,000	1,301,998	5.60	2,209,000	27,533	12.46	*	*	12.82	364,006	*
1911	252,465,000	1,592,283	6.31	2,498,000	31,572	12.64	*	*	12.82	348,205	*
1912	271,189,000	1,623,287	5.97	3,594,000	41,476	11.76	*	*	14.00	313,972	*
1913	273,571,000	1,461,188	5.34	1,488,000	21,121	11.28	*	*	14.71	415,543	*
1914	269,154,000	1,461,188	5.43	*	*	11.28	*	*	14.71	421,941	*
1915	277,399,000	1,856,587	6.69	*	*	18.02	*	*	15.59	305,156	*
1916	279,175,000	1,882,042	6.74	*	*	24.22	*	*	14.78	548,795	*
1917	236,612,000	1,915,599	8.09	*	*	*	*	*	17.16	734,042	*
1918	94,746,000	*	9.65	*	*	*	*	*	15.23	565,398	*
Totals	4,461,802,000	\$25,981,268								\$6,328,795	

\*Concealed; less than three producers.

ANNUAL PRODUCTION OF BRICK AND TILE PRODUCTS IN MICHIGAN, 1899-1918.—Continued

YEAR	Tile (not drain).	Fire-proofing.	Miscellaneous.	Hollow building tile or blocks.	Per cent of total product	Rank of state.	No. of firms operating.	Total Value.
1899					1.68	13	196	\$1,254,256
1900		\$5,900	\$22,709		1.50	17	189	1,147,378
1901		2,350	406		1.71	14	180	1,497,169
1902		1,880	637		1.69	13	182	1,660,942
1903		3,290		\$19,138	1.58	14	178	1,662,414
1904				8,080	1.58	14	168	1,670,892
1905				4,286	1.41	16	154	1,719,746
1906				2,900	1.38	16	142	1,793,367
1907				6,386	1.39	17	136	1,786,190
1908		4,100	1,500		1.54	16	132	1,666,381
1909			66,128		1.44	16	122	1,947,059
1910					1.53	15	111	2,083,525
1911			228,530		1.53	15	118	1,953,442
1912		1,461	235,459		1.73	13	101	2,350,606
1913			350,000		1.73	13	95	2,451,242
1914		3,752	234,280		1.88	10	80	2,434,872
1915		10,850	49,755		1.79	11	82	2,248,068
1916		2,492	216,265		1.71	13	73	2,705,054
1917			79,996	4,621	1.48	12	69	2,846,264
1918			73,511	*				1,708,736
Totals								\$38,587,603

\* Concealed; less than three producers.

## 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 several 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 the return of normal business conditions following the War reconstruction period.

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.

## 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

\*H. Reis, Vol. VIII, pt. I, p. 48, Clays and Shales of Michigan, Geol. Surv.  
\*\*See also "Brick and Tile" and "Pottery."

special burning qualities. The lake clays are comparatively free from pebbles and coarse sand but some contain much very fine grit. 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 Chipewewa 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	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
1918.....	1,236	4,639	*	*	*	*	2,359	6,373
Total.....								\$63,714

\*Included in total.

### POTTERY

The pottery industry in Michigan has made almost uninterrupted growth since 1899 and since 1908 the growth has been rapid, increasing over 3,000 percent in ten years, the main increase being during the past three years. In 1899 the total value of the pottery output was \$29,741; in 1908, \$62,409; in 1917, \$1,187,981 and in 1918 \$1,976,436 a gain of 66.3 percent over the value for 1917. The increases were largely due to the greatly increased output of porcelain electrical and sanitary supplies and porcelain and decorated ware.

The products are chiefly porcelain electrical supplies, sanitary ware, decorated and white ware, "white granite" ware, and flower pots. Of eight firms the Jeffery-DeWitt Co., of Detroit manufacture a variety of porcelain products,—sanitary ware, insulators, spark plugs, tumbling jars, crucibles, etc. The Kalamazoo Manufacturing Co., manufactures sanitary ware exclusively. The Anton Hupprich Co. of Detroit and the Ionia Pottery Co. manufacture flower pots exclusively. The Mt. Clemens Pottery Co. manufactures decorated ware and the Pontiac Clay Pipe Novelty Co., 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, 1899-1918

YEAR	Rank of state.	No. firms.	Red earthen-ware value.	Porcelain electrical supplies value.	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	15.4	17
1900	17	4	34,317				34,317	30.2	17
1901	16	5	42,465			\$2,400	44,865	87.4	20
1902	14	4	44,098			39,000	83,098	87.3	41
1903	19	4	42,007			6,000	48,007	-42.2	19
1904	17	4	40,921			3,000	43,921	-4.1	17
1905	17	5	40,921*			7,000	47,921	4.3	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	16	6	54,659			7,750	62,409	1.3	25
1909	13	6	60,939			34,500	95,439	52.9	31
1910	13	6	94,450			13,300*	112,697	18.1	33
1911	13	6	80,580				130,490	15.8	38
1912	10	6	99,555				194,892	49.3	53
1913	10	5	65,000				222,133	20.8	59
1914	9	5	106,452				265,194	33.6	75
1915	8	6	112,863				521,989	96.7	40
1916	8	7	132,784			668,982	792,716	51.8	1.64
1917	8	8	133,784*			13,722	1,187,981	49.9	2.12
1918	6	8				88,842	1,976,436	66.3	3.00
Total							4,997,670		

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

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 1912 was only 1,201,230 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 was improved but labor shortage was an important factor in limiting production.

During 1918 production was increased to 1,468,818 tons valued at \$5,615,097, a gain of 288,458 tons or 24.4 percent in quantity, and of \$1,188,783 or 26.8 percent in value.

To meet the unprecedented demand caused by the severe winter of 1917-18 and the general tie-up of coal shipments, some new mines were opened and some old ones reopened, the most important being the New Robert Gage No. 3, Robert Gage No. 8, Uncle Henry No. 2, Riverside No. 2, Middleton, and a new mine east of Owosso operated by a Detroit company. During the year four old mines were abandoned. There were eleven mines worked in Saginaw County, seven in Bay County, three in Shiawassee County, and one each in Tuscola, Genesee, Calhoun, and Eaton counties.

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. During 1918, there was not sufficient labor to maintain the operating mines up to maximum capacity, much less

\*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, COST OF MINING, PROFITS, AND VALUE OF COAL IN MICHIGAN, 1900-1918

YEAR.	*Number active mines.	Average num-ber employees per month.	**Average daily wage.	†Total tons of coal mined.	Total cost of coal mined.	Average cost per ton.	***Total tons of coal mined.	***Total value of coal mined.	***Average price received per ton.	†Average profit per ton.
1900	31	1,676	\$2 34	871,388	\$1,209,228	\$1.387	849,475	\$1,259,683	\$1.483	\$0.096
1901	30	1,847	2 44	1,016,496	1,442,415	1.419	1,241,241	1,753,064	1.412	.007
1902	32	1,616	2 75	899,967	1,284,342	1.427	964,718	1,653,192	1.714	.287
1903	34	3,014	2 91	1,601,984	2,529,027	1.579	1,367,619	2,707,527	1.979	.400
1904	33	2,733	3 01	1,408,375	2,266,098	1.609	1,342,840	2,424,935	1.806	.197
1905	38	2,776	2 96	1,413,307	2,244,434	1.588	1,473,211	2,512,697	1.705	.117
1906	38	2,106	2 40	1,367,385	2,090,489	1.529	1,346,338	2,427,404	1.803	.274
1907	37	2,897	3 24	1,911,201	3,162,837	1.655	2,035,858	3,660,833	1.798	.143
1908	38	3,115	3 02	1,842,778	3,089,759	1.677	1,835,019	3,322,904	1.811	.134
1909	36	2,907	2 93	1,736,573	2,863,083	1.650	1,784,692	3,199,351	1.793	.143
1910	34	2,471	3 07	1,462,276	2,626,342	1.796	1,534,967	2,930,771	1.909	.103
1911	32	2,539	3 39	1,389,585	2,623,244	1.887	1,476,074	2,791,461	1.891	.004
1912	26	1,886	3 19	1,160,768	2,170,076	1.869	1,201,230	2,399,451	1.989	.120
1913	24	2,076	3 49	1,138,163	2,250,559	1.977	1,231,786	2,453,227	1.993	.016
1914	23	2,146	3 35	1,153,869	2,285,281	1.99	1,283,030	2,559,786	1.99	.000
1915	20	1,942	3 45	1,069,798	1,929,386	1.77	1,156,138	2,372,797	2.05	.280
1916	18	1,794	3 57	1,076,215	2,049,812	1.90	1,180,360	2,653,182	2.25	.350
1917	22	1,938	4 25	1,393,180	3,148,148	2.27	1,374,805	4,426,314	3.22	.95
1918	25	2,117	5 56	1,520,883	5,195,944	3.41	1,468,818	5,615,097	3.83	.42

\* Compiled and adapted from reports of State Coal Mine Inspector, Ann. Repts. State Department of Labor.

