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MINERAL RESOURCES OF MICHIGAN
WITH
STATISTICAL TABLES OF PRODUCTION AND VALUE OF MINERAL PRODUCTS
FOR
1923 AND PRIOR YEARS

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PART II. NON-METALLIC MINERALS

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SALT

The manufacture of salt is one of Michigan's most stable operations in non-metallic minerals and gives promise of being continued as a successful operation indefinitely. Plants can be located on trunk lines of transportation both by lake and rail so that the fortunate location, together with a practically unlimited supply of very pure mineral salt, which is easily brought to the surface by solution and pumping, give Michigan high rank as a salt producing State. There are six important brine and salt bearing formations,—the Salina, Detroit River (Upper Monroe), Dundee, Berea, Napoleon, and Parma. Of these the Salina is by far the most important as the salt occurs in bedded deposits of great purity and often of great thickness. In the other salt bearing formations quantities of salt are found in brines contained in the rocks but other substances which are also contained in solution render these brines more important at the present time for other uses and the salt produced from them is frequently a by-product from other manufacturing operations. This restriction of salt manufacture to the Salina deposit is of recent date. Formerly salt was produced in important quantities from the Berea, Napoleon, and Parma, but with the beginning of operations in Wayne County (1895) the other sources were soon abandoned or were continued only where waste heat could be utilized, or salt could be produced as a by-product during the recovery of other chemicals.

The Salina formation has never been identified with certainty in outcrop within the State. Rominger* visited and described several outcrops in the vicinity of Point

aux Chenes and St. Martin's Bay near St. Ignace but reported no fossils or salt beds, and it is now believed that these are outcrops of the Bass Island formation. A small area around the Straits of Mackinac is the only place where outcrops are supposed to occur and it is known that in this region the salt bearing beds are generally absent. The northernmost record of salt at the Salina horizon was in the St. Ignace well No. 1, where 4 feet of salt was reported. In the No. 2 well two miles north of No. 1 no salt was found. The beds containing salt at St. Ignace have not been determined as Salina. They may belong with the Monroe and without fossil evidence it is not possible with the present data to make a satisfactory correlation. Lithologically they differ from both the typical Bass Island and the typical Salina as they are chiefly red and blue shales. This area is apparently at the border of both the Monroe and Salina basins. Because of the limited area of outcrop, which has never been examined in detail, all of the information accumulated has been from deep borings with the exception of a mining operation at Oakwood, a suburb of Detroit, where rock salt has been recovered by shaft mining. Here the Salina section has been observed and a careful search made for fossils but without finding any trace whatever of organisms. Three deep wells have been drilled since accounts of the Salina were published which throw some light upon its extent and its relation to formations above and below. Two wells drilled by Henry Ford, one at Dearborn, Wayne County, and one at Highland Park, Wayne County, and a well drilled near Chesterfield, Macomb County, by the Macomb County Oil & Gas Syndicate have completely penetrated the Salina. These new records added to some already known in Ontario and Michigan, make it possible to show graphically the relation of the Salina to other beds and the northern and southern terminations of the salt beds. This section shows the salt bearing part of the Salina as a lenticular bed with its deepest part at Chesterfield and its thickest part near Dearborn. In the Chesterfield well the salt beds were not encountered at the usual horizon but a series of dark colored shales and dolomites was found and penetrated for 311 feet. These dolomites and shales were not found in the Dearborn or St. Clair wells and their position in the lowest part of the basin, together with their lithologic character, which is more like that of the dolomites at the base of the Salina than those of the overlying Bass Island (Lower Monroe) formation, led to their assignment to the Salina. That these dolomites belong to the Salina sedimentary unit seems obvious but like all other correlations made from well records this one implies no exact time relationship. The cross section brings out the fact that the salt bearing part of the Salina is a continuous deposit throughout the basin of its deposition and this is held to be an important observation when applied to the question of the extent of the salt beds. Suggestions have been made that the Michigan deposits were distinct from those of the New York basin and were of a different type, being continental deposits of desert lakes and therefore apt to be found in restricted areas. The broad, regular, and continuous deposit of the Salina as it is shown leads to an opposite conclusion. From its shape and extent it seems reasonable to infer a regular and continuous deposit over the central and northern parts of the Michigan basin. From the prevailing white and gray color of the salt beds, the absence of red excepting in the upper part, the absence of the more soluble salts, and the absence of sands or grits, these beds are held to have had their origin in a large body of water, most probably with a connection with marine waters.

One most important conclusion in regard to the value of the Salina salt beds which follows from the records of recent wells is that potash salts do not occur in appreciable quantities in the Detroit-St. Clair area of Wayne and Macomb Counties. If we accept the inference, made above, of shifting marine conditions with repeated influx of marine waters it is most probable that such salts do not anywhere occur in the Michigan Salina. Prospecting with the intention of recovery of any of the more valuable salts is not warranted by past experience.

While the Salina is thought to be continuous under the greater part of the Southern Peninsula, it is not exploited excepting near the outer margin along the shores of lakes Huron, Michigan, and St. Clair and the Detroit river where the salt beds are not so deep as to make drilling operations unduly hazardous. The salt beds are not found in the southern part where the Salina is represented by shales and shaly dolomites only. The area of productive Salina as it is known at present is bounded on the north by a line connecting Alpena, Onaway, and Manistee and on the south by a line from Muskegon to Trenton. The southern line represents in general a known limit of the salt but the northern line represents only a limit of exploration. The salt beds continue some distance north from Onaway and Alpena. The region which gives greatest promise for new exploration is the Alpena-Onaway area where the salt is thick and comparatively near the surface, having been encountered at 1284 feet at Grand Lake and at 1630 feet at Onaway. The productive area varies greatly as to the amount of salt imbedded in the Salina. Attempts which have been made to correlate salt beds between wells have been fairly successful, and five major salt beds in the Detroit region have been found to occur at similar positions in several of the deep wells. While thick deposits of salt probably occur throughout the Salina basin within the limits described above, it is not at present practicable to exploit them in the central portion of the State because of the great depth at which they occur. The area under which the Salina is practically out of reach is the portion which has Pennsylvanian and Upper Mississippian rocks at the surface under the drift cover as shown on the geological map.** The territory which offers possibilities for the exploitation of salt deposits in the Salina includes the counties bordering Lake Michigan from Ludington north, those bordering Lake Huron from Oscoda north, those bordering Lake Huron from Grindstone City (Huron County) south, and those along the St. Clair river, Lake St. Clair, and the Detroit river as far south as Trenton in Wayne County.

Michigan produced more salt than any other state in 1923. This has been the case since 1880 with the exception of a few years when New York has had a greater production. It is recorded that Michigan was first in salt production from 1880 to 1892, in 1901, from 1905 to 1909, from 1912 to 1921. and in 1922 and 1923.

In 1923 the salt producers in Michigan reported 2,127,412 short tons valued at $8,684,148. This is but a small increase over the reported production of 1922 which was 2,005,088 short tons valued at $8,693,604. The low point in production since 1910 was reached in 1921 and the rapid recovery which took place in 1922 has been sustained during 1923.

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

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 fait. 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. Over 96.2 per cent of the State output of salt for 1923 came from these two districts, the production being 14,613,300 barrels, valued at $8,201,024 or 96.2 per cent of the total State production and 94 per cent of the total value.

The salt industry in Wayne County made a most remarkable growth from 1895 to 1919. Salt was first produced in this country in 1895, the output for that year being 13,077 barrels. In 1906 the production exceeded 1,000,000 barrels and in 1919 a maximum of 11,539,258 barrels, or 64.8 per cent of the total for the State was reached. The value was $2,324,164 or only 24.5 per cent of the total. The industry began to decline in 1920, production being 9,713,564.3 barrels valued at $2,510,789, a decrease of 1,925,694 barrels or 16.6 per cent in production but an increase of $186,625 or 8 per cent in value. Production continued to decrease in 1921, being only 5,950,521.4 barrels valued at $2,052,596, a decrease of 3,763,043 barrels or 38.7 per cent in quantity (a decrease of 48.4 per cent from the maximum of 1919) and of $458,193 or 17.1 per cent in value. In 1922 Wayne County produced 9,363,564 barrels valued at $2,437,710; in 1923, 10,457,185 barrels valued at $2,873,664.

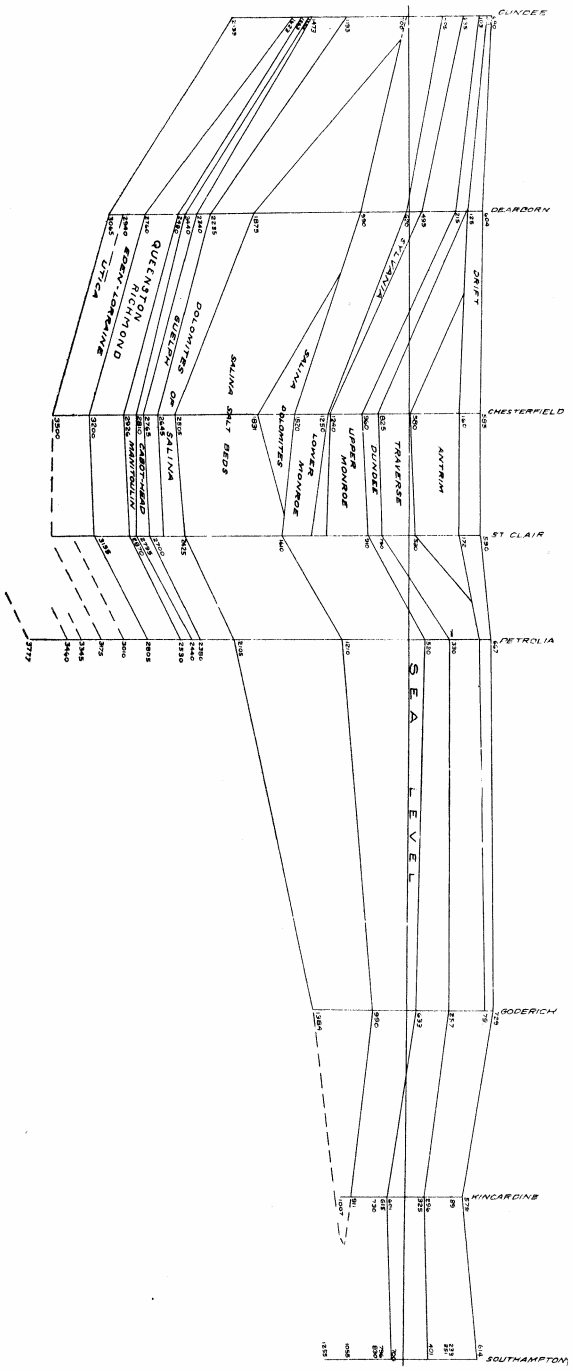

Fig. 1. A cross section from Dundee, Michigan to Southampton, Ontario along line A-B shown in Fig. 2. Straight lines are used to emphasize the diagrammatic nature of the section.

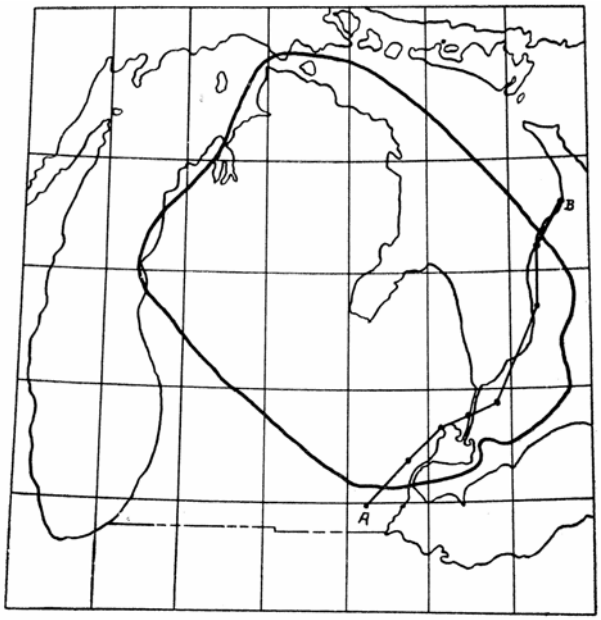

Fig. 2. Limits of the Michigan-Ontario salt basin. In Michigan the central part is untested because of its great depth. Line A-B indicates the direction of the section shown in Fig. 1.

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 1923 was 2,604,607 barrels or 17.1 per cent of the State total, but the valuation of $4,097,427 represents 47.2 per cent of the total value for Michigan. The exceptionally high value for this county is due to the fact that much of the salt produced is of the better grades, practically 50 per cent being table and dairy salt.

During 1917 pressed blocks of salt were placed on the market as a substitute for the large lumps of rock salt formerly used in field and stable to salt cattle. The blocks are made by hydraulic press, and dispose of the refined salt spilled around the machines in the evaporating and packing departments. Although the profit from the industry is not great, the demand for the pressed block has increased.

In the Manistee-Ludington district, salt is made at Manistee, Manistee County, and at Ludington, Mason County. 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. The district produced 1,551,507 barrels of salt valued at $1,229,933. This is equivalent to 10.2 per cent of the total quantity and 14.2 per cent of the value for the State. Most of the product is packer's salt, i. e., common fine and common coarse. About fifty years ago Saginaw Valley was the center of the salt industry. The industry was chiefly along Saginaw River. Salt was produced as a byproduct of the lumber industry. More than a hundred concerns, chiefly lumber mills, utilized waste material in manufacturing salt from brine, which was obtained from the Marshall sandstone at depths varying from about 650 feet at Saginaw to nearly 1000 feet at Bay City. The production of salt declined with the lumber industry. At present there are only a few concerns along Saginaw River producing salt.

*Rominger, Carl, Michigan Geological Survey Vol. I, Part 3, p. 30, 1873.

**Mich. Geol. Surv. Pub. 23, 1917.

PRODUCTION AND VALUE OF SALT IN MICHIGAN AND UNITED STATES 1880-1923††

Year.	U. S. production quantity bbls.	Michigan production. State Salt Inspectors† Quantity. bbls.	Michigan production. U. S. G. S.= Quantity. bbls.	Per cent of total Michigan.	Rank quantity.	Value Michigan.	Michigan. Rank value.	Michigan. Price bbl.
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	.....	2,261,743	.....	0.585
1889	8,005,565	3,846,979	3,856,929	48.17	1	2,088,909	.....	0.541
1890	8,776,991	3,838,637	3,838,632	43.72	1	2,302,579	.....	0.600
1891	9,987,945	3,927,671	3,966,748	39.52	1	2,037,289	.....	0.513
1892	11,698,890	3,812,504	3,829,478	32.81	1	2,046,963	.....	0.523
1893	11,897,208	3,514,485	3,057,898	25.70	2	888,837	.....	0.287
1894	12,968,417	3,138,941	3,341,425	26.53	2	1,243,619	.....	0.375
1895	13,669,649	3,529,362	3,343,395	24.46	2	1,048,251	.....	0.315
1896	13,850,726	3,336,242	3,164,238	22.89	2	718,408	.....	0.229
1897	15,973,202	3,622,764	3,993,225	24.99	2	1,243,619	.....	0.313
1898	17,612,634	4,171,916	5,263,564	29.88	2	1,628,081	.....	0.311
1899	19,708,614	4,732,669	7,117,382	36.14	2	2,205,924	.....	0.309
1900	20,869,342	4,738,085	7,210,621	34.55	2	2,033,731	2	0.282
1901	20,566,661	5,580,101	7,729,641	37.58	1	2,437,677	1	0.328
1902	23,849,231	4,994,245	8,131,781	34.10	2	1,535,823	2	0.188
1903	18,968,089	4,387,982	4,297,542	22.65	2	1,119,984	2	0.260
1904	22,030,002	5,390,812	5,425,904	24.62	2	1,579,206	2	0.309
1905	25,966,122	5,671,253	9,492,173	35.24	1	1,851,332	2	0.196
1906	28,172,380	5,644,559	9,936,802	36.31	1	2,018,760	2	0.203
1907	29,704,128	6,298,463	10,786,630	35.39	1	2,231,129	2	0.208
1908	28,822,062	6,247,073	10,194,279	35.34	1	2,458,303	1	0.241
1909	30,107,646‡	6,055,661	9,966,744	33.10	1	2,732,556	1	0.274
1910	30,305,656‡	5,097,276	9,452,022	31.18	2	2,231,262	2	0.236
1911	31,183,968‡	.....	10,320,074	33.10	2	2,633,155	1	0.255
1912	33,324,808‡	.....	10,946,739	32.84	1	2,974,429	1	0.277
1913	34,393,227‡	.....	11,528,800	33.52	1	3,293,032	1	0.285
1914	34,402,772‡	.....	11,670,976	33.92	1	3,299,005	1	0.283
1915	38,231,496‡	.....	12,588,788	32.93	1	4,304,731	1	0.342
1916	45,449,329‡	.....	14,918,278	32.84	1	4,612,567	1	0.309
1917	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
1919	49,157,686‡	.....	17,800,564	36.21	1	9,456,138	1	0.531
1920	49,745,373‡	.....	16,163,679	32.49	1	10,698,674	1	0.662
1921	35,579,672	.....	10,196,179	28.66	2	7,439,445	1	0.729
1922	48,520,350‡	.....	14,322,057	29.52	1	8,693,604	1	0.607
1923	50,933,664	.....	15,195,800	29.83	1	8,684,148	1	0.571
Total	1,038,069,125	.....	343,643,530	.....	.....	$159,712,922	.....	.....

†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 and 1922.
††For the State total 1865–1879 see Pub. 29, G. S. 24, Michigan Geological Survey.

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY METHODS OF MANUFACTURE, 1906-1923.

	Evaporated. Quantity.	Evaporated. Value.	Pressed blocks. Quantity Tons.	Pressed blocks. Value.	Other rock. Quantity. Bbls.	Other rock. Value.	Brine and other.† Quantity. Bbls.	Brine and other.† Value.	Total. Quantity. Bbls.	Total. Value.
1906–										
1910	29,278,297	$10,302,732	.....	.....			20,796,007	$1,083,643	50,336,468	$11,503,238
1911	5,355,707	2,232,046	.....	.....	576,695	$181,865	4,387,772	219,244	10,320,074	2,633,155
1912	5,441,288	2,486,735	.....	.....	763,908	250,640	4,737,038	236,852	10,946,739	2,974,429
1913	6,042,657	2,811,429	.....	.....	727,364	244,472	4,756,779	237,431	11,528,800	3,293,032
1914	6,141,711	2,806,895	.....	.....	712,530	252,024	4,816,735	240,086	11,670,976	3,299,005
1915	6,595,113	3,602,886	.....	.....	919,735	321,354	5,073,940	380,491	12,588,788	4,304,731
1916	6,549,467	3,747,695	.....	.....	1,012,942	368,022	7,365,927	506,850	14,918,278	4,612,567
1917	6,253,793	5,729,911	.....	.....	1,304,543	568,717	8,639,800	578,574	16,078,136	6,877,202
1918	7,307,928	7,679,927	.....	.....	1,405,671	827,348	8,451,578	541,375	17,165,178	9,048,650
1919‡	7,021,800	8,004,713	.....	.....	1,350,634	972,517	9,430,264	660,119	17,800,564	9,456,138
1920	6,452,785	8,677,108	.....	.....	1,511,050	1,186,682	8,199,843	549,824	16,163,678	10,698,674
	Open pans or grainers. Quantity. Bbls.	Open pans or grainers. Value.	Vacuum pans. Quantity. Bbls.	Vacuum pans. Value.						
1921	2,349,893	$3,557,177	2,482,693	$2,449,417	29,657	$273,187	1,367,643	$868,348	10,196,179	$7,439,445
1922	2,987,250	4,543,626	2,786,443	2,471,455	††	††	††	††	14,322,057	8,693,604
1923	2,747,835	4,221,764	2,708,664	2,688,779	††	††	††	††	15,195,800	8,684,148

†Brine only after 1910.
‡1919 computed from census return and subject to revisions and corrections.
††Included in total.

BROMINE AND CALCIUM CHLORIDE

The brines of the Napoleon and Lower Marshall formations contain considerable quantities of magnesium bromide, together with various chlorides. These substances were extracted first by the salt companies, but later chemical plants were built for the purpose. The brines are generally heavier and more complex near the center of the Michigan basin and the industry has been developed especially at Midland where the Dow Chemical Company has successfully produced bromine and other chemicals. The brines contain an especially large amount of bromine.

Owing to German competition before the War bromine was produced in this country chiefly for domestic purposes, but from 1914 to 1919 inclusive there was a large increase to meet the war needs of the Allies and the United States as well. During 1921 the production declined greatly but the amount of annual production since has been from about 50 to 75 per cent higher than immediately before the War. The average price for bromine sold in the United States has declined from $1.31 per pound in 1916 to $.17 in 1923. In 1885 the Midland district began producing bromine and a production of 40,000 pounds was reported for that year. Large quantities of bromine, chiefly in the form of bromides and calcium chloride were produced. The Marshall brines are said to contain four times as much bromine as those of Ohio and West Virginia, and the exclusive Dow process results in a maximum recovery of the element.

Over-production, dullness of trade, and competition with German bromine forced the price of bromine so low that for a number of years prior to the war the recovery of bromine was abandoned by all of the salt manufacturing concerns. The Dow Chemical Company of Midland, however, continued to produce large quantities of bromine and other chemicals derived from the brines. The production in the Midland district increased rapidly until by 1904 Michigan's production was far ahead of any other State.

Bromine dropped in value to 25 cents and 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 supplies. The price of bromine advanced to unprecedented figures, the average price for 1916 being $1.31 a pound, the highest since 1885. The industry was revived in the Saginaw Valley. In 1917 there were five producers. In 1917 brombenzylcyanide, a tear gas for use in trenches, was invented, and 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 manufacturing of disinfectants, dyes, and drugs. During the war because of its effect upon the eyes and throat bromine was extensively used in the manufacture of tear and asphyxiating gases but after the Armistice was signed the large demands for this purpose naturally fell off, although the price still remained twice as high as the pre-war normal. After the war production increased due to the demand for new dyes, for potassium bromide used as a depressant in the treatment of certain nervous diseases, and to the continued demand for bromides in the photographic trade, especially for moving picture films.

In 1919 the maximum quantity of bromine was marketed in Michigan, i.e., 1,736,633 pounds valued at $1,179,834, or 93.6 per cent of the total United States production at 95.5 per cent of the total United States valuation of $1,234,969. Although the war-need for bromine passed in 1918 the chemical and photographic demand continued to keep production and price up.

In 1923 bromine production in the United States decreased somewhat, the production reported for the year being 842,352 pounds. Michigan produced the greater part of the United States production. The average price per pound for the United States was $.17.

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 bleaching agent, 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 play-grounds.

The United States output of calcium magnesium chloride for 1923 was 43,596 tons valued at $642,874, an increase from 1922 of 10,529 tons. The average price per ton dropped from $17.28 in 1922 to $14.75 in 1923. Michigan produced the greater part of the total quantity produced in the United States.

The above figures refer to the direct production of calcium chloride from raw mineral material and there is a large additional output from chemical plants which produce it in various manufacturing operations.

MAGNESIUM

The latest product recovered from the Marshall brines is metallic magnesium.

Before the war magnesium was an almost exclusively German product, but early in the war when the German supply was cut off, the Dow Chemical Company of Midland began the production of metallic magnesium, and, later on, of magnesium alloys.

Magnesium chloride is obtained from the brines and decomposed by passing a heavy direct current through a molten bath of the salt; the extremely light metal, magnesium, floats to the surface from which it is skimmed off. The recovery method is expensive and accounts for the high cost of the metal.

The metal has been used chiefly in the chemical laboratory, in metallurgy as a deoxidizing agent, and in the finely powered state, as a flash light powder for military and photographic purposes. Prior to the experiments of the Dow chemists no alloy using magnesium as the main constituent had been made although very light but strong alloys are becoming more and more needed.