\*\* For year beginning December 1 and ending November 30.

\*\*\* From Mineral Resources of United States, U. S. G. S.

† Does not include coal used for steam and heat.

‡ Not including depreciation, interest on capital invested, etc.

PRODUCTION, COSTS, ETC., OF COAL MINED IN MICHIGAN IN 1918

No. men employed.	Average hours worked per day.	Average days worked per month.	Average daily wages.	Total wages paid in wages.	No. mines using powder.	Keys of powder used.	Picked coal mined, Tons.	Coal mined by machine, Tons.	Total cost.	Average cost per ton.
December	7.9	24.9	\$5.22	\$391,059.41	18	1,860	17,725	122,951	\$419,837.99	\$2.98
January	7.8	23.1	4.84	357,370.07	18	1,731	13,666	112,194	417,585.37	3.27
February	7.9	22.5	4.84	347,774.79	19	1,530	13,595	109,026	403,915.84	3.29
March	7.9	20.3	5.06	230,813.00	15	1,423	14,897	93,149	398,992.43	3.69
April	8.0	21.4	5.45	242,163.92	17	1,361	8,671	103,626	388,017.78	3.46
May	7.5	21.8	5.32	275,665.36	17	1,162	12,149	111,399	423,856.31	3.43
June	8.0	22.4	5.92	304,193.69	15	1,330	10,329	118,403	403,223.21	3.13
July	8.0	18.8	5.94	207,192.69	17	974	12,457	90,853	388,784.92	3.76
August	7.5	25.8	6.05	304,148.13	17	1,485	14,473	140,969	506,522.48	3.26
September	7.9	21.6	6.05	276,148.02	18	1,270	18,618	119,674	482,539.54	3.49
October	7.9	25.5	6.06	320,450.25	18	1,430	15,369	144,961	562,230.39	3.51
November	7.9	17.3	6.17	235,843.17	18	1,032	9,208	90,521	400,437.71	4.02
Aggregate				\$3,125,750.78		16,588	163,157	1,357,726	\$5,195,943.97	
Average	7.9	22.1	\$5.56			1,382	13,596	113,144		\$3.41

## 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 percent of sulphur and 47 percent 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 percent of sulphur and 60 percent 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 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 gradually became more or less completely cut off. Under only the most urgent conditions were ships spared for its importation. To meet the pressing shortage the Federal Government 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 percent 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. Wolverine Mine No. 3, clean- est 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.

## TEST

Weight of sample 9.3 pounds			
Crushed through ½-inch hole screen			
Screened on ¼-inch screen			
Undersize, ¼ in.—0. Wt. 4.3 lbs.		Oversize, ¼ in.—½ in. Wt. 5 lbs.	
Panned		Jigged	
Pyrites Wt. 0.9 lbs. Sulphur 19.7 %	Tailings and Loss Wt. 3.4 lbs. Sulphur 9.5 %	Pyrites Wt. 3.0 lbs. Sulphur 40.6 %	Tailings Wt. 2.01 lbs. Sulphur 12.6 %

From the above it may be seen that the refuse yielded 3 pounds or over 32 percent 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 percent of recoverable pyrite of commercial grade. However with the signing of the Armistice, the War need for pyrites ceased; there was prospect of an early release of ships for the foreign trade and the prospective recovery of pyrites from Michigan "coal brasses" did not materialize.

#### 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 percent. This value was further increased in 1918 to \$5,186,867 an increase of \$1,865,972 or 56.18 percent.

The great increases in the annual value of the output for 1913-17 were due not only to greater production but also to constantly increasing prices for the various products. The great increase in 1918 represents the War demand and the War-time inflation of prices for all products. The chief increases for 1918 were in stone for blast furnace flux and for the manufacture of soda ash and allied products occasioned by the enormous War demands on the blast furnaces and chemical industries for iron and steel and chemicals used directly in the prosecution of the War. The output of flux stone in 1918 was 4,289,289 tons valued at \$2,892,179 a gain of 14 percent in quantity and 77 percent in value over the 1917 production and a gain of 41 percent in quantity and 139.5 percent in value over pre-War figures of 1916. The value of stone sold to alkali plants increased from \$438,783 in 1916 to \$787,760 in 1917 to \$1,097,291 in 1918 an increase of 39.2 percent over 1917 and of 150.0 percent over 1916, an increase due directly to War demands. Building and road making for military purposes caused an increase in the output for crushed stone for concrete in 1917 but with the cessation of general building activities production decreased during 1918 from 418,403 tons valued at \$244,648 to 389,176 tons valued

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

at \$261,877, a decrease in quantity of 29,227 tons or 6.9 percent but an increase in value of 7 percent over 1917 and of 68.8 percent in value over 1916. Railroad ballast which decreased in 1917 shows an increase from 182,375 tons valued at \$90,560 in 1917 to 209,825 tons valued at \$125,395 in 1918 or 15 percent in quantity and 38.4 percent in value. This value is an increase of 116.4 percent over that of 1916. Production of road-making stone continued to decrease from 834,937 tons in 1916 to 726,937 tons in 1917 to 591,781 tons in 1918; the value of the stone also decreased from \$420,467 in 1916 to \$344,970 in 1917 to \$251,265 in 1918. There was a notable increase also in the limestone used as fertilizer the production increasing from 62,027 tons valued at \$58,148 in 1917 to 160,016 tons valued at \$150,604 in 1918 or an increase of 157.9 percent in quantity and of 159 percent in value.

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 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, 1899-1918

Year.	Rough building. Value.	Rubble. Value.	Riprap. Value.	Crushed stone.	
				Road making.	
				Tons.	Value.
1899	\$30,299		\$1,111		
1900	32,362		799		
1901	47,785	\$5,098	*		\$31,605
1902	58,707	3,101	5,740		56,261
1903	36,528	710	800		61,342
1904	32,941	2,800	2,405		58,655
1905	17,071	744	1,568		112,113
1906	9,368	4,654	1,204		78,437
1907	15,120	1,433	1,234		131,708
1908	7,276	15,907	1,574		182,510
1909	4,450	1,572	3,615		132,902
1910	3,522	2,205	908		110,184
1911	7,526	165	380	224,307	113,574
1912	9,997	380	75	603,553	295,449
1913	8,274	3,511	610	532,311	266,316
1914	3,537	1,651	6,727	505,133	242,839
1915	4,262	743		482,262	194,970
1916	5,633	*		834,215	420,467
1917	*	*		726,937	344,970
1918	*	*		591,781	251,265
Total					\$3,094,567

\* Included in total for year.

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1899-1918.—Continued.

Year.	Crushed stone.				To blast furnace flux.	To sugar factories.	To alkali works.
	Railroad ballast.		Concrete.				
	Tons.	Value.	Tons.	Value.			
1899					\$27,512		
1900					3,200		
1901		\$18,200		\$75,643	13,488		
1902		49,430		49,430	32,246		
1903		55,340		48,504	15,502		
1904		57,100		60,745	62,586		
1905		43,649		107,396	109,883		
1906		103,442		61,852	81,517		
1907		46,516		97,762	109,429	\$224,356	
1908		33,900		73,200	56,841	22,234	
1909		42,445		112,829	91,915	32,594	
1910		42,558		178,318	100,149	25,845	
1911	91,713	34,998	306,385	137,285	186,046	69,647	
1912	54,327	28,368	185,423	97,298	137,812	65,141	
1913	116,000	48,400	292,616	145,965	36,944	36,944	\$508,044
1914	38,000	20,600	362,209	166,959	494,495	38,215	329,961
1915	60,159	19,640	398,948	217,304	565,012	69,477	269,087
1916	186,949	57,950	323,479	155,084	763,029	46,143	481,759
1917	182,375*	90,560	418,403	3,033,155	1,207,326	41,709	438,783
1918			389,176	244,648	1,633,965	37,004*	787,760
Total				\$2,302,009	\$8,584,132		\$3,904,549

\*Included in total.

## PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1889-1918.—Concluded

Year.	To carbonic acid plants. Value.	To paper mills. Value.	Fertilizer.		Other purposes.	Rank of state. Value.	Total. Value.
			Tons.	Value.			
1899					\$2,375	12	\$281,769
1900					124,220	12	330,847
1901					101,399	12	429,771
1902					68,164	13	413,148
1903					4,747	14	390,473
1904					5,323	10	501,708
1905					142,790	12	544,754
1906					278,297	10	656,260
1907					253,990	11	760,333
1908					327,571	9	669,017
1909					299,305	11	750,589
1910					440,857	9	842,126
1911		\$12,558		\$3,008	1,139,560	8	1,005,751
1912		8,150		3,447	1,408,703	8	1,139,560
1913		10,723		7,048	1,457,961	7	1,408,703
1914		8,307		11,104	31,529	8	1,457,961
1915	\$53,138	8,620	10,907	9,746	39,896	7	1,828,766
1916	*	11,827		11,088	97,129	6	2,389,763
1917	*	24,097	62,027	58,148	284,649	5	3,320,895
1918	*	25,153	160,016	150,604			5,186,867
Total		\$109,435		\$ 254,198	\$2,951,234		\$24,309,074

\*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 percent greater than in 1914. The value increased from \$385,341 in 1916 to \$892,682 in 1917 an increase of \$507,341 or about 132 per cent. This increased production and value caused Michigan to jump from thirteenth place to seventh in rank in State production, Pennsylvania, Ohio, Virginia, West Virginia, Missouri and Wisconsin ranking Michigan. In the production of chemical lime, Michigan ranked third in quantity and second in value, Virginia being the largest producer and Pennsylvania second. Michigan produced over 14 percent of the chemical lime used in the country at 16 percent of the value. Michigan held sixth place in the amount of lime consumed. Production fell short of consumption by 89,068 tons; 11,702 tons were shipped out of the State and 100,770 tons shipped in, or the State received nine tons for every ton shipped outside the State. These figures do not take into consideration limestone from Presque Isle County which is shipped to Buffalo, New York, and manufactured into lime near Buffalo. The largest shipments came from Ohio and West Virginia; a few thousand tons were sold in Indiana, Wisconsin and Minnesota.

In 1918 Michigan with the rest of the United States showed a decrease in lime production. However, since most of the lime produced in Michigan is chemical lime used in the manufacture of calcium carbide and needed for War industries the percentage decrease was less for Michigan than for any other State, the production being 134,813 tons as compared with 135,920 tons in 1917, a decrease of but 1,107 tons or 0.8 percent. Michigan succeeded Wisconsin in sixth rank. There was a continued increase in value to \$1,186,007, an increase of \$293,325 or 32.8 percent over the value of \$892,682 for 1917. The total increase over the maximum pre-War value (1916) was 207.7 percent. The great increase in value in 1917 was due to the increased production and advance in the average selling price per ton. The great increase in value in 1918 was due to the continued advance in price per ton which reached \$8.79 as compared with \$6.72 in 1917 and \$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. Very little of the lime produced in Michigan is used for building purposes hence the lime industry in 1918 did not suffer the general depression due to the restriction of building trades, and the small decrease in production may be ascribed to the shortage of labor and of fuel and to the difficulties of transportation.

PRODUCTION AND VALUE OF LIME IN MICHIGAN, 1904-1918

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	7
1918.....	134,813	1,186,007	8 79	6	6

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, until the maximum production of 72,004,000 bricks valued at \$499,711, was reached in 1916. Somewhat normal conditions were maintained during the first half of 1917 but after the car shortage became acute in August 1917 and prevented shipment sand lime brick production suffered a sharp decline, which, due to Government restrictions in building operations, increased transportation difficulties, scarcity and high cost of labor, and the shortage of coal, continued during 1918. Production decreased 46.4 percent in value and 52.9 percent in quantity in 1918, there being a production of but 22,564,000 brick of all classes valued at \$198,633 as compared with 47,998,000 brick in 1917 valued at \$370,723. Thus

the production for 1918 was but 31.3 percent of the maximum pre-War production.

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. But during 1918 the demand for this as for other brick decreased until there was but one producer hence values may not be published.

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 1918 Michigan produced 23 percent of the sand-lime brick made in the United States, valued at 22 percent of the total value of the production for the entire country. The decided setback suffered by the sand-lime brick industry in common with other building industries in 1918 caused many operators to close their plants, so that of eleven firms reporting in 1917, but seven were operating in 1918 and in October one of these ceased operating. Plants are located in Detroit, Grand Rapids, Rives Junction, Rochester, Saginaw and Sibley.

ANNUAL PRODUCTION AND VALUE OF SAND-LIME BRICK IN MICHIGAN AND UNITED STATES, 1904-1918

Year.	No. of operating firms reporting—Mich.	No. of operating firms reporting—U. S.	Michigan production.				Fancy br. ck.		Total value Michigan.	Change per cent Michigan.	Total value United States.	Per cent of total production U. S.	Rank.	
			Common brick.		Front brick.		Average price per thou-sand.	Quan-tity (thou-sands).					Value.	Value.
			Quan-tity (thou-sands).	Value.	Average price per thou-sand.	Quan-tity (thou-sands).	Value.	Average price per thou-sand.	Quan-tity (thou-sands).	Value.				
1904	10	57	9,886	\$64,034	\$6.64	580	\$5,234	\$9.02	19	\$497	\$69,765	\$453,128	15.6	1
1905	12	84	24,841	155,883	6.28	1,577	12,183	8.17	27	525	193,302	972,064	17.4	1
1906	11	87	27,281	162,879	5.97	1,796	12,023	6.67	27	20	174,921	1,170,003	15.0	1
1907	13	94	25,488	158,603	6.22	*2,000	14,231	7.17	..	..	172,840	1,225,769	14.1	1
1908	10	87	21,997	131,827	5.99	*2,000	14,231	6.92	..	..	138,839	1,029,699	13.5	1
1909	11	74	34,217	207,082	6.05	*1,600	10,144	6.97	..	..	215,225	1,150,580	19.0	1
1910	10	76	37,648	218,627	5.81	3,253	22,092	6.75	..	..	240,649	1,169,153	20.5	1
1911	10	66	32,889	192,224	5.84	2,723	17,777	6.52	..	..	210,001	897,664	23.4	1
1912	11	71	48,129	307,106	6.38	1,163	9,165	8.27	..	..	316,732	1,200,223	23.4	1
1913	12	68	49,373	315,832	6.41	..	..	..	..	..	321,784	1,238,325	23.9	1
1914	12	62	41,456	248,113	5.98	..	..	..	..	..	253,784	1,058,512	23.5	1
1915	11	56	46,513	281,009	6.04	..	..	..	..	..	236,945	1,135,101	25.3	1
1916	12	53	71,116	491,866	6.92	888	7,845	8.83	..	..	459,711	1,474,073	33.8	1
1917	11	47	46,979	362,246	7.71	1,019	8,477	8.31	..	..	370,723	1,420,330	25.1	1
1918	7	42	22,248	195,636	8.79	..	..	9.48	..	..	198,633	883,529	22.5	1
Tota.	..	..	540,061	\$3,493,020	\$6.46	..	..	..	..	..	\$3,604,289	..	..	..

\*—Estimated. †—Included in total.

## 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. How-

ever, no tests have been made to determine which is the better grade of gravel.