CEMENT†

The first attempts to manufacture Portland cement in Michigan were made in 1885, when an experimental vertical kiln plant was constructed at Kalamazoo, using marl and clay in the process. The venture was a failure and no second attempt was made to establish the industry in Michigan until 1896. In that year the Peerless Portland Cement Company 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 the rotary type. In 1897 the Bronson Portland Cement Company erected a plant at Bronson, Branch County, and in 1898 the Coldwater Cement Company, now the Wolverine Portland Cement Company, built plants at Coldwater and Quincy, also in Branch County. The early "wet process" of manufacture in the vertical kiln was expensive and it was not until 1896 that the successful introduction of the rotary kiln and the use of powdered coal as fuel revolutionized cement manufacture and enabled the industry in the United States to excel that of Europe, and thus inaugurate 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 continued almost uninterruptedly until 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. During 1919 production and shipment gained by 13.7 per cent and 20.7 per cent respectively over 1918, production being 80,777,935 barrels and shipments were valued at $146,734,844 with the average price per barrel at $1.71. In 1920 production reached the unprecedented figure of 100,023,245 barrels with shipments of 96,311,719 barrels valued at $194,439,025, an increase of 13 per cent in quantity shipped over 1919, and of 32.5 per cent in value of shipments. The average price for cement in the United States was $2.02, an increase of $0.31 or .18 per cent per barrel.

The period between 1899 and 1901 was the "boom" period of the industry, twenty companies being organized for the manufacture of Portland cement from marl and clay or shale. In 1900 Michigan with six plants attained third rank with Pennsylvania and New Jersey holding first and second rank respectively. 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-eight different cement plants have been projected or built in Michigan. Eleven plants were in operation in 1921 and 1922; thirteen in 1924.

In 1918 Michigan shared with other states the general decrease in output due to war conditions, only seven of the ten operating plants operating the entire year. After the Armistice the expectation of a decline in prices deterred building operations until the middle of 1919, when the "underbuilt" conditions of the country forced construction in spite of the high prices, thus causing a shortage of Portland cement and an increase in its price. Stocks of cement in Michigan were lower at the end of 1919 than they had been since 1910.

The demand was heavy the first ten months of 1920, but fell off during the last two. The difficulties in obtaining either coal or cars for transportation of raw materials and the finished product forced Michigan cement to $2.46 per barrel (compared with $1.70 in 1919), a price greater than ever received in Michigan and greater than received in any other state in 1920. The average factory price per barrel in the United States was $2.02. Stocks held at the end of 1920 were greater than at the close of any previous year, being 666,389 barrels as compared with 219,699 barrels at the end of 1919. Prosperity in the cement industry continued during 1921 and Michigan produced 5,777,533 barrels of cement, an increase of 886,076 barrels or 18.1 per cent. Shipments reached 5,680,156 barrels or 27.9 per cent but a decrease in value of $639,344 or 5.8 per cent. The decrease in value is due to the decreased price received per barrel, $1.81, which is $0.65 or 26 per cent less than the maximum price per barrel of 1920. Stocks on hand at the end of 1921 were greater than ever before, being 760,503 as compared with 666,389, an increase of

94,114 barrels or 14.1 per cent. This increase in production caused Michigan to advance in rank from seventh to third place, being outranked only by Pennsylvania and California.

During 1922 there was a further increase in production in Michigan and in the United States. Michigan produced 6,243,805 barrels, an increase of 466,272 barrels or 11.8 per cent over the production for 1921. In 1923 Michigan produced 7,619,792 barrels—an increase of 22 per cent over the production of the preceding year.

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 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 whenever practical. Of eleven plants five are reported to be using marl and clay, five using limestone and clay or shale, and one using clay and the waste from the plant of the Michigan Alkali Company. All plants use coal as fuel, nine manufacture cement by the wet process, and two by the dry process.

In 1920 the Petoskey Portland Cement Company erected a plant on the limestone deposits of Little Traverse Bay about two and one-half miles west of Petoskey to manufacture cement from limestone of the company's holdings on Little Traverse Bay, and shale from a quarry at Ellsworth in Antrim County, twenty-seven miles southwest of Petoskey. The plant began operating March 21, 1921, with a capacity of 2,500 barrels a day. The mill building contains all of the machinery for the manufacture of cement, including waste heat boilers which supply all the power used in driving the mill. This plant is one of "the best and most efficient wet process" plants and attracted the attention of all American as well as foreign cement manufacturers.

The National Portland Cement Company was organized and it purposed to erect a plant at Coldwater Lake near Mount Pleasant to utilize the marl beds surrounding the lakes in the manufacture of cement, but nothing came of this project.

In December 1921 the Aetna Portland Cement Company, which has a plant at Fenton, purchased 33 acres of land on the Saginaw River near Bay City and erected one unit of a modern plant equipped with waste heat boilers. This began production in 1923. It utilizes "fines" or "waste" stone from limestone quarries.

The Peerless Portland Cement Company, with one plant at Union City, Branch County, is building another at Detroit. The source of raw material is to be refuse from the soda ash plants at Detroit, "fines" or screenings from the limestone quarries in the northern part of the Southern Peninsula, and surface clay in the vicinity of Detroit.

†For more detailed reports see Pub. 24, Geol. Series 17, Michigan Geological Survey, Mineral Resources for 1916 and Bulletin 522, United States Geological Survey.

PRODUCTION, VALUE, ETC., OF PORTLAND CEMENT IN MICHIGAN AND UNITED STATES, 1896-1923.

Year.	No. of plants in operation.	Michigan Rank.	No. of kilns. Rotary.	Daily capacity. Bbls.	Michigan, cement made. Bbls.	U. S., cement made. Bbls.	Michigan, per cent made.	†Change per cent cement made.	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	.....	.....	.....	4,000	1,543,023	0.25	.....	.....	$7,000	$2,244,011	0.29	.....	$1.75	$1.57
1897	2	.....	.....	.....	15,000	2,677,775	0.56	275.0	.....	26,250	4,315,893	0.6	.....	1.75	1.61
1898	2	.....	.....	.....	77,000	3,692,284	2.11	413.3	.....	134,750	5,970,773	2.3	.....	1.747	1.62
1899	4	4	.....	.....	343,566	5,652,266	6.1	346.2	.....	515,849	8,674,371	5.96	.....	1.492	1.43
1900	6	2	.....	.....	664,750	8,482,020	7.8	93.4	.....	830,990	9,280,525	8.9	.....	1.25	1.09
1901	10	3	.....	.....	1,025,718	12,711,225	8.0	54.1	.....	1,128,290	12,532,360	9.0	.....	1.10	0.99
1902	10	3	.....	.....	1,577,006	17,230,644	9.1	53.7	.....	2,134,396	20,864,078	10.2	.....	1.353	1.21
1903	13	3	.....	.....	1,955,183	2,342,973	8.7	23.9	.....	2,674,760	27,713,319	9.7	.....	1.367	1.24
1904	16	4	.....	.....	2,247,160	26,505,881	8.5	14.9	.....	2,365,656	23,355,119	10.1	.....	1.052	0.88
1905	16	5	.....	.....	2,773,283	35,246,812	7.9	23.4	.....	2,921,507	33,245,867	8.7	.....	1.053	0.94
1906	14	4	.....	.....	3,747,525	46,463,424	8.06	35.5	.....	4,814,965	52,466,186	9.2	.....	1.284	1.13
1907	14	4	.....	.....	3,572,668	48,785,390	7.3	−4.6	.....	4,384,731	53,992,551	8.1	.....	1.227	1.11
1908	15	7	.....	.....	2,892,576	51,672,612	5.6	−19.0	.....	2,556,215	43,547,679	5.8	.....	0.883	0.85
1909	12	7	.....	.....	3,212,751	64,991,431	4.9	11.6	.....	2,619,259	52,858,354	4.9	.....	0.815	0.813
1910	12	8	.....	.....	3,687,719	76,549,951	4.8	11.7	.....	3,378,940	68,205,800	4.9	.....	0.916	0.891
1911	11	8	96	22,400	3,686,716	78,528,637	4.69	−0.03	.....	3,024,676	66,248,817	4.56	506,758	0.82	0.843
1912	11	8	92	19,450	3,494,621	82,438,096	4.23	−5.21	3,651,094	3,145,001	69,109,800	4.55	370,956	0.861	0.813
1913	11	8	83	19,900	4,186,236	92,097,131	4.21	19.79	4,228,879	4,228,879	89,106,975	4.74	473,563	1.035	1.005
1914	11	7	77	19,100	4,285,345	88,230,170	4.85	2.27	4,218,429	4,064,781	80,118,475	5.07	538,846	0.964	0.927
1915	11	5	71	20,800	4,765,294	85,914,907	5.55	11.2	4,727,768	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	5.37	3.2	5,151,818	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	5.03	−4.47	4,313,771	6,122,887	122,775,088	4.98	791,919	1.419	1.354
1918	10	6	49	22,160	3,554,872	71,081,663	5.00	−24.2	3,618,088	6,078,167	113,153,513	5.37	635,447	1.680	1.596
1919	11	4	58	20,425	4,675,244	80,777,935	5.78	32.00	4,990,308	8,468,196	146,734,844	5.77	219,641	1.70	1.71
1920	11	7	58	22,700	4,891,437	100,023,245	4.89	5.00	4,442,455	10,939,633	194,439,025	5.62	666,389	2.46	2.02
1921	11	3	53	23,600	5,777,533	98,293,090	5.78	18.1	5,680,156	10,300,289	180,778,415	5.69	760,503	1.815	1.89
1922	12	5	60	25,550	6,243,805	115,679,412	5.39	11.8	6,349,751	11,145,573	207,170,430	5.38	759,703	1.76	1.76
1923	12‡	5	62	29,400	7,619,792	137,460,238	5.54	22.	7,466,283	14,038,322	257,684,424	5.44	738,892	1.88	1.76

†Minus sign indicates decrease.
‡Thirteen including branch plants but excluding one plant now under construction.

POTASH

Though Michigan has depoits of rock salt of great extent they are not known to contain important amounts of 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 203 tons from wood ashes. In 1919 the production of potash reckoned as K_2O amounted to but 166 tons (from 666 tons of crude potash) of which 149 tons valued at $48,581 were sold. This represents a decrease of 238 tons or 58.8 per cent in quantity and of $52,066 or 51.7 per cent in value. Production was further decreased in 1920 to 56 tons (from 93 tons of crude potash) of which 49 tons were sold for $18,312, a decrease from 1919 of 110 tons or 66.2 per cent in quantity and $30,269 or 62.3 per cent in value. Eighteen plants reported production of potash in 1919. There were seven producers in 1920. There was no potash produced in Michigan in 1921, 1922, or 1923.

GYPSUM

Commercial gypsum occurs in the Michigan formation which underlies the Bayport formation of the Upper Mississippian and also in the Salina formation of the Silurian, a much older formation. Only the gypsum of the Michigan formation is mined and quarried at the present time. In Kent County at least three and probably four gypsum beds are worked. 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 difficulties with water, which increased 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 about 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 overburdens 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.

The gypsum beds of the St. Ignace Peninsula, and St. Martins and other adjacent islands are of Silurian age. The gypsum appears to be of as high quality as that of Grand Rapids, but locally water would cause difficulty in quarrying.

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 indicate the presence of seven quarryable beds of gypsum in this district.

In the southern part of the State the gypsum of the Salina where it has been penetrated by deep wells, is for the most part in the form of anhydrite but is too deep to be considered capable of commercial exploitation.

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 trade. 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, although the same year shows a 65.11 per cent increase in value over pre-war production.

In the early days of the industry four-fifths of the raw gypsum was ground into land plaster and from 1860 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 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 and in 1919 had further decreased to 1,597 tons. In 1919 the Gypsum Industries Association of Chicago, Illinois, launched a campaign to induce greater use of gypsum as land plaster, as a deodorizer and fixative of ammonia in manure about stables, as a soil stimulant, and as a specific for black alkali. That the campaign was effective is shown by the fact that the production of agricultural gypsum for the United States increased from 40,000 to 107,000 tons. In Michigan the increase was from the minimum production of 1,597 tons in 1919 to 12,092 in 1920 and 26,558 tons in 1921. The 1922 production was 13,054 tons, but in 1923 the total reported was greatly reduced, the figures being withheld from publication because of the small number of producers.

PRODUCTION OF GYPSUM IN MICHIGAN, 1868-1923

Year.	Ground into land plaster. Tons.	Calcined sold. 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	1	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	384,227	621,547	2	3
1913	9,604	278,368	60,706	423,896	721,325	3	3
1914	9,322	240,648	61,227	393,006	705,841	3	3
1915	9,799	245,484	69,572	389,791	686,309	3	4
1916	9,072	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	1,597	250,687	58,754	339,125	2,390,367	3	3
1920	12,092	261,499	73,842	382,212	3,521,028	3	3
1921	26,558	240,648	110,677	408,224	3,312,096	2	2
1922	13,054	275,885	107,708	471,355	2,843,117	3	4
1923	†	341,746	†	586,987	3,252,993	3	4
Totals	.....	6,564,430	.....	10,592,216	$38,647,624	.....	.....

†Included in total.

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.

The most important of these products are mixed wall plaster; gypsum board, block and tile, and stucco follow in second and third place.

The character of the building activity inaugurated in 1919 and continuing through 1920, 1921, 1922, and 1923 is reflected in the production of gypsum products. In 1920 the production of mixed wall plaster decreased 14.1 per cent from the production of 1919, but in 1921 a

production of 169,809 tons was reached, and in 1922 a production of 160,109 tons shows only a small decline, which was more than compensated by the increased production of 1923.

The production of stucco increased in 1920, decreased in 1921, and increased in 1922 and 1923. Stucco production in 1922 was 72,157 tons valued at $501,595; in 1923 it was 104,271 tons valued at $685,992. Plaster board and tile show an increase in quantity and value over 1922.

PRODUCTION OF GYPSUM IN MICHIGAN, 1913-1923.

Year.	Crude gypsum mined.	Gypsum sold crude.							
		To Portland cement mills.		As land plaster.		For other purposes.		Total sold crude.	
	Quantity.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons	Tons		Tons		Tons		Tons	
1913	423,896	†	†	9,604	$10,222	10,320	$9,011	60,706	$55,969
1914	393,006	†	†	9,322	10,761	.....	.....	61,227	51,242
1915	399,791	†	†	9,799	9,894	†	†	69,572	63,236
1916	457,375	.....	.....	9,072	16,658	.....	.....	80,298	90,973
1917	375,903	60,846	$92,874	7,096	22,903	†	†	68,155	110,653
1918	296,168	40,314	105,621	5,892	23,876	†	†	46,608	131,438
1919	339,125	48,798	138,611	1,597	10,422	†	†	58,754	174,110
1920	382,212	52,705	188,391	12,092	54,030	†	†	73,847	268,968
1921	408,224	74,672	245,593	26,558	98,139	9,447	25,453	110,677	369,185
1922	471,355	85,275	228,982	13,054	40,583	26,120	164,198	107,708	291,295
1923	586,987	120,539	324,582	††	††	††	††	135,616	355,067

Year.	Gypsum sold calcined.										
	As mixed wall plaster.		As stucco.		As boards, tile, etc.		Total sold calcined.†		Total value.	No. mines and quarries.	No. mills.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.			
	Tons		Tons		Tons		Tons				
1913	166,711	$437,720	95,402	$292,675	.....	.....	278,368	$665,356	$721,325	7	8
1914	163,972	473,638	83,780	173,172	.....	.....	249,648	654,599	705,841	8	8
1915	155,861	426,432	80,172	177,317	.....	.....	245,484	623,073	686,309	8	8
1916	193,816	668,795	87,405	279,597	.....	.....	292,109	975,626	1,066,599	7	8
1917	147,371	949,511	85,426	384,661	19,158	$67,741	257,588	1,452,002	1,568,655	7	8
1918	117,902	931,725	52,132	330,761	33,253	339,901	207,059	1,629,711	1,761,149	7	8
1919	152,162	1,460,572	48,039	315,516	46,377	415,972	250,687	2,216,257	2,390,367	7	8
1920	133,289	1,499,226	62,458	446,381	60,996	1,266,659	261,499	3,252,060	3,521,028	7	8
1921	169,809	1,662,343	37,968	298,538	22,809	807,519	240,648	2,442,911	3,312,096	7	8
1922	160,109	1,432,458	72,157	501,595	12,713	245,302	275,885	2,551,823	2,843,117	7	8
1923	††	††	††	††	††	††	341,746	2,897,926	3,252,993	5	8

†Included in the total are values for sanded plaster, plaster of Paris, Keene's cement, dental plaster, gypsum for plate glass works and for other purposes.
††Included in totals.

BRICK AND TILE PRODUCTS

The greatest part of the clay and shale that is produced in Michigan is manufactured at the place where it is found and reaches the market as a finished product such as brick or tile. A discussion of the different kinds of raw materials used in the manufacture of brick and tile will be found below under the headings Clay and Shale. The industry is an important one, but its importance is far less obvious than that of many industries which consume products of the earth because it is scattered in small units throughout the State, and, on account of the great variation in the raw materials used, is not well adapted to a central control either of manufacture or of marketing. The large number of abandoned brick plants which are seen in all parts of the State bear mute testimony of the hazards of the industry especially when it is undertaken without a careful investigation of the raw materials both as to quality and quantity or without sufficient capital to endure through a period of experimentation while the burning qualities of the material are being worked out.

In 1919 the brick and tile industry recovered somewhat from the war-induced slump of 1918. The total value of clay products exclusive of pottery (see Pottery) was $3,699,929, an increase of 116.5 per cent over the 1918 production. The quantity of common brick produced was 200,352,000, or 105,606,000 brick more than in 1918 but falling short of the maximum of 1916 by 78,823,000; this represents an increase of 111.4 per cent over 1918. The value of common brick was $2,734,503 or an average of $13.64 a thousand as compared with $9.65 in 1918 and $6.65 in 1916. This is an increase in value over 1918 of 198.6 per cent and an advance in average price per ton of $3.99. Drain tile also advanced in value from $565,398 in 1918 to $737,124 in 1919, an increase of $171,726 or 30.3 per cent.

The rise in production was not maintained during 1920, only one producer reported 100 per cent normal business; others reported better sales but inability to meet demands due to coal and labor scarcity; and others report business in the brick industry as very dull. However, the value of the brick and tile products was greater than ever in the history of the industry.

Scarcity of coal and labor and the transportation difficulties are responsible for both the decrease in production and increase in price. Decrease in the production of drain tile is ascribed to "Scarcity of labor to lay drains," although the percentage decrease in drain tile production is much less than for other products. The production of common brick was 186,526,000 valued at $3,062,660, a decrease of 13,826,000 brick or 6.9 per cent in quantity but an increase of $328,157, or 12 per cent in value. The average price for common brick in 1920 was $16.42 per thousand. The production value of drain tile decreased from 68,967 tons valued at $737,124 in 1919 to 69,225 tons valued at $690,816 in 1920.

In 1921 the total value of brick and tile products decreased by $1,063,772 or 26.7 per cent from $3,979,691 in 1920 to $2,915,919 in 1921. Common brick showed a slight decrease in quantity (3.6 per cent), production being 193,730,000 brick valued at $2,417,809, a decrease in value of $644,851 or 21.05 per cent. The decrease in value is due to the decrease in average price per thousand, from $16.42 (in 1920) to $12.47. The value of drain tile decreased 44.7 per cent from $690,816 to $381,507; hollow building tile shows the greatest decrease in value, the decrease being from $25,486 in 1920 to $8,209 in 1921, a decrease of 67.7 per cent; production of vitrified brick was not reported.

In 1922 the total value of brick and tile products increased by $999,391, or 34.3 per cent, thus recovering from the decrease in 1921 to a total value of $3,915,310, which was but little less than the maximum value of $3,979,691 reported in 1920. The production of common brick which for 1922 includes a small amount of face brick, showed a gain of 54,878,890 brick or 28.3 per cent over the 1921 production, and an increase in value of $1,195,733, or an increase over the 1921 value of 49.5 per cent. The average price per thousand increased from $12.47 in 1921 to $14.53 in 1922. The value of drain tile showed a large decrease, from $381,507 in 1921 to $169,419 in 1922, or a decrease of 44.4 per cent, continuing a steady decline which began in 1919.

In 1923 the total value of brick and tile products showed a decrease of $192,292. This decrease was due to a decrease in the amount and value of brick; other items show an increase in amount and value. The average price per thousand decreased from $14.53 to $14.36 or 17 cents. The value of drain tile which decreased sharply in 1922 increased again in 1923 by $168,414,

reaching a value of $337,833. This figure approximates an average figure for drain tile since 1902 and shows that the marked decrease in 1922 was not caused by permanent factors.

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 produced in the State are made in this vicinity. The growth of Detroit westward, 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 is 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 1920 the Grand Ledge plant reported the production of face brick.

Other brick and tile products are hollow building tile, faience tile, sewer tile, sewer pipe, fire brick, conduits, flue lining and wall capping. In 1917 a plant was projected at Williamston, Ingham County, to utilize Coal Measure shales but it did not materialize.

ANNUAL PRODUCTION OF BRICK AND TILE PRODUCTS IN MICHIGAN, 1899-1923.

Year.	Common brick. ‡		Average price per M.	Vitrified Brick Average price per M.	Drain tile.	Fire-proofing.	Miscellaneous. †	Hollow building tile or blocks.	Rank of state.	No. of firms operating.	Total value.
	Quantity.	Value.			Value.	Value.	Value.	Value.			
1899	200,144,000	$933,176	$4.66	.....	$140,171	$5,900	$22,709	.....	13	196	$1,254,256
1900	180,892,000	863,250	4.77	$12.42	114,747	2,350	406	.....	17	189	1,147,378
1901	215,836,000	1,095,254	5.07	12.30	98,972	1,880	637	.....	14	180	1,497,169
1902	237,254,000	1,331,752	5.61	12.26	96,645	3,290	.....	.....	13	182	1,660,942
1903	215,791,000	1,251,572	5.80	13.27	129,028	.....	.....	$19,138	14	178	1,662,414
1904	205,196,000	1,116,714	5.44	13.28	208,088	.....	.....	8,680	14	168	1,670,892
1905	211,556,000	1,152,505	5.45	13.37	205,445	†	.....	3,585	16	154	1,719,746
1906	206,583,000	1,178,202	5.70	13.13	314,098	.....	.....	4,290	15	142	1,793,367
1907	200,817,000	1,181,015	5.88	11.96	289,868	.....	1,500	6,386	17	136	1,786,190
1908	181,049,000	994,525	5.49	12.43	327,630	4,100	40,100	.....	16	132	1,666,381
1909	219,830,000	1,250,787	5.69	12.34	364,006	†	66,128	.....	16	122	1,947,659
1910	232,551,000	1,363,316	5.86	12.83	348,305	.....	.....	.....	15	118	1,883,525
1911	252,465,000	1,301,998	5.16	14.00	313,072	.....	228,530	†	15	111	1,953,442
1912	271,189,000	1,592,283	5.87	13.94	387,945	1,451	235,459	†	13	101	2,350,666
1913	273,571,000	1,626,287	5.94	14.71	415,543	†	350,000	†	13	95	2,451,242
1914	269,154,000	1,633,216	6.67	15.59	421,941	3,752	234,280	†	10	90	2,434,872
1915	277,399,000	1,461,188	5.23	14.50	305,156	10,850	49,755	†	11	82	2,248,068
1916	279,173,000	1,856,587	6.65	14.78	548,795	2,492	216,265	.....	13	73	2,705,654
1917	236,612,000	1,882,042	7.95	17.16	734,042	.....	29,996	4,621	12	69	2,846,264
1918	94,746,000	915,599	9.65	15.23	565,398	.....	73,511	†	12	61	1,708,736
1919	200,352,000	2,734,563	13.64	19.43	737,124	89,147	132,844	6,901	.....	.....	3,699,929
1920	186,526,000	3,062,660	16.42	18.21	690,816	†	200,729	25,486	.....	.....	3,979,691
1921	193,730,000	2,417,699	12.47	.....	384,507	.....	108,394	8,209	.....	.....	2,919,919
1922	248,608,800	3,613,542	14.53	.....	169,419	.....	126,435	5,913	.....	.....	3,915,310
1923	193,350,653	2,775,925	14.36	.....	337,833	.....	609,259	.....	.....	33	3,723,018
Total	5,484,369,553	$40,585,767			$8,645,494						$56,821,470

†For 1919 includes also vitrified brick, sewer pipe, faience tile; in 1920 includes also face brick, faience tile, sewer pipe; and in 1921 includes faience tile, sewer pipe and other.
‡For 1922 includes face brick.

SHALE

Shale is quarried near Cold water and Union City, Branch County; at Paxton, Alpena County; one mile south of Ells worth, Antrim County; near Corunna, Shiawassee 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 Corunna, Shiawassee 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. Formerly shale was quarried at Flushing, Genesee County, for vitrified brick and for use in the manufacture of Portland cement.