In 1918 the reported production of sand and gravel in Michigan was 2,837,376 tons or 977,074 tons less than in 1917. The value of the product was \$1,239,874 or \$401,874 less than in 1917. Most of the loss in tonnage was due to the great decrease in building sand produced which was only 433,497 tons in 1918 compared with 782,305 tons in 1917 and the maximum production of 1,234,280 tons in 1916. The amount of gravel produced for road making decreased from 2,292,374 tons produced in 1917 to 1,741,687 tons in 1918 a decrease of 550,693 tons. The production of paving and filter sand increased during the year.

The effect of the War upon the sand and gravel industry is seen in the reduced production. Some operators reported an increased demand for sand and gravel but inability to supply the demand on account of car shortage, increase of freight rates, and lack of labor. Others reported their pits closed for the War period. In some cases notably where Government building and road making were in progress operators report increased production, in others that if it were not for the Government demands the pits would remain idle.

The increased activity in road building due to the road building campaign inaugurated by the adoption of the amendment to the State Constitution authorizing the issuance of \$50,000,000 bonds for road building purposes, is sufficient to encourage operators of sand and gravel pits producing road metal to prepare for active operations beginning in 1919.

PRODUCTION AND VALUE OF SAND AND GRAVEL IN MICHIGAN, 1905-1918

Year.	Molding sand.		Building sand.		Engine sand.		Paving sand.		Filter sand.		Other sand. **	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.		Tons.		Tons.		Tons.	
1905	19,382	13,247	263,315	148,065	4,000	\$100					50,187	\$14,476
1906	61,387	26,108	403,199	127,937	1,534						51,005	12,140
1907	54,172	24,190	451,646	157,150	1,991						173,724	12,187
1908	4,384	2,892	474,238	228,395	1,991						29,187	6,850
1909	53,226	20,756	1,090,419	327,247	12,415						372,880	57,385
1910	93,812	24,004	833,729	334,346	2,173						114,801	52,005
1911	68,878	17,901	902,556	247,997	4,147						130,624	54,746
1912	182,433	40,145	1,326,016	415,737	4,447						115,201	107,302
1913	50,763	17,493	1,088,650	360,152	6,357						111,105	12,248
1914	53,400	36,583	843,837	236,956	70,077						228,003	103,722
1915	82,666	25,998	1,234,280	350,138	4,096						94,227	41,267
1916	117,200	31,978	1,782,305	433,546	5,174						135,502	28,301
1917	147,256	52,686	433,497	174,888								
1918	116,485	55,255	433,497	174,888								
Totals.....	1,075,644	389,236	11,279,325	3,836,659	176,337	20,690	1,733,590	420,930			2,015,466	574,013

\*Included under other sand.  
\*\*Includes fire, furnace, blast, filter sand.

PRODUCTION AND VALUE OF SAND AND GRAVEL IN MICHIGAN' 1905-1918—Concluded.

Year.	Railroad ballast.		Gravel.		Total.		Rank.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.		Tons.	
1905			76,625	\$32,321	414,509	210,609	10	11
1906			72,598	25,614	537,789	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	7	8
1910			1,197,791	364,841	2,862,738	816,337	6	7
1911			985,072	203,218	2,185,165	565,969	9	10
1912			1,409,180	407,925	2,681,821	818,603	4	5
1913			3,928,874	915,205	6,422,818	1,528,892	3	4
1914			2,140,359	530,338	3,757,979	1,143,771	4	5
1915			2,457,094	671,970	3,776,726	1,036,759	5	6
1916			2,226,878	726,033	4,407,475	1,295,717	7	8
1917			207,827	21,829	4,407,475	1,641,748	7	8
1918			161,552	18,314	2,837,371	1,239,874	8	9
Totals.....			19,616,097	6,367,667	37,845,825	11,181,550		

## 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 five 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 scythestones. 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.

## GRINDSTONES AND SCYTHESTONES

Of the various mineral activities the production of grindstones seems at first thought to offer little contribution to War activities. Yet this industry during 1918 contributed practically its entire output directly or indirectly to the prosecution of the War. The manufacture of cutlery, hardware and tools, which were used either directly as War material or in the manufacture of War materials used a large part of the grindstone output. Large numbers of grindstones were used for dressing or sharpening tools in the industrial plants that made the many articles required by military operations.

The War time production of grindstones for the entire United States increased over 11 percent but the value of the product in 1918 was increased 98 percent over that of 1916. Michigan, followed in third place by West Virginia, ranks a far second in the production of grindstones, Ohio being first with 85 percent of the entire total for the United States. Although the production for the entire country increased during 1917-1918, the labor situation and shipping conditions in Michigan caused a decrease of about 17 percent from pre-War production although the value increased a little over 47 percent.

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 stones a foot in diameter to those seven feet in diameter having a 14-inch face, and weighing from  $1\frac{1}{4}$  to 2 tons. 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.

#### 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.

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

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.

Some years ago the Rockwood Silica Sand Co. drilled a well just 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 water. However, most of the sandstone is very free from iron and the washed product from some horizons contains only about .001 of one percent 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 percent 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	.....
Sulphuric 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. It was found that from the deposits near Rockwood it is possible, under careful supervision, to obtain carload lots of glass sand which averaged 0.015 percent iron oxide, and some analyses as low as 0.004 iron oxide are reported. Glass sand for optical purposes is also obtained at Ottawa, Ill., and Hancock, Maryland, but analyses from the best of these deposits averaged 0.02 percent iron oxide.

The washed sludge containing the fine grit is used for the ignition surfaces on match boxes. There was but one producer of glass sand, hence figures on 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. The plant of the Rockwood Silica Company was destroyed by fire July 2, and was not rebuilt during the year.

#### 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 884,893 gallons valued at \$52,642 in 1913. Since 1913 production has increased 37 percent in quantity and 146 percent in value, being 1,216,882 gallons valued at \$129,592 in 1918, the gain in value being due to the greater average price per gallon. In 1917 the gain in production was 7 percent over that of 1916 but the average price per gallon decreased to 9.8 cents. In 1918 the gain in production was 147,718 gallons valued at \$129,592 representing an increase of nearly 14 percent in production and 13 percent in value. The increase in value is due in part to the increased average price per gallon—10.3 cents as compared with 9.8 cents per gallon in 1917.

#### PRODUCTION AND VALUE OF MINERAL WATERS IN MICHIGAN, 1902-1918

Year.	Rank.		No. of Springs active.	Total.		Medicinal value.	Table value.	Average price per gal.
	Quan- tity.	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.	12	12	11	1,069,164	105,641	500	105,641	0.098
1918.	10	8	9	1,216,882	129,592	*	128,809	0.103
Total.	.....	.....	.....	49,802,488	\$3,632,609	.....	\$1,125,060	\$0.074

\*Concealed, less than three producers.

#### 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 Onekama. 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 2,422,000 cubic feet in 1914, dwindling to 1,173,000 cubic feet in 1918, 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, 1911-1918

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
1918	14	745*	745			428	300	1,173	1,045

\*Estimated.

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. At 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 1918, 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, whiting, 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 four years ago but lack of transportation facilities, labor shortage, etc., hindered operations. A considerable amount of stone was quarried and stocked pending the completion of a railroad spur to the quarry. The spur connecting the quarry with the Chicago and Northwestern railroad has been completed and blocks of marble will be shipped to Marquette where the company has purchased a stone sawing mill. Marble will be cut and polished at this mill, the electric power being supplied by the city of Marquette. The company is now (July 1919) shipping broken pieces of green marble to eastern manufacturers of terrazzo, which is used as flooring. Lack of available cars prevents maximum shipments. The broken pieces were blasted from the face of the ledge some years ago and are of little value as marble, but make excellent terrazzo. There are reported fine blocks of verde antique in stock, and more shortly to be ready for the finishing plants.

Other projects have been started in the past four years to develop other deposits of marble in this region but the War prevented developments. In this locality there are, apparently, several undeveloped deposits of verde antique marble which are under favorable quarrying conditions. The cutting off of foreign sources of marble in 1914 led to the development and appreciation of American marbles; architects and builders are urging the use of American marbles, and building operations are rapidly being resumed, hence it is possible that with the return of normal labor and business conditions 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 percent 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.

No graphite was produced in 1918.

## 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 discontinued mining operations 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 (SiO <sub>2</sub> )	65.25
Alumina (Al <sub>2</sub> O <sub>3</sub> )	18.60
Iron oxide (Fe <sub>2</sub> O <sub>3</sub> )	0.40
Lime (CaCO <sub>3</sub> )	0.38
Magnesia (MgO)	0.23
Sodium oxide (Na <sub>2</sub> O)	1.99
Potassium oxide (K <sub>2</sub> O)	13.40

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 a rock knob 20 to 15 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 1918.

## 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 riprap. 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 1918.

PRODUCTION AND VALUE OF TRAP ROCK IN MICHIGAN, 1911-1918.

Year.	No. of producers.	Crushed stone.				Riprap. Rubble. Value.	Total. Value.	Rank. Value.
		Roadmaking		Concrete				
		Quantity.	Value.	Quantity.	Value.			
		Tons.		Tons.				
1911.....	3			45,250	\$38,429		\$51,000	8
1912.....	5	21,805	\$18,366	11,355	9,340	\$8,500	36,206	8
1913.....	5	24,920	23,369	*	*	*	92,201	10
1914.....	5	25,690	24,863	4,448	4,771		34,406	12
1915.....	6	28,262	29,764	18,775	22,047		105,855	12
1916.....	8	38,193	37,475	9,601	9,715		83,072	.....
1917.....	4	50,420	64,098	*	*		70,197	.....
1918.....	4	23,686	32,605	*	*		53,269	.....
Total...							\$529,506	.....

## SLATE\*

In the Northern Peninsula extensive deposits of black slate occur on the northwestern side of the Huron Mountains in Baraga County. The slate is very black, of fine texture, and uniform in quality. It appears to be of superior quality, and suitable for roofing and other purposes for which slate is adapted.

From 1875 to 1878 and 1883 to 1888 a number of slate quarries were operated at and in the vicinity of Arbon. All of the companies failed because of poor methods and means of quarrying, the great distance from markets and lack of cheap transportation facilities.

\*See Pub. 16, Min. Res. of Mich. for 1913, pp. 92-95, for a more complete report.

SUMMARY TABLE OF THE PRODUCTION AND VALUE OF MINERAL PRODUCTS IN MICHIGAN, 1914-1918

	1914.		1915.		1916.		1917.		1918.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Brick and tile products, number of brick	278,384,000	\$2,434,872	281,819,000	\$2,248,068	288,391,000	\$2,705,054	239,670,000	\$2,846,264	98,747,000	1,708,736
Brick, sand-lime, number of brick	42,465,000	255,784	47,285,000	286,948	72,004,000	499,711	47,998,000	370,723	22,564,000	1,198,623
Brownine, pounds	(a)	(a)	600,325	494,271	(a)	(a)	738,654	405,059	1,605,696	855,841
Calcium fluoride, tons	4,218,429	4,064,781	4,765,294	4,454,608	4,919,033	6,017,911	4,088,899	294,683	20,615	394,200
Cement, Portland, bbls. made, value cement shipped	1,463	4,572	3,142	5,605	3,454	11,153	5,746	6,122,887	3,554,872	6,078,167
Clay, tons	1,231,786	2,559,786	1,156,138	2,372,737	1,180,360	2,685,357	1,574,805	14,426,314	2,359	6,373
Coal, tons	158,009,748	21,426,122	238,956,410	(d)41,775,296	339,599,198	(d)61,831,805	268,508,091	**75,622,256	1,464,818	5,615,097
Copper, lbs.	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	226,224,305	55,120,307
Grapelite	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Grudstones, tons	393,006	705,841	380,791	686,309	457,375	1,066,599	375,803	1,568,655	286,768	1,761,149
Gypsum, tons mined, value gypsum products sold	8,835,274	18,065,058	13,151,612	26,574,188	18,626,051	45,884,330	17,839,548	††60,508,942	**17,567,119	††90,015,426
Iron ore, shipments long tons	379,619	(b)5,229,948	486,106	(b)6,624,589	565,646	(b)8,881,361	509,460	(b)18,300,501	489,816	(b)17,823,684
Lime, long tons made; value pig iron shipped	66,507	287,648	81,359	349,970	86,447	385,341	135,920	892,682	134,813	1,186,007
Limestone	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Mineral paints	931,343	70,310	913,765	72,711	996,875	108,867	1,069,164	105,641	1,248,082	129,592
Natural and spring waters, gallons sold	2,442	1,442	2,060	1,510	1,298	948	1,184	1,013	1,173	1,045
Natural gas, M. cu. ft.	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Petroleum	265,194	265,194	(a)	821,989	(a)	(a)	(a)	792,716	(a)	1,976,436
Potash (Furr K <sub>2</sub> O)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	404	(a)
Preussite	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Quartz	11,670,976	3,299,005	12,588,788	4,304,731	14,918,278	4,422,567	16,078,136	6,877,202	17,168,178	9,048,650
Salt, bbls.	3,647,790	1,118,978	3,776,726	1,036,739	4,407,475	1,296,717	3,814,446	1,641,748	2,887,371	1,242,794
Sand and gravel, tons	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

Sandstone	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Silver, fine oz. Troy	\$413,500	\$228,665	\$555,933	\$297,068	(a)	\$247,485	759,068	\$499,300	473,342	\$504,480
Tyraprock	(a)	34,406	105,855	105,855	(a)	83,072	(a)	70,197	(a)	53,269
Miscellaneous	(a)	566,147	119,965	119,965	(a)	971,263	(a)	159,406	(a)	247,204
Total	\$57,641,013	\$94,236,558	\$140,446,220	\$185,906,614	\$109,264,604					

\* Figures from Iron Trade Review in 1913 and from State Tax Commission in 1914 to 1918 inclusive.  
 \*\* Estimated at \$.28164 per pound, the average price received for copper sold.  
 † Estimated at \$.50 per ton.  
 †† Includes 182,817 tons of low grade ore for which no value was reported. Value of this estimated at \$.3.00 per ton.  
 ††† Iron Trade Review reports 17,610,107 long tons iron ore shipped from Michigan.  
 †††† Includes 527,967 tons not reported, value estimated at \$.12394 a ton.  
 a Included under miscellaneous.  
 b Excluded from total; covered by iron ore.  
 c Included under sand and gravel.  
 d Copper sales.



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APPENDIX

DIRECTORY OF THE PRODUCERS OF NON-METALLIC  
MINERALS IN MICHIGAN, 1918

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## BRICK AND TILE MANUFACTURERS, 1918

Operator	Office	Works
<i>Allegan County:</i> Allegan Brick Works (Fish & Fish).. Zeeland Brick Co.....	Allegan..... Zeeland.....	Allegan. Zeeland.
<i>Berrien County:</i> Manner Brick Co.....	Benton Harbor.....	Benton Harbor.
<i>Chippewa County:</i> Rudyard Brick Works.....	Rudyard.....	Rudyard.
<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> Scholl, L. J. & C. E..... McCann, Fred'k W..... Sharp, Frank.....	Clio..... Gaines..... R. D. No. 1, Linden.....	Clio. Gaines. South Mundy.
<i>Gratiot County</i> Ashley Tile Co..... Stevenson & Sons, David..... North Star Tile Co..... Lyle G. Smith & Fred Bernard..... Riverside Brick & Tile Co.....	Ashley..... Ashley..... North Star..... St. Louis..... Sumner.....	Ashley. Ashley. North Star. St. Louis. Sumner.
<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.....	Mich. Ave. and Fuller St., Grand Rapids..... Sparta.....	Grand Rapids. Sparta.
<i>Lenawee County:</i> Britton Pressed Brick Co..... Ellis, G. D..... American Brick & Tile Co..... Comfort, Albert A..... Corncross, E. E. & Son.....	Ann Arbor..... Macon..... Morenci..... R. D., Tecumseh..... Morenci.....	Britton. Macon. Morenci. Tecumseh. Seneca.
<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.
<i>Mecosta County:</i> Nehmer, Wm. F.....	Big Rapids.....	Big Rapids.
<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> Grant Tile Mfg. Co.....	R. D., Grant.....	Grant.