For several years a project was 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. Plans are being contemplated for constructing a plant near East Jordan to utilize the shale beds in that vicinity.

The shale beds at Grand Ledge, Flushing, Jackson, and Corunna belong to the Coal Measures. The beds vary from soft white, or light gray shale to compact, dark, or black bituminous shale. Probably further tests will show that some of the beds are suitable for other products than these 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 shale and huge balls of iron carbonate and dolomite. The shale beds at Ellsworth belong to the Bedford formation, 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 show that this shale is suitable for a variety of purposes. Other exposures of the Antrim shale occur in Antrim, Charlevoix, Cheboygan, and Alpena Counties, notably at East Jordan, Chestonia, and Boyne City, near Afton, Walloon Lake, and Central Lake, along the shore of Lake Michigan south of Norwood, and at Paxton.

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 White Rock, 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 and Rogers, and some miles northeast of Posen, Presque Isle County. At Rockport the Bell shale forms the floor of the limestone quarry. The shale is. soft, bluish, and in places highly calcareous. Probably it will be found to be suitable for the manufacture of Portland cement, though the high lime content probably makes some of the beds 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 Company, Charlevoix County. Another bed of shale occurs at the surface about one mile southwest. The burning qualities of the deposits at Ellsworth, Chestonia, and Boyne City have been thoroughly investigated and the results are promising. Tests have also been made on most of the other deposits. The results are to appear in a forthcoming report on the clay and shale resources of the State.

Unfortunately most of the larger and more promising deposits of shale occur in the northern part of the

Southern Peninsula, relatively distant from large markets or from means of cheap transportation.

CLAY

Pure clay is a fine grained material usually derived from weathering action on the crystalline rocks but often moved from its place of origin and deposited as a sediment. It is earthy when dry, plastic when wet, and is composed chiefly of hydrous aluminum silicates but with a large variety of other minerals present in small amounts. Its characteristic reaction to heat is to become rock-hard at a red heat, and with higher temperatures to undergo incipient fusion, vitrification, and finally fusion. The nature of clays is greatly affected by the agents of transportation which carry them to basins of deposition and in Michigan there is a great variety of clays because of the varied conditions of transportation and deposition 'which accompanied the advance and retreat of the ice of the glacial period. All of the clays of the State were so modified that they must be called glacial clays, although some were not deposited directly by the ice but were carried in glacial streams and deposited in the quiet basins of lakes or the flood plains of rivers. The greatest effect on the composition of the glacial clays was by the addition of finely powered sedimentary rocks of Paleozoic age which were ground up by the over-riding glacier ice and worked into the glacial sediments. This caused an addition of considerable material that is more or less soluble and in this State a high percentage of carbonates is especially noticeable. Much of the clay material is found in the terminal and ground moraines as a direct deposit of the ice, and as there has been no sorting of this material by water transportation and deposition there is a mixture of pebbles, boulders, sand, and clay, which is termed boulder clay. In places the boulders and pebbles are lacking and the clay was used extensively in pioneer days for brick making. The high content of carbonates, however, results in a brick of very light color and usually with a grayish cast which is not desirable for building brick. The brick has a low crushing strength, so that the brick yards which were started in morainal clays have very largely succumbed to the competition resulting from modern transportation facilities. In some parts of the State these morainal clays can still be utilized to advantage, because of the high freight rates on the imported brick and the ever increasing value of lumber. Brick manufacture from morainal clays is expensive because of the constant care which must be taken to eliminate pebbles, sand, and organic matter, the distribution of which is so irregular that it cannot be determined except by actual opening up of the deposit. These undesirable materials are liable to appear at any time in a face which started in an uncontaminated clay. Fortunately large amounts of the glacial clays were transported by water and deposited in the glacial lakes. These are called lake clays. In the process of transportation they lost some of the more soluble constituents such as the carbonates and were sorted when the water stream carrying them entered the quiet waters of the lake, the coarse particles having been quickly dropped near the shore as the current was retarded while the extremely fine particles of clay material were held in suspension for a considerable time and settled to the bottom, slowly forming broad sheets of clay uncontaminated by coarse sand or pebbles, and without much included organic material. In the shifting of the drainage system which accompanied the changes of the ice front the lake clays were undoubtedly often reworked, and it is reasonable to suppose that with each working over of the material by running water more of the carbonates would be removed by solution. At any rate these lake clays in some places are found to be very low in carbonates and are a commercial clay of a good grade for brick, tile, and coarse pottery manufacture. These clays are usually thin but in places they occur in beds over fifty feet in thickness and sometimes their thickness even exceeds a hundred feet. It has been found that in general the upper layers are more free from carbonates than the lower layers. This is a result not only of the reworking of these clays as noted above, but of a leaching of the uppermost beds which is made possible by openings in the clay caused by the penetration of the clay by plant roots, frost cracks, and similar wedging agencies. The proof of a solution of the carbonates can often be found in a layer containing carbonates in the form of concretions three feet or less from the surface. This layer often marks the lower limit of commercial clay, but in the case of reworked clays, beds of commercial grade may be found at lower levels.

These lake clays are found over broad areas bordering the Great Lakes, their distribution indicating the approximate area of some of the ancient glacial lakes which flooded the land surface during intervals when the outlets were clogged by ice or by glacial debris. The largest areas are in the western part of the Upper Peninsula in the vicinity of Keweenaw Point, in the eastern part in the vicinity of Sault Ste. Marie; in the Lower Peninsula east of Mackinaw City, in the country bordering Saginaw Bay, and in the lowlands along the lake and river shores from the tip of the Thumb District south to the State line. They are not extensively exposed anywhere on the shore of Lake Michigan.

As far as known there are no deposits of kaolin or china clay within the State and discoveries of this kind of clay are not expected because of the disturbance and reworking of residual deposits by the glacial ice. There is a very light colored slip clay that is found in the western part of the glacial lake basins bordering the Lake Superior Basin and is sometimes mistaken for kaolin. This clay, which is mined at Ontonagon, has a low fusion point and is shipped to Ohio and other states for glazing purposes. With the exception of this clay at Ontonagon the clays of Michigan are mined at or near the plants which utilize them so they are not extensively stocked or shipped. The shales of the Saginaw Formation which can be used for brick and tile manufacture when they are free from overburden are discussed under the topic shales. The production of clay

given in the following table includes only the clay which was marketed in the raw state. When the clay is worked and burned by the same company the production is given as that of the finished product in tables of production for brick and tile and pottery.

PRODUCTION OF CLAY IN MICHIGAN, 1910-1923.

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	193
1917	2,153	8,824	†	†	.....	.....	5,746	13,627
1918	1,236	4,639	†	†	†	†	2,359	6,373
1919	568	2,123	.....	.....	†	†	568	2,123
1920	505	2,249	.....	.....	4,561	9,046	5,066	11,295
1921	484	2,047	.....	.....	208	308	692	2,355
1922	†	†	†	†	.....	.....	1,653	4,852
1923	†	†	.....	.....	†	†	3,617	11,903
Total	.....	.....	.....	.....	.....	.....	.....	$96,242

†Included in total.

POTTERY

The pottery industry in Michigan has made almost uninterrupted growth since 1899, and after 1908 the growth was rapid, increasing over 4,054 per cent in 12 years, the main increase being in the period 1916-1920. In 1899 the total value of the pottery output was $29,741; in 1908, $62,409; in 1919, $2,096,874; and $2,592,625 in 1920. The increases were largely due to the greatly increased output of porcelain electrical and sanitary supplies and porcelain and decorated ware. In 1921 value decreased to $1,781,923, a decrease of $810,702, or 25.1 per cent, and in 1922 there was a decrease to $1,337,000 or 33.3 per cent.

In 1923 the total value of pottery increased by over 110 per cent in spite of the fact that two firms reported no returns, saying that the amount of business done by them was negligible.

Clays used for the manufacture of flower pots are obtained in Michigan. Two firms reported business for 1923. Other articles are manufactured from clays imported from other states and include such varied products as spark plugs, sanitary ware, white ware, saggers, and filter stones. A very little decorative pottery is also made.

VALUE OF POTTERY PRODUCTS IN MICHIGAN, 1899-1923.

Year.	Rank of State	No. firms.	Red earthenware value.	Miscellaneous value.††	Total value.	Gain per cent.	Per cent of total product in U. S
1899	18	4	$29,641	.....	$29,741	.....	.17
1900	17	4	34,317	.....	34,317	15.4	.17
1901	16	5	42,465	$2,400	44,865	30.2	.20
1902	14	4	44,098	39,000	83,098	87.4	.41
1903	19	4	42,007	6,000	48,007	−42.2	.19
1904	17	4	40,621	3,000	43,621	−9.1	.17
1905	17	5	.....	7,000	45,961	4.5	.16
1906	17	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	1.5	.25
1909	13	5	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	3	106,452	†	265,194	33.0	.75
1915	8	6	112,863	†	521,989	96.7	1.46
1916	8	7	133,734	668,982	797,716	51.8	1.64
1917	8	8	†	13,722	1,187,981	49.9	2.12
1918	6	8	†	88,842	1,976,436	66.3	3.00
1919	.....	8	†	12,708	2,096,874	6.1	.....
1920	.....	8	.....	16,848	2,592,625	23.5	.....
1921	.....	.....	138,055	1,643,868	1,781,923	−35.1	.....
1922	.....	.....	38,000	1,299,000	1,337,000	−33.3	.....
1923	.....	9	†	†	1,810,619	110.2	.....
Total	.....	.....	.....	.....	$16,623,711	.....	.....

†Included in the total.
††1920 includes art pottery, clay pipes and filter stones, 1921 and 1922 includes white ware, sanitary ware, porcelain electric supplies, and other miscellaneous ware.

COAL

The maximum output of coal, 2,035,858 tons, was reached in 1907. Following 1907 a rapid decline set in and continued until 1912, when production was only 1,201,230 tons. Production remained practically stationary until 1917, when it increased to 1,374,805 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.

†PRODUCTION AND VALUE OF COAL IN MICHIGAN, 1900-1923.

Year.	Number active mines.	Total tons of coal mined. Excluding that used for steam and heat.	Total tons of coal mined.	Total value of coal mined.	Average price received per ton.
1900	31	871,388	849,475	$1,259,683	$1.483
1901	30	1,016,496	1,241,241	1,753,064	1.412
1902	32	899,967	964,718	1,653,192	1.714
1903	34	1,661,984	1,367,619	2,707,527	1.979
1904	33	1,408,375	1,342,840	2,424,935	1.806
1905	38	1,413,307	1,473,211	2,512,697	1.705
1906	38	1,367,385	1,346,338	2,427,404	1.803
1907	37	1,911,201	2,035,858	3,660,833	1.798
1908	38	1,842,778	1,835,019	3,322,904	1.811
1909	36	1,736,573	1,784,692	3,199,351	1.793
1910	34	1,462,276	1,534,967	2,930,771	1.909
1911	32	1,389,585	1,476,074	2,791,461	1.891
1912	26	1,160,768	1,201,230	2,399,451	1.989
1913	24	1,138,163	1,231,786	2,455,227	1.993
1914	23	1,153,869	1,283,030	2,559,786	1.99
1915	20	1,069,798	1,156,138	2,372,797	2.05
1916	18	1,076,215	1,180,360	2,653,182	2.25
1917	22	1,393,180	1,374,805	4,426,314	3.22
1918	25	1,520,883	1,468,818	5,615,097	3.83
1919	22	971,603	996,545	3,864,228	3.87
1920	18	1,373,616	1,489,765	7,346,000	4.93
1921	15	1,125,156	1,141,715	5,555,000	4.87
1922	14	822,441	929,390	4,693,376	5.05
1923	15	1,086,198	1,172,075	5,545,000	4.73

†From Mineral Resources. U. S. Geological Survey.

PRODUCTION OF COAL IN MICHIGAN, 1860-1923, IN SHORT TONS.

Year.	Quantity. Tons.	Year.	Quantity. Tons.	Year.	Quantity. Tons.	Year.	Quantity. Tons.	Year.	Quantity. Tons.
1860	2,320	1873	56,000	1886	60,434	1899	624,708	1912	1,164,973
1861	3,000	1874	58,000	1887	71,461	1900	849,475	1913	1,138,639
1862	5,000	1875	62,500	1888	81,407	1901	1,241,241	1914	1,283,030
1863	8,000	1876	66,000	1889	67,431	1902	964,718	1915	1,156,138
1864	12,000	1877	69,197	1890	74,977	1903	1,367,619	1916	1,180,360
1865	15,000	1878	85,322	1891	80,307	1904	1,342,840	1917	1,374,805
1866	20,000	1879	82,015	1892	77,990	1905	1,473,211	1918	1,464,818
1867	25,000	1880	100,800	1893	45,979	1906	1,346,338	1919	996,545
1868	28,000	1881	112,000	1894	70,022	1907	2,035,858	1920	1,489,765
1869	29,080	1882	135,339	1895	112,322	1908	1,835,019	1921	1,141,715
1870	28,150	1883	71,296	1896	93,882	1909	1,784,692	1922	929,390
1871	32,000	1884	96,712	1897	223,592	1910	1,534,967	1923	1,172,075
1872	33,600	1885	45,178	1898	315,722	1911	1,476,074		

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 re-opened, in Saginaw and Shiawassee Counties. Production reached 15468,818 tons. In November of 1918, however, Michigan coal was not in demand and the mines operated but half time.

The coal strike of 1919 closed most of the mines and those not affected by the strike order did not operate full time. Partial settlement of the strike caused the mines to be reopened early in July of 1919 and they operated full time until November 1, when all the mines went on strike. During 1919 two new shafts were opened, one two miles east of Corunna in Shiawassee County, and the other three miles west of Jackson, Jackson County; two mines suspended operations, and three were abandoned. Production in 1919 decreased to 996,545 tons valued at $3,864,228; and in 1920 production increased by 49.5 per cent to 1,489,765 tons valued at $7,346,000, the highest value attained by Michigan's annual coal output. In 1921 production again declined, 1,141,715 tons being mined, and having a value at

$5,555,000. This was followed in 1922 by a further sharp decline to 929,390 tons mined, valued at $4,693,376. The price received per ton partly offset the decline from 1921 to 1922. The average price per ton in 1921 was $4.87 but increased in 1922 to $5.05. The mining cost decreased from an average of $4.43 in 1921 to an average of $3.85 in 1922. The average profit derived from these figures is $1.20 per ton in 1922 which is the highest reported profit from Michigan coal mines. The cost figures, however, do not include depreciation, interest on investment, etc., hence the profit factor is considerably less than indicated. The year 1923 saw an increase to 1,172,075 tons of coal produced, valued at $5,545,000 or at an average price of $4.23 per ton.

LIMESTONE†

HISTORY

The development of the limestone industry in Michigan began almost with its first settlers, the French. The strategic military points around the Straits of Mackinac and the mouth of St. Marys River were in the vicinity of extensive exposures of limestone rocks. The trails from Toledo to Detroit passed directly across the limestone exposures in Monroe County.

Quarrying limestone and burning lime for the construction of fortifications and buildings were logical industries in these localities. The slow settlement and development of the State, the limited markets, and poor interior transportation facilities tended, however, to retard the early development of the limestone industry except in a few favored localities. By 1850 burning lime and quarrying of building stone were flourishing industries in Monroe County. The chief centers were in the vicinities of Monroe and Dundee, especially along Plum Creek and near the mouth of Macon River. Detroit was the principal market but Monroe lime, which enjoyed a reputation for good quality, was shipped to many other parts of the State. Other small centers of lime burning were in the vicinity of Bellevue, Eaton County; and Jackson, Jackson County. The great distance of the deposits in the northern part of the State from markets prevented their early development, but here and there quarries were operated for burning lime or producing building stone chiefly for local needs. Later with the settlement of the State and with improvement in lake and railroad transportation facilities lime burning became a thriving industry around Thunder and Little Traverse bays, where there are extensive deposits of limestone. Large quarries were opened on Drummond Island to furnish block stone for use in building the first locks of the present group at Sault Ste. Marie.

Wood was used in burning lime. With the exhaustion of cheap wood fuel and competition from lime from northern Ohio, the lime burning industry in Monroe County gradually died out. The industry in the other centers also died out with the gradual exhaustion of cheap wood fuel supplies. At the present time there are no commercial lime kilns south of the Little Traverse Bay region. The lime burning industry is now confined to the northern portions of the State where there are still supplies of wood fuel, chiefly wastes from timber industries. The industry, however, has declined even in this part of the State, chiefly because of the growing scarcity of cheap wood fuel and competition from Portland cement and from gypsum building materials.

The production of limestone block for building purposes never became an important industry. This was due chiefly to the variable character and quality of the limestone beds, which made it difficult to produce a uniform product without excessive quarry waste.

The real growth of the limestone industry in Michigan followed the rapid growth of the cement industry, which occurred between 1899 and 1903. The growth of the limestone industry lagged behind that of the cement industry in Michigan because in the early days marl was used rather than limestone in the manufacture of cement. Gradually limestone was substituted for marl until only a few cement plants in Michigan now use marl. A large amount of limestone is used in the manufacture of cement, and in concrete aggregates. The industry received another impetus from the discovery near cheap water transportation of large deposits of pure limestone especially adapted for blast furnace flux and other purposes requiring a pure limestone. A third impetus came from the initiation of a state-wide program of road building requiring large quantities of both cement and crushed stone. A steady growth in the chemical industries using large quantities of limestone products has also helped to increase the growth of the limestone industry.

In 1901 Michigan was twelfth among the states in value of its limestone output, but by 1910 it had climbed to ninth place, and in 1920 to fourth place. It fell back, however, to seventh place in 1923, not because of a decline in production but because of higher average prices obtained in rival states. In quantity it was second in 1920 and a close third in 1923.

CHARACTER AND OCCURRENCE

Most of the commercially important limestone deposits of Michigan occur in two belts, one extending around the northern part of the Southern Peninsula from Little Traverse Bay eastward to Thunder Bay, and the other in the Northern Peninsula extending from Menominee eastward along the north shores of Lake Michigan and Lake Huron into Ontario. A large amount of siliceous and slaty magnesian limestone, partially marbleized, occurs in the iron bearing districts of the western part of the Northern Peninsula, but these limestones appear to be of limited economic importance. South of the Little Traverse and Thunder Bay belt, deposits of limestone are relatively few and scattered, and only three or four are of any considerable commercial importance.

In Charlevoix, Emmet, Cheboygan, Presque Isle, and Alpena Counties of the Southern Peninsula, and in

Menominee, Delta, Schoolcraft, Luce, Mackinac, and Chippewa Counties of the Northern Peninsula there are many exposures of pure limestone, and hundreds of exposures of pure dolomite, of commercial quality. The few commercially important deposits of limestone south of the Little Traverse-Thunder Bay belt are in Arenac, Huron, Wayne, Monroe, and Eaton Counties. There are several exposures of limestone in the vicinity of Jackson, but the deposits appear to be patchy and very thin and of little commercial importance.

The limestones in the Northern Peninsula are largely dolomite or high magnesian limestone, but there is one series of beds which is chiefly pure limestone. The exposures of magnesian limestones of the Northern Peninsula occupy a belt generally 10 to 15 miles wide along the northern shores of Lake Michigan and Lake Huron, from Green Bay to Marblehead, Drummond Island. The exposures of pure limestone are unfortunately inland, forming a narrow belt immediately north of the belt of high magnesian limestone deposits. The inland position of the deposits of pure limestone make them of much less economic importance than they would be were they near lake transportation.

The limestones of the Little Traverse-Thunder Bay belt are generally low in magnesia, though here and there high magnesian beds occur. Shales and shaly and siliceous limestones are associated with the pure limestones, especially at certain horizons. Many of the larger deposits of limestone are near lake transportation. The pure limestones are suitable for most purposes requiring high calcium limestone and most of the siliceous and argillaceous limestones are adapted for use in the manufacture of Portland cement.

The predominance and extent of low magnesian limestones, and the proximity of many of the deposits to lake transportation give great economic importance to this belt. These two factors account for the great development of the limestone industry in this part of the State and undoubtedly will continue to make this the principal limestone producing district in Michigan for an indefinitely long period.

DEVELOPMENT AND USE

The chief developments in the Southern Peninsula are near Rogers, Presque Isle County; Alpena and Rockport, Alpena County; Petoskey, Emmet County; Afton, Cheboygan County; Bayport, Huron County; and Sibley, Wayne County; in the Northern Peninsula, near Trout Lake and Ozark, Mackinac County; Blaney and Manistique, Schoolcraft County; and Escanaba, Delta County. Important quarry operations were formerly carried on at Charlevoix, Charlevoix County. Recently a large quarry at Hendricks, Mackinac County, was closed indefinitely.

Most of the important deposits near water have been developed or acquired by present operating companies or by limestone using concerns. Important undeveloped deposits near water transportation occur near Norwood and Charlevoix, Charlevoix County; Mackinaw City, Cheboygan County; and at El Cajon Beach about seven miles northeast of Alpena, Alpena County; on Adams Point and near Twin Lakes and Rogers, Presque Isle County.

The inland limestone deposits of the Little Traverse-Thunder Bay belt are very large and numerous, but the only important inland quarry is at Afton, Cheboygan County. Very extensive undeveloped deposits of pure limestone also occur in this vicinity and also at Rogers, Presque Isle County. The interior deposits of undeveloped limestone in Alpena and Presque Isle Counties are practically inexhaustible. South of the Little Traverse-Thunder Bay belt undeveloped deposits of pure limestone occur near Omer, Arenac County; on Heisterman's Island, Huron County; and near Dundee, Monroe County.

Practically inexhaustible deposits of very pure high magnesian limestone or dolomite occur near the lake shore between Seul Choix Point, Schoolcraft County, and Drummond Island, Chippewa County. These dolomites, because of their purity and porosity, are especially adapted for paper manufacture by the sulphite process. They are also suitable for lining furnaces. The only development of this stone is at Ozark, Mackinac County. The limestone in Monroe County is largely impure dolomite, suitable chiefly for concrete, road material, and ballast.

The limestone in the vicinity of Rogers and Twin Lakes, Presque Isle County, averages very high in calcium, low in magnesia, and exceptionally low in silica and alumina. This makes it especially adapted for flux in smelting iron and other ores, for which it is extensively used. The limestone produced elsewhere is generally considerably higher in silica; therefore is not so well adapted for fluxing purposes. More than half of the total production of limestone in the State is sold for flux. A large part of the remainder of the output is used in the alkali industries, the manufacture of Portland cement, calcium carbide, the clarification of sugar, etc. Siliceous and shaly limestones and "fines" or screenings are used extensively in the manufacture of Portland cement. A large tonnage of the harder varieties of limestone are utilized for road building and concrete construction especially in localities deficient in good sand and gravel.

The production and value of limestone in 1923 were the greatest in the history of the industry. The increase was due chiefly to an increase of 1,600,400 tons in the production of flux stone, 434,880 tons of stone for concrete aggregates, and 768,170 tons for the manufacture of alkali products. The increases or decreases in the other stone products were of minor importance.

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

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1899-1923.