## BRICK AND TILE MANUFACTURERS, 1918—Continued.

Operators.	Office.	Works.
<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. .... Miller City Tile 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.	Saginaw, W.S. Saginaw. Saginaw. Saginaw. Saginaw. Paines.
<i>St. Clair County:</i> St. Clair Brick Co. ....	Detroit. ....	St. Clair.
<i>Sanilac County:</i> Croswell Brick Co. ....	Croswell. ....	Croswell.
<i>Wayne County:</i> Daniel Brick Co., Jacob. .... Hagerty, John S. .... McDonald & Son, John C. .... Bunte Bros. Tile Co. .... Clippert & Bro. Brick Co., Geo. H. .... Clippert, Wm. .... Mercier, Bryan, Larkins Brick Co. .... 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. .... 306 Free Press Bldg., Detroit. 1009 Hammond Bldg., Detroit. 2161 Jefferson Ave., Detroit. ....	Detroit. Detroit. Detroit. Springwells. Flat Rock. Springwells. Springwells. Springwells. Springwells. Springwells. Springwells. Detroit.

## SAND-LIME BRICK PRODUCERS, 1918

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>Menominee County:</i> Menominee Brick Co. ....	Menominee. ....	Menominee.
<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, 1918

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. .... Newago Portland Cement Co. .... Peerless Portland Cement Co. .... Wyandotte Portland Cement Co. .... New Egyptian Portland Cement Co. ....	412 Union Trust Bldg., Detroit Grand Rapids. .... Union City. .... 1525 Ford Bldg., Detroit. .... Fenton. ....	Fenton. Newago. 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.	Wm. A. Jones.	Bay City.
Robert Gage Coal Co. No. 7.	Bay	Chas. Coryell.	Bay City.	Edward Gunther.	Bay City.
Beaver Coal Company	Bay	Chas. Coryell.	Bay City.	Wm. A. Jones.	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	Wm. Cameron.	Bay City.	O. S. Callahan.	Bay City.
What Cheer Coal Mining Company No. 1.	Bay	W. A. Fancher.	Bay City.	Alex Jeffreys.	Bay City.
B. S. K. Coal Mining Co.	Calhoun.	A. N. Knapp.	Albion.	W. C. Sellars.	Albion.
American Sewer Pipe Co.	Caton.	Clyde H. Earl.	Grand Ledge.		
What Cheer Mining Company No. 2.	Genesee	A. N. Fancher.	Bay City.	Alex Jeffreys.	Bay City.
Robert Gage Coal Company No. 2.	Saginaw	Chas. Coryell.	Bay City.	Wm. A. Jones.	Bay City.
Robert Gage Coal Company No. 3.	Saginaw	Chas. Coryell.	Bay City.	Wm. A. Jones.	Bay City.
Robert Gage Coal Company No. 8.	Saginaw	Chas. Coryell.	Bay City.	Wm. A. Jones.	Bay City.
Robert Gage Coal Company No. 9.	Saginaw	Chas. Coryell.	Bay City.	Wm. A. Jones.	Bay City.
Bliss Coal Mining Company	Saginaw	C. E. Linton.	Saginaw.	Thomas Kanary.	Bay City.
Banner Coal Mining Company	Saginaw	Wm. B. Carmichael.	Saginaw.	J. T. Phillips.	Saginaw.
Chappell and Fordney No. 2.	Saginaw	R. M. Randall.	Swan Creek.	Richard Jenkins.	Swan Creek.
Community Coal Company.	Saginaw	Alex Jeffreys.	Saginaw.	Alex Liddle.	Saginaw.
Riverside Coal Company No. 2.	Saginaw	R. M. Randall.	Bay City.	Wm. Follis.	Bay City.
Shlawassee Coal Company	Saginaw	R. M. Randall.	Saginaw.	Alex Liddle.	Bay City.
Uncle Henry Coal Co. No. 2.	Saginaw	R. M. Randall.	Saginaw.	Alex Liddle.	Bay City.
Middleton Mining Co.	Shlawassee.	Isaac Middleton.	Corunna.	Alex Liddle.	Bay City.
Liberty Coal Corporation.	Shlawassee.	Wm. A. Knapp.	Bay City.		
Corunna Coal Mining Co.	Shlawassee.	Harry Cohoney.	Corunna.		
Akron Coal Mining Co. No. 2.	Tuscola.	Chas. Handy.	Bay City (W. S.).	Chas. Period.	Akron.

Hon. A. K. Smith, State Coal Mine Inspector, Bay City, Michigan.

CLAY MINERS, 1918

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.
Jeffs, F. A.	Rockland.	Rockland.
<i>Wayne County:</i> Geo. H. Clippert & Bro. Brick Co.	Detroit.	Springwells.

COKE PRODUCERS, 1918

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.

NAURAL GAS PRODUCERS, 1918

Operator.	Address.
<i>Benzie County:</i> Gordon & Conklin Son.	Beulah.
<i>Hillsdale County:</i> DeWitt, C. M.	Osseo.
<i>Oakland County:</i> McClelland, James.	Redford.
<i>St. Clair County:</i> Haas, H. G. 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. Connor, L. M. McKenzie, Norman J. Kurrer, Sr., Benj. L.	Port Huron, 1615 Griswold St. Port Huron. Port Huron. Port Huron, 2478 Military St. Port Huron, 4008 Military St. Port Huron. Port Huron. Marysville. Port Huron. Port Huron, North St. R. D. 1 Port Huron.
<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 SCYTHSTONE PRODUCERS, 1918

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, 1918

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. ....	Eagle Mill. ....	Grand Rapids.
	Bldg., Gd. Rapids	Grandville. ....	Grandville.

\*No graphite produced in 1918.

LIMESTONE AND LIME PRODUCERS, 1918

Operator.	Office.	Quarry.
<i>Alger County:</i> County Road Commrs. ....	Munising. ....	Eben.
<i>Alpena County:</i> Michigan Alkali Co. ....	Wyandotte. ....	Wyandotte.
Great Lakes Stone and Lime Co.	Alpena. ....	Rockport.
<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.
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.
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>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>Menominee County:</i> Menominee Co. Road Commrs.	Menominee. ....	Menominee.
Spencer, Henry. ....	Menominee. ....	Menominee.
<i>Monroe County:</i> The France Stone Co. ....	1800 Second National Bank Building, Toledo, Ohio. ....	Monroe.
Morris, Sam W. ....	Monroe. ....	Monroe, S. part of City.
Augerer & Gutman. ....	Hammond Bldg., Detroit. ....	Schofield.
<i>Presque Isle County:</i> Michigan Limestone and Chemical 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.
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, 1918

Operator.	Office.	Spring.
Artic Spring Water Co. ....	412 Ottawa Ave., Grand Rapids.	Artic.
Ogemaw Spring Water Co. ....	Bay City.	Ogemaw.
Ponce de Leon Co. ....	Grand Rapids.	Ponce de Leon.
Shorkey, Chas. ....	Mt. Clemens.	Victory.
Magnetic Spring Water Co. ....	Saginaw, W. S.	Andrew's Magnetic Mineral.
Charbeneau, Jno. H. ....	Mt. Clemens.	Maple Leaf Springs.
Preussel, Frank W. ....	47 Crocker Ave., Mt. Clemens.	Panacea.
Silver Springs Water Co. ....	Detroit.	Northville.
McAisler Mfg. Co. ....	Mt. Clemens.	Eureka.

## PETROLEUM PRODUCERS, 1918

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

## PIG IRON PRODUCERS, 1918

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.
Stephenson Charcoal Iron Co. ....		Stephenson.	Wells.
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.