Year.	Crushed stone.						For blast furnace flux.		To sugar factories.		To alkali works.	
	Road making.†		Railroad ballast.		Concrete.							
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
1899	.....	.....	.....	.....	.....	.....	.....	$27,512	.....	.....	.....	.....
1900	.....	.....	.....	.....	.....	.....	.....	3,300	.....	.....	.....	.....
1901	.....	$31,605	.....	$18,200	.....	$75,643	.....	13,488	.....	.....	.....	.....
1902	.....	56,261	.....	40,810	.....	49,430	.....	32,246	.....	.....	.....	.....
1903	.....	61,342	.....	35,340	.....	48,504	.....	15,502	.....	.....	.....	.....
1904	.....	58,655	.....	57,100	.....	60,745	.....	62,586	.....	.....	.....	.....
1905	.....	112,113	.....	43,649	.....	107,396	.....	109,883	.....	.....	.....	.....
1906	.....	78,437	.....	103,442	.....	61,852	.....	81,517	.....	$224,356	.....	.....
1907	.....	131,708	.....	46,516	.....	97,762	.....	109,429	.....	22,234	.....	.....
1908	.....	182,510	.....	33,900	.....	73,200	.....	56,841	.....	32,594	.....	.....
1909	.....	132,902	.....	42,445	.....	112,829	.....	91,915	.....	25,845	.....	.....
1910	.....	110,184	.....	42,358	.....	178,318	.....	100,149	.....	69,047	.....	.....
1911	224,307	113,574	91,713	34,998	306,385	137,283	341,027	186,046	.....	65,141	.....	†
1912	603,553	295,449	54,327	28,368	185,423	97,298	295,941	137,812	.....	36,944	.....	$508,044
1913	532,311	266,316	116,000	48,400	292,616	145,965	1,202,817	494,495	.....	38,215	.....	329,961
1914	505,133	242,839	38,000	20,600	362,209	166,959	1,604,340	565,012	.....	69,477	.....	269,087
1915	482,262	194,970	60,159	19,640	398,948	217,304	2,254,984	763,629	.....	46,143	.....	481,759
1916	834,215	420,467	186,949	57,950	323,479	155,084	3,033,155	1,267,326	.....	41,709	.....	438,783
1917	736,937	344,970	182,375	90,560	418,403	244,648	3,575,178	1,633,965	.....	37,004	.....	787,760
1918	591,781	251,265	†	†	389,176	261,877	4,289,389	2,992,179	.....	†	.....	1,697,251
1919	548,463	321,777	†	†	508,107	273,085	3,585,440	1,857,686	.....	.....	.....	654,632
1920	688,090	460,369	154,050	122,060	884,820	578,039	4,890,400	2,963,095	.....	.....	.....	1,031,251
1921	.....	.....	37,090	28,752	1,265,690	889,937	2,422,950	1,275,880	.....	124,678	.....	543,994
1922	.....	.....	38,300	33,024	1,024,110	662,781	4,812,850	2,390,692	62,070	75,961	1,177,780	842,131
1923	.....	.....	144,280	122,648	1,459,090	1,033,883	6,413,200	3,129,104	††	††	1,945,950	953,485
Total	.....	$3,876,713	.....	$1,071,660	.....	$5,739,734	.....	$20,200,569	.....	$909,948	.....	$7,030,042

†Included under concrete after 1920.
††Included in total.

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1899-1923—Concluded.

Year.	To paper mills.		Fertilizer.		Other purposes. ‡		Number of plants.	Rank of state.	Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.		Value.	Tons.	Value.
1899	.....	.....	.....	.....	.....	$2,375	.....	.....	.....	$281,769
1900	.....	.....	.....	.....	.....	124,230	.....	12	.....	330,847
1901	.....	.....	.....	.....	.....	101,399	.....	12	.....	429,771
1902	.....	.....	.....	.....	.....	68,164	.....	13	.....	413,148
1903	.....	.....	.....	.....	.....	4,747	.....	14	.....	390,473
1904	.....	.....	.....	.....	.....	5,333	.....	10	.....	501,768
1905	.....	.....	.....	.....	.....	142,790	.....	12	.....	544,754
1906	.....	.....	.....	.....	.....	.....	.....	10	.....	656,269
1907	.....	.....	.....	.....	.....	278,297	.....	11	.....	766,333
1908	.....	.....	.....	.....	.....	253,990	.....	9	.....	669,017
1909	.....	.....	.....	.....	.....	327,571	.....	11	.....	750,589
1910	.....	.....	.....	.....	.....	299,305	.....	9	.....	842,126
1911	.....	$12,558	.....	$2,003	.....	440,857	.....	8	.....	1,003,751
1912	.....	8,150	.....	3,447	.....	13,596	.....	8	.....	1,139,560
1913	.....	10,723	.....	7,048	.....	395,874	.....	7	.....	1,409,793
1914	.....	8,307	10,907	11,164	.....	39,523	.....	8	.....	1,457,961
1915	.....	8,620	.....	9,746	.....	31,529	.....	7	.....	1,828,766
1916	.....	11,827	.....	11,088	.....	39,896	.....	6	.....	2,389,763
1917	.....	24,097	62,027	58,148	.....	97,129	.....	5	.....	3,320,895
1918	.....	25,153	160,016	150,604	.....	284,649	.....	3	.....	5,186,467
1919	.....	45,706	.....	.....	.....	678,936	18	5	.....	3,797,522
1920	.....	81,718	170,460	191,146	.....	514,651	24	5	.....	5,943,229
1921	.....	77,850	285,960	201,251	.....	245,400	24	6	.....	3,387,722
1922	50,520	79,438	218,360	211,192	259,440	235,895	.....	.....	7,646,550	4,533,998
1923	110,300	147,909	164,700	108,554	351,370	353,066	.....	.....	10,589,070	5,848,649
Total	.....	$542,056	.....	$1,205,686	.....	$4,979,187	.....	.....	.....	$47,820,191

†Included in total.
‡Includes rubble and limestone for glass, and sugar factories and, when not given separately, railroad ballast, marl, and agricultural limestone.

LIME

From 1904 to 1914 the lime industry made little or no growth, the production in those 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. In 1916 there was only a slight increase, the production being 86,447 tons. But the 1917 production increased 57.2 per cent over 1916, reaching 135,920 tons and the value increased 132 per cent to $892,682. This increase in production and value caused Michigan to advance from thirteenth place to seventh in rank in state production. In the production of chemical lime Michigan ranked third in quantity and second in value and produced over 14 per cent of the chemical lime used in the country at 16 per cent of the value. Michigan held sixth place in the amount of lime consumed.

In 1918 production decreased slightly, 0.8 per cent, but increased in value. Production in 1919 increased 8.1 per cent in quantity and 16.5 per cent in value, but decreased somewhat in quantity and increased in value in 1920, reaching the maximum value of $1,386,760 in the latter year.

The business depression of 1921 plus high cost of coal and high freight rates which closed markets for lime, caused Michigan to suffer more than any other State from the general decrease in lime production. The average decrease for the United States was 29.1 per cent, ranging from a decrease of 9.4 per cent in Massachusetts to 65.8 per cent in Michigan. Michigan's production was 48,164 tons valued at $445,386, decreases of 92,649 tons (65.8 per cent) in quantity and of $941,374 or 67.8 per cent in value. The production was the lowest since 1905 and Michigan dropped in rank from eighth to fifteenth place. Lime burned was sold for building, chemical, tanning, metallurgical, and fertilizer purposes, and to paper mills, sugar factories, and dealers. The greatest decreases were in the sale of lime for chemical and metallurgical purposes and to paper mills. In 1920 of the 28 kilns operating eighteen burned wood, one coal, and nine coke, but in 1921 wood was burned in the twenty-three kilns operating. Conditions were not much improved in 1922. A production of 53,635 tons valued at $484,945 was reported, an average price of $9.04. This was an increase over 1921 of 11.3 per cent in quantity and 11.2 per cent in value. In 1923, 59,629 tons were produced, valued at $612,369, an average price of $10.27 per ton.

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 buildings, (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 a 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 in 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 fuel and to the difficulties of transportation.

In 1919 the increase in production was for all uses of lime but particularly for building purposes. The slight decrease of 1920 was due to inability to supply the demand owing to shortage of labor and is shown in the production of lime for chemical works, for tanneries, and for metallurgy; and as stated above, the great decrease for 1921 was due to the closing of markets for the lime industry, and the general depression throughout the United States. The continuance of this condition permitted but little increase in production and value of lime in 1922 or 1923.

PRODUCTION AND VALUE OF LIME IN MICHIGAN, 1904-1923

Year.	Total lime		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
1919	145,783	1,381,534	9.48	7	6
1920	140,813	1,386,760	9.85	7	8
1921	48,164	445,386	9.24	6	15
1922	53,635	484,945	9.04	7	16
1923	59,629	612,369	10.27	7	18

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 convinced 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 brick made was 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 clay working industries, or were located near large cities which furnish a ready market for a limited production. The industry in the State therefore did not suffer from as large a proportion 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 bricks of all grades, valued at $69,765. In 1905, twelve plants produced 26,421,000 bricks, valued 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. A sharp decline began in August of 1917, due to the car shortage and, because of war-time conditions was continued during 1918, production dropping to 47,998,000 bricks of all classes in 1917 and to 22,564,000 bricks in 1918, the lowest production since 1904.

In 1919 the industry rallied and increased 88.6 per cent in quantity and 158 per cent in value. The increase in quantity was from 22,564,000 to 42,570,000 or 20,006,000 bricks and in value from $198,633 to $513,094. The increase in quantity was due to the resumption of building operations and the relatively larger increase in value was due to the increased demand and to increased cost of production. The production of 1919 was less than the maximum of 1916 by 29,434,000 bricks. Michigan continued the leading State in marketing sand-lime brick and produced 29 per cent of the quantity at 30 per cent of the value for the United States.

Although in 1920 the total production of sand-lime brick for the United States increased, the production in Michigan decreased to 39,280,000 bricks of all classes, a decrease of 3,290,000 bricks or 7.7 per cent. The value of $670,744 was an increase of $127,650 or 24.8 per cent and is the highest value recorded. The industry in 1920 was handicapped by the shortage and ineffiiency of labor and difficulties of transportation and in securing raw material. Despite the decreased production Michigan continued in first rank and produced 23 per cent of the total United States production at 26 per cent of the total value.

Since statistics for sand-lime brick were collected by the Bureau of the Census there has been considerable delay in securing production figures and details of the industry. In 1921 a production of 33,658,000 bricks of all classes valued at $403,929 is reported. The production value shows a decrease of $236,815 or 36.9 per cent when compared with the 1920 reports. In 1922 a production of 46,558,000 at $557,647 shows a gain of 38 per cent in value over the 1921 figure. In 1923, 64,650,000 valued at $777,693 show a gain of 39 per cent.

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 molding, producing a more shapely brick, or better methods of manufacture, producing a less easily crumbled brick, accounted for the increased demand, but the output quickly declined and at present no bricks other than common bricks are made by the sand-lime process.

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 bricks as any other State. The decided set back 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 operated in 1918. The increase in building operations caused one plant to be reopened and in 1919 and 1920 eight operators reported production. Plants are located in Detroit, Flint, Grand Rapids, Menominee, Rives Junction, Rochester, Sebewaing, and Saginaw.

ANNUAL PRODUCTION AND VALUE OF SAND-LIME BRICK IN MICHIGAN AND UNITED STATES, 1904-1923

Year	No. of operating firms reporting—Mich.	No. of operating firms reporting—U. S.	Michigan production. Common brick. Quantity (thousands).	Common brick. Value.	Average price per thousand.	Front brick. Quantity (thousands).	Front brick. Value.	Average price per thousand.	Fancy brick. Quantity (thousands)	Fancy brick. Value.	Total value Michigan.	Change per cent Michigan.	Total value United States.	Per cent of total production of U. S.	Rank. Production.	Rank. Value.
1904	10	57	9,886	$64,034	$6.64	580	$5,234	$9.02	19	$497	$69,765	....	$463,128	15.6	1	1
1905	12	84	24,841	155,883	6.28	1,577	12,898	8.17	24	526	169,302	142.7	972,064	17.4	1	1
1906	11	87	27,281	162,879	5.97	1,706	12,022	6.69	7	20	174,921	3.3	1,170,005	15.0	1	2
1907	13	94	25,488	158,606	6.22	†2,000	14,284	7.17	......	......	172,840	−1.2	1,225,769	14.1	1	1
1908	10	87	21,997	131,827	5.99	†900	6,982	7.76	......	......	138,809	−19.7	1,029,699	13.5	1	1
1909	11	74	34,217	207,082	6.05	†1,600	11,144	6.97	......	......	218,226	57.2	1,150,580	19.0	1	1
1910	10	76	37,648	218,627	5.81	3,256	22,022	6.76	......	......	240,649	10.3	1,169,153	20.5	1	1
1911	10	66	32,889	192,224	5.84	2,726	17,777	6.52	......	......	210,001	−12.7	897,664	23.4	1	1
1912	11	71	48,129	307,106	6.38	1,163	9,926	8.27	......	......	316,732	50.8	1,200,228	26.4	1	1
1913	12	68	49,373	315,882	6.40	‡	‡	......	‡	‡	321,245	1.7	1,238,325	25.9	1	1
1914	12	62	41,456	248,113	5.98	‡	‡	......	‡	‡	255,784	−24.4	1,058,512	23.5	1	1
1915	11	56	46,513	281,009	6.04	‡	‡	......	‡	‡	286,948	11.8	1,135,104	25.3	1	1
1916	12	53	71,116	491,866	6.92	888	7,845	8.83	......	......	499,711	74.14	1,474,073	33.8	1	1
1917	11	47	46,979	362,246	7.71	1,019	8,477	8.31	......	......	370,723	−25.8	1,420,330	26.1	1	1
1918	7	42	22,248	195,636	8.79	‡	‡	9.48	......	......	198,633	−46.4	883,929	22.5	1	1
1919	8	35	42,063	507,010	12.05	‡	‡	12.00	......	......	513,034	+ 8.67	1,705,163	28.6	1	1
1920	8	37	38,810	632,112	16.80	‡	‡	18.36	......	......	640,744	+26.0	2,490,283	23.1	1	1
1921	....	....	*33,658	....	....	....	....	....	......	......	403,929	−36.9	....	....	......	......
1922	8	....	*46,558	557,647	11.97	....	....	....	......	......	557,647	+38.0	....	....	......	......
1923	9	....	64,6:0	777,693	12.03	....	....	....	......	......	777,693	+39.4	....	....	......	......
Total	....	....	765,800	$5,967,482	....	....	....	....	......	......	$6,557,396	....	....	....	......	......