## POTTERY PRODUCERS, 1918

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, 1918

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

SALT PRODUCERS, 1918

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

SANDSTONE PRODUCERS, 1918

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

SAND AND GRAVEL PRODUCERS, 1918

Operator.	Office.	Pit.
<i>Alcona County:</i> Jas. Bell & Co. Huron Shore Gravel Co.	Greenbush Greenbush	Greenbush. Greenbush.
<i>Allegan County:</i> Sutler, Fred W. Kool, Henry Powell, J. C. Craine, W. C. Fry, W. G. Purdy, P. Gray, Tom C. Dendel, Martin Clawson, Jacob Dean, Mrs. John	Byron Center New Richmond Plainwell Douglass South Haven, R. F. D. 6 Fennville Fennville, R. F. D. 2 Allegan, R. F. D. 5 Martin Shelbyville	Burnips Corners. New Richmond. Plainwell. Douglass. South Haven. Saugatuck. Monterey. Martin. Shelbyville, 3 1/2 mi. E. of.
<i>Alpena County:</i> Riley, J. Preston Sissons, F. E. Burch, A. O.	501 State St., Alpena Central Lake, R. F. D. 1 Central Lake	Alpena. Central Lake, Central Lake.
<i>Arenac County:</i> Mayor of Omer City	Omer	Omer.
<i>Barry County:</i> Woolston, Chas. Dunham, P. O. Clever, Daniel Hinckley, C. G.	Hastings Nashville Nashville Hastings	Hastings. Grove Center, Nashville. Hastings.
<i>Bay County:</i> Hayward, R. Schabel, A. J. Whitney, Geo. A.	Bay City, R. F. D. 3 Munger Bentley	Bay City. Munger. Bentley.
<i>Benzie County:</i> Huddleston, Wm. Betsy River Orchards, Ben Newhall & Co. Rice, James R.	Bendon, R. F. D. 1 840 Ohio Bldg., Chicago or Thompsonville, Mich. Benzonia	Bendon, Thompsonville, Sec. 15, Joyfield.
<i>Berrien County:</i> Warren, Paul C. Benton Harbor Sand Co. American Sand & Gravel Co. Garden City Sand Co. Kerlikowske Bros. Brewer, Frank Thar, Anton Brant, Mrs. Rebecca Andrews, C. Harmount, Wm. Ireland & Lester Rick, Frank	Lakeside Benton Harbor Benton Harbor Riverside St. Joseph Galien Coloma, R. F. D. 3 Bridgeman Galien Berrien Springs Benton Harbor Baroda, R. D. 2	New Buffalo. Benton Harbor. Benton Harbor. Riverside. St. Joseph. Galien. Riverside. Bridgeman. Galien. Oronoka. Benton Harbor. Baroda.
<i>Branch County:</i> Werner, Jake F. Barnes, Mrs. J. M. Wilkins, W. H. Holcomb, Preston Graham, Herbert A. Bretz, John D.	Bronson Montgomery Coldwater, R. F. D. 3 Bronson Elkhart, Ind. Ray, Ind.	Matteson Lake. Kinderhook. Kinderhook. Bronson. Union City. Ray, Ind.
<i>Calhoun County:</i> Abbott, L. N. Marsh, Andrew Young, Willard A. Funk, F. J. Hiscock, Seth Grosbeck, Fred Brownlee Park & Material Co. Michigan United Traction Co. Van Sickles, Elmer Halstead, E. H.	Albion Union City, R. F. D. 5 Albion Battle Creek, R. F. D. 2 Battle Creek Battle Creek Burlington Battle Creek Jackson Albion 182 W. Fountain St.	Albion. Union City. Albion. Battle Creek. Battle Creek. Burlington. Brownlee Park. Marshall. Albion. Battle Creek.

## SAND AND GRAVEL PRODUCERS, 1918.—Continued.

Operator.	Office.	Pit.
<i>Cass County:</i> Crandall, Lester	Cassopolis	Cassopolis.
<i>Charlevoix County:</i> Ward, E. B.	Charlevoix	Charlevoix.
<i>Chippewa County:</i> Balanger, Louis Rye Bros.	Sault Ste. Marie. 409 Maple St., Sault Ste. Marie.	Sugar Island. Sault Ste. Marie., Pt. Aux Pines. Pickford.
Taylor, F. H.	Pickford	Pickford.
<i>Clinton County:</i> Parmenter, Geo. Gleason, S. B. Allen, Frank Keys, Hiram Wilhelm, Noah Stowell, Elmer Coats, Lowey Schultz, A. A. Bateman, Geo. W.	Shepardsville. Ovid. Elsie. St. Johns. Bath, R. D. Ovid. Ovid. Lainzburg. Grand Ledge.	Shepardsville. Ovid. Elsie. St. Johns. Bath. Ovid. Ovid. Lainzburg. Near Grand Ledge.
<i>Crawford County:</i> Campbell Gravel Co.	Roscommon	Roscommon.
<i>Delta County:</i> Potsvin, Louis Chicago & N. W. R. R. Escanaba Stone & Gravel Co. Bereman, Andrew	Garden. Chicago. Escanaba. Gladstone.	Garden. Escanaba. Escanaba, Flat Rock. Gladstone.
<i>Dickinson County:</i> Chicago & N. W. R. R. Chicago, Milwaukee & St. Paul Ry.	Chicago. Iron Mountain.	Iron Mountain and Loretto, Dickinson.
<i>Eaton County:</i> Palmiter, S. J. Hull Bros.	Bellevue, R. F. D. 4. Dimondale.	Bellevue. Dimondale.
<i>Genesee County:</i> Scott, F. D. Boston, H. W. Miner, Carton Goodrich, Ford Stine, Martin Bowles, E. Hogan, Daniel Bigelow, Elma H. City of Flint. Genesee Gravel Co. Otisville Gravel Co.	Genesee. Goodrich, R. F. D. 1. Flint. Grand Blanc. Goodrich. Linden. Linden. Linden. Grand Blanc. Flint. Ford Bldg., Detroit. Saginaw.	Genesee. Goodrich. Fenton. Goodrich. Linden. Linden. Linden. Grand Blanc. Otisville. Mt. Morris. Otisville.
<i>Gladwin County:</i> Soldan, L. V.	Butman	Butman.
<i>Gogebic County:</i> Chicago & N. W. R. R. Co.	Chicago	Wellington.
<i>Cratiot County:</i> Church, J. H. Dexter, Jas. Lippert, Jacob Curtis, C. Tomlin, A. E. Wiles, Wm. Church, E.	Alma. Shepherd, R. D. 2. Elwell. Ithaca, R. F. D. 6. Sumner. Sumner, R. F. D. 2. Alma.	Pine River, Sec. 31. Summerton. Elwell. Ithaca. Sumner. Sumner. Alma.
<i>Hillsdale County:</i> Scholfeld, H. C. Thompson, L. W. Wolcott, C. Nelson E. Howald, Geo.	Pittsford. Waldron. Hillsdale. Camden.	Pittsford. Rensom. Hillsdale. Camden.

## SAND AND GRAVEL PRODUCERS, 1918.—Continued

Operator.	Office.	Pit.
<i>Huron County:</i> Conkey, Sam. Merrick Gravel Co. Wallace Co., The Garey & Conley	Caseville. Pigeon. Port Austin. Port Austin.	Caseville. Bad Axe. Port Austin. Port Crescent.
<i>Ingham County:</i> Burwell Sand & Gravel Co. Potts, W. S. Holbrook & Skinner. Stockman, F. M. Campbell, Hugh & Son. Okobock, Dennis. Sheltraw, A. E. Michigan United Traction Co. Hunter, DeWitt	S. Wash. Ave., Lansing. Mason, R. F. D. 1. Lansing. Lansing. 1516 6th St., Bay City. Mason. Saginaw. Jack on Lansing.	Lansing. Mason. Lansing (Holt). Lansing. Mason. Sec. 5, Vevay Twp. Mason. Sec. 25, Delhi Twp., Mason and Haslett. Lansing.
<i>Ionia County:</i> Glick, Cephas M. Miller, Henry Knapp, A. M. Trowbridge, Forest P. Elvert, Forest P. Hazelitt, J. I. Gilmore, Niel. Grieves, Mrs. Keyser, Chas.	Lowell, R. F. D. East Main St., Ionia. Ionia, R. F. D. 7. Ionia. Muir, R. F. D. Ionia, Star Route. Shiloh. Saranac, R. F. D. 12. Saranac, R. F. D. 10.	Saranac. Ionia. Ionia. Ionia. Muir. Palo. Shiloh. Saranac. Saranac.
<i>Iosco County:</i> Boomer & Son, Jno.	Tawas City	Tawas City.
<i>Iron County:</i> Chicago, Milwaukee & St. Paul R. R.	Chicago	Crystal Falls.
<i>Jackson County:</i> Greenville Gravel Co. Cooper, Fred B. Blake, Wm. Emmons, Wm. P. Hunn, G. L.	Greenville, Ohio. Horton. Jackson, R. F. D. 6. 123 Clinton St., Jackson. Parma.	Ackerman Lake, 3 mi., S. of Jackson. Horton. Jackson. Jackson. Parma.
<i>Kalamazoo County:</i> Balch, Wm. A. Buurma, Sam'l H. Haas Bros. Kalamazoo-Greenville Gravel Co. Klepper, Jacob. Molhock, Peter. Owens, Michael. Mich. United Traction Co. Kalamazoo County Road Comm'r. Myron Pierce Estate. Balch, Niel. Southside Lumber Co.	Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo.	Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. 3 or 4 mi. N. of Kalamazoo on G. R. & I. siding. Kalamazoo. Kalamazoo. Kalamazoo. Kalamazoo. Augusta. Kalamazoo. Alamo. Kalamazoo. Kalamazoo.
<i>Kalkaska County:</i> Anderson, Lynn	Kalkaska	Kalkaska.
<i>Kent County:</i> Holt, C. E. Deiss, Jos. Read, Percy. Brewer, Earl. Battjes Fuel & Bldg. Mat. Co. Harrison Land Co., Ltd.	Ada, R. F. D. 42. Ada, R. F. D. 17. Alpine. Byron Center, R. F. D. Grand Rapids. Grand Rapids.	Cascade. Alpine. Alpine. Byron Center. Grand Rapids. Grand Rapids.

SAND AND GRAVEL PRODUCERS, 1918.—Continued.

Operator.	Office.	Pit.
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.
Standard Builders Supply Co.	Grand Rapids.	Grand Rapids.
Gifford J.	Lowell.	Lowell.
Mich. Railway Co.	Jackson.	Grand Rapids.
<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>Lenawee County:</i>		
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.
Butler, Dwight.	Hamburg.	Hamburg.
Hosby, E. B.	Howell.	Howell.
Thomas, Henry.	Oak Grove.	Oak Grove.
Detroit Greenville Gravel Co.	Greenville, Ohio.	Brighton.
<i>Macomb County:</i>		
Blay Bros.	Mt. Clemens.	Clinton River.
Chapman, Jas.	Memphis.	Memphis.
Lake Side Ice & Coal Co.	Mt. Clemens.	Mt. Clemens.
Harder, Henry.	Richmond.	Lenox.
Wacker, H. Jacob.	Mt. Clemens.	Mt. Clemens.
Detroit Sand & Gravel Co.	34 McGraw Bldg., Detroit.	Utica.
United Fuel & Supply Co.	Free Press Bldg., Detroit.	Utica, Rochester.
Detroit Ballast & Gravel Co.	Armada.	Armada.
Tucker, John.	Mt. Clemens.	Clinton River.
<i>Manistee County:</i>		
Hubbell Sand Co.	Manistee.	Manistee.
Summerfield, Porter M.	Manistee.	Manistee.
Farr & Co., M. A.	Chicago.	Onokama.
McMartin, Chas.	Chief, R. F. D. 2.	Chief.
Detroit Clay Products & Sand Co.	Chief.	Kaleva.
<i>Marquette County:</i>		
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.
Beaume, Oliver.	Ludington, Box 68.	Ludington.
Dodge, C. C.	Walhalla.	Tallman.
Edmonson, James.	Tallman.	Tallman.
Hubbell Sand Co.	Manistee.	Ludington.
Mason Sand & Gravel Co.	Scottville, R. F. D.	Amber.
<i>Mecosta County:</i>		
Riley, J. E.	Millbrook, R. F. D. 2.	Millbrook.
<i>Menominee County:</i>		
County Road Comm'r.	Menominee.	Menominee.

SAND AND GRAVEL PRODUCERS, 1918.—Continued

Operator.	Office.	Pit.
<i>Montcalm County:</i>		
Belknap Cement Products Co.	Greenville.	Greenville.
Boezwinkle, Wm.	Pierson.	Pierson.
Christiansen, Niels.	Greenville.	Greenville.
Williams, E. O.	Edmore.	Edmore.
<i>Muskegon County:</i>		
Homer, Wm.	Ravenna, R. F. D.	Ravenna.
Valley, Edw.	Twin Lakes.	Twin Lakes.
Barlow, John C.	Muskegon.	Casnovia.
<i>Oakland County:</i>		
Park & Son, A. H.	Birmingham, R. F. D. 2.	Birmingham.
Ely, C.	Farmington.	Farmington.
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.
Rockwell, C. L.	Pontiac.	Pontiac.
Standard Gravel Co.	Pontiac.	New Hudson.
Rochester Sand & Brick Co.	Detroit.	Rochester.
Boomer Sand & Gravel Co.	520 Forest St., E., Detroit.	Rochester.
Muncie, Chas.	Farmington.	Farmington.
Benedict, Steve.	Holly.	Holly.
Thompson, W. R.	100 Beaubien St., Detroit.	Goodison.
Slater Construction Co.	1105 Kresge Bldg., Detroit.	New Hudson.
United Fuel & Supply Co.	Detroit.	Oxford.
Ward Sand & Gravel Co.	Penobscot Bldg., Detroit.	Oxford.
<i>Oceana County:</i>		
Aldrich, A. O.	Hart.	Crystal Valley.
Wherle, Frank.	Rothbury, R. F. D. 1.	Rothbury.
<i>Osceola County:</i>		
Marquette Gravel Co.	Saginaw.	Evert, 4 mi. W. of.
Hersey Gravel Co.	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>Saginaw County:</i>		
Moiles & Donely.	336 Howard St.	Saginaw River.
<i>St. Clair County:</i>		
Snyder, Wm.	Atkins, R. F. D. 1.	Atkins.
Westrick & Son, C. A.	Marine City.	Marine City.
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.
Chapman, Jas.	Memphis.	Memphis.
Recor, L.	Marine City.	Marine City.
<i>St. Joseph County:</i>		
Hill, S.	Colon.	Colon.
Kerlikowske Bros.	St. Joseph.	St. Joseph.
<i>Sanilac County:</i>		
Gilbert, Geo.	Melvin, R. F. D. 6.	Melvin.
Mills, Henry.	Minden City.	Minden City.
Carney, Chas.	Sandusky.	Sandusky.
Dawson & Son.	Sandusky.	Marlette Twp.

SAND AND GRAVEL PRODUCERS, 1918.—*Concluded*

Operator.	Office.	Pit.
<i>Shiawassee County:</i>		
Gilmore, Edw. ....	Durand .....	Lennon.
Ackerman, Clarence .....	Durand .....	Durand.
Darling, E. R. ....	Carland .....	Carland.
Hibbard, Joseph .....	Byron .....	Byron.
Graham, John .....	Byron, R. D. 1 .....	Byron.
<i>Tuscola County:</i>		
Baker, Gilbert .....	Kingston .....	Kingston.
<i>Van Buren County:</i>		
Wade, Leonard .....	Hartford .....	Hartford.
Burger, F. A. ....	Bangor .....	Bangor.
Hopping, A. D. ....	Bangor .....	Bangor.
Sherburn, John .....	Decatur .....	Decatur.
Fry, W. G. ....	South Haven .....	South Haven.
Doyle Stephen .....	Hartford .....	Hartford.
<i>Washtenaw County:</i>		
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 .....	Ypsilanti, 1 mi. from.
Cadillac Sand & Gravel Co. ....	1452 Penobscot Bldg., Detroit .....	Ann Arbor.
<i>Wayne County:</i>		
Thompson, W. R. ....	Detroit, 606 Kress Bldg.	Detroit.
Rockwood Silica Co. ....	Detroit, 933 Dime Bank Bldg. ....	1½ miles E. of Rockwood.
Cameron Steamship Co. ....	Detroit, 39 Buhl Block ..	

## TRAP ROCK PRODUCERS, 1918

Operator.	Office.	Quarry.
<i>Houghton County:</i>		
Winona Copper Co. ....	Winona .....	Winona.
<i>Marquette County:</i>		
City of Negaunee .....	Negaunee .....	Negaunee.
Marquette Trap Rock Co. ....	Marquette .....	Marquette.
<i>Ontonagon County:</i>		
Blumgren, J. E. ....	Norway .....	Bergeland.
<i>Iron County:</i>		
Iron Co. Road Comm'r. ....	Crystal Falls .....	N.W. of N.E. Sec. 7-43-32

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