†Estimated.
‡Included in total.
*Includes common and front brick.

SAND AND GRAVEL

The sand and gravel resources of Michigan are inexhaustible. The most important deposits occur in the form of ridges known as "hogbacks" 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 soft limestone and is of low grade.

Only a small portion of the sand and gravel deposits in the State has 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 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 pebbles 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 is of inferior grade. The Marshall formation underlies much of Jackson, Calhoun, and Kalamazoo, 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 limestone in the northern part of the Southern Peninsula. However, few tests have been made to determine the better grades of gravel in these areas and belts.

Sand and gravel have been produced in greater quantities each year since 1918. In 1919 production was 3,772,535 tons valued at $1,994,143, and in 1920, 4,386,522 tons valued at $2,867,466 were produced. In 1921, reports total 5,515,253 tons valued at $2,916,917 and this was followed by a further increase in 1922 to a total production of 5,962,916 tons valued at $3,222,043, while in 1923 a much greater increase was indicated by the report of a total production of 9,601,562 tons valued at $5,096,071. From the tables it will be seen that there was a marked increase in all of the important kinds of sand and gravel production.

PRODUCTION AND VALUE OF SAND AND GRAVEL IN MICHIGAN, 1905-1923

Year.	Molding sand. Quantity.	Molding sand. Value.	Building sand. Quantity.	Building sand. Value.	Engine sand. Quantity.	Engine sand. Value.	Paving sand. Quantity.	Paving sand. Value.	Filter sand. Quantity.	Filter sand. Value.	Other sand.‡ Quantity.	Other sand.‡ Value.
	Tons		Tons		Tons		Tons		Tons		Tons	
1905	19,382	$13,247	263,315	$148,065	....	....	....	....	....	....	50,187	$14,476
1906	61,387	26,108	403,199	127,937	4,000	$400	....	....	....	....	51,005	12,140
1907	54,172	24,190	451,646	157,150	1,534	153	....	....	....	....	173,724	12,187
1908	4,584	2,892	474,238	228,395	1,991	319	....	....	....	....	29,187	6,850
1909	53,226	20,756	1,090,419	327,247	12,415	1,493	....	....	....	....	295,612	50,953
1910	93,812	24,004	1,151,588	334,346	22,270	2,172	....	....	....	....	372,880	57,385
1911	68,878	17,901	833,729	247,997	25,392	4,447	152,144	$29,650	....	....	114,801	52,005
1912	152,433	40,145	902,556	294,115	18,575	4,774	68,453	16,898	....	....	130,624	54,746
1913	50,763	17,493	1,326,016	415,737	4,447	647	533,261	108,328	....	....	113,318	20,342
1914	53,400	36,583	1,088,650	360,152	6,357	1,066	320,322	74,866	....	....	115,291	107,392
1915	82,666	25,998	843,887	236,956	70,077	2,794	131,466	14,021	....	....	111,105	12,248
1916	117,200	31,978	1,234,280	350,138	†	†	154,413	38,068	†	†	228,003	103,722
1917	147,256	52,686	782,305	433,546	4,096	1,103	136,214	49,669	....	....	94,227	41,267
1918	116,485	55,255	433,497	174,888	5,174	1,322	237,317	89,430	6,163	$3,048	135,502	28,301
1919	124,006	66,877	539,800	251,733	6,958	2,268	204,045	75,228	....	....	190,327	147,247
1920	239,439	179,754	789,495	482,081	5,547	2,943	460,438	254,723	....	....	213,851	28,879
1921	96,554	25,576	823,791	416,432	3,508	1,201	754,011	311,341	....	....	137,505	35,552
1922	147,546	40,862	858,764	445,970	†	†	731,933	342,499	....	....	61,887	152,424
1923	342,936	84,965	1,748,825	1,143,971	1,915	790	1,069,859	530,514	....	....	272,514	164,160
Totals	2,028,124	$787,270	16,040,000	$6,577,373	194,265	$27,892	4,953,276	$1,935,235	....	....	2,891,550	$1,302,275

†Included under other sand.
‡Includes furnace, filter, polishing, and glass sand.

PRODUCTION AND VALUE OF SAND AND GRAVEL IN MICHIGAN, 1905-1923—Concluded.

Year.	Railroad ballast. Quantity.	Railroad ballast. Value.	Gravel. Quantity.	Gravel. Value.	Total sand and Gravel. Quantity.	Total sand and Gravel. Value.	Rank. Quantity.	Rank. Value.
	Tons.		Tons.		Tons.		Tons.	
1905	....	....	76,625	$32,321	414,509	$210,609	10	11
1906	....	....	72,598	25,614	597,789	197,699	12	13
1907	....	....	329,407	81,182	1,024,641	289,595	10	11
1908	....	....	312,262	94,081	842,591	370,365	8	9
1909	....	....	695,902	200,523	2,219,757	685,632	8	8
1910	....	....	1,197,791	364,841	2,862,738	816,337	7	8
1911	....	....	935,072	203,218	2,185,165	565,969	9	10
1912	....	....	1,409,180	407,925	2,681,821	818,603	9	8
1913	....	....	3,928,874	915,205	6,422,818	1,528,892	4	5
1914	7,565	$781	2,140,359	530,338	3,757,979	1,143,771	8	7
1915	....	....	2,457,094	671,970	3,776,726	1,036,739	8	7
1916	....	....	2,226,878	726,033	4,407,475	1,295,717	7	7
1917	207,827	21,829	2,292,374	1,011,182	3,814,445	1,641,748	7	6
1918	161,552	18,314	741,681	869,316	2,837,371	1,239,874	8	9
1919	67,916	21,861	2,639,483	1,378,929	3,772,535	1,944,143	6	7
1920	233,816	61,672	2,444,006	1,658,414	4,386,582	2,867,466	8	6
1921	249,588	59,752	3,416,881	1,959,610	5,515,253	2,916,917	....	....
1922	484,112	208,311	3,507,567	1,992,232	5,962,916	3,222,043	....	....
1923	1,078,343	257,564	5,087,170	2,914,107	9,601,562	5,096,071	....	....
Totals	....	....	35,911,204	$16,270,959	67,084,673	$27,228,289	....	....

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 the 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.

The sandstone is exposed or is near the surface 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. Before developments at this place, the rock was exposed† or covered by a few inches of soil on an area of 8 to 10 acres and on an area of 60 acres the overburden is reported to be nowhere more than two or three feet thick.

There are no natural exposures of the Sylvania in Wayne County, but east of Rockwood in section 15, 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 Company east of Rockwood, Wayne County, and of the Ford Plate Glass Company, near Steiner, Monroe County, the sandstone formerly was 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 Company drilled a well just east of Rockwood (SE¼ SW¼ 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 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 Company, which operated them up to 1916 when its plant was burned down. The property was then sold to the Ford Plate Glass Company of Toledo, and a new plant was 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 free from iron and the washed product from some horizons contains only about .001 of one per cent of iron. In the quarry of the Rockwood Silica Company near Rockwood there are numerous masses of celestite (strontium sulphate) together with native sulphur produced by the reduction of the celestite. The masses of celestite are most numerous near the horizon of the dolomitic sandstone. Washing removes practically all of the small amount of dolomitic cement in the incoherent sandstone and also removes most of the cement from the dolomitic portions. The sand as marketed is stated to contain over 99 per cent of silica.

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

ANALYSES OF GLASS SAND

	Crude Per Cent	†Washed 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 average 0.015 per cent iron oxide, and some analyses running as low as 0.001 per cent in iron 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 per cent iron oxide.

The washed sludge containing the fine grit is used for the ignition surfaces on match boxes.

†W. H. Sherzer, Geology of Monroe County; Mich. Geol. Survey, Vol. VII, Pt. 1, p, 54.

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.

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 building. 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 quarry operating in the Marshall at the present time is at Grindstone City, Huron County, where the gritstones near the base of the formation are quarried for grindstones and scythestones. Formerly some rubble and riprap were 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 Company is the only active operator. The sandstone is known as the Jacobsville "redstone" or "brownstone." It 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.

In 1919 four plants were operated and production reached a value of $24,413. Uses of sandstone reported were: rough building stone, rubble, riprap, and road metal. In 1920 there were but two operators; hence production values may not be given. In 1921 sandstone for rough building material and road metal was produced to the value of $49,270.

In 1923 sandstone produced for building stone, rough blocks, rubble, and riprap totalled 19,030 tons valued at $36,963.

GRINDSTONES AND SCYTHESTONES

The lower part of the Marshall formation which is exposed in flat low-lying benches along the shore of Lake Huron near the end of the "Thumb" contains the "grit" stone from which grindstones are made. The surface material is stripped off and the stone is cut by channelling machines into square blocks eight feet or more in thickness. The blocks are split by wedges into slabs which are loaded on 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 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% to 2 tons. The broken stone is sawed into various grades of scythestones.

Until after the war Michigan ranked third in the value of grindstones and scythestones produced, Ohio being first with a total value about six times larger than that of Michigan and West Virginia together, the nearest competitors. There were but two active quarries, both located in Huron County near the end of the "Thumb," but these ceased operations during the war. The Wallace Company of Port Austin formerly operated a quarry at Eagle Mills and the Cleveland Stone Company a quarry at Grindstone City. The latter resumed operations in 1923 but the former has permanently abandoned its quarry operations. The 1923 production was 1,253 tons valued at $38,212.

MINERAL WATERS

From 1902 to 1906 there was a steady decline in the mineral water industry of Michigan, despite annual fluctuations in amount and value of mineral and spring water produced, but from 1906 to the present time there has been little change. 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 few years 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. From 1913 to 1919 production and value steadily increased and reached a total of 1,570,906 gallons valued at $132,312. There were ten commercial springs. In 1921 production and value of mineral waters increased from 1,227,485 gallons valued at $122,010 to 1,344,900 gallons valued at $154,405, an increase of 117,415 gallons or 9.5 per cent in quantity and of $32,395 or 26.2 per cent in value. There were nine commercial springs in 1921. In 1922 with nine producing springs, Michigan again was ninth in the production of mineral waters although there was a decline from the 1921 production of 1,344,900 gallons at $154,405 to 1,229,802 gallons at $150,237, or a decrease of 8.5 per cent in quantity and of 2.7 per cent in value. In 1923 Michigan produced 1,478,135 gallons valued at $164,968, an increase of 20% in quantity and 10% in value.

PRODUCTION AND VALUE OF MINERAL WATERS IN MICHIGAN, 1900-1923

Year.	Rank.		No. of springs active.	Total.		Medicinal value .	Table value.	Average price per gal.
	Quantity.	Value.		Quantity gals.	Value.			
1900	6	4	28	3,398,996	$411,935	.....	.....	$0.121
1901	2	1	28	7,019,168	1,195,614	.....	.....	0.170
1902	1	9	28	8,653,690	275,763	.....	.....	0.032
1903	1	9	19	6,919,107	200,668	.....	.....	0.029
1904	7	13	19	3,385,675	118,422	.....	.....	0.035
1905	4	4	17	2,684,800	277,188	$38,900	$238,288	0.100
1906	13	23	19	902,528	73,357	.....	.....	0.081
1907	8	15	19	1,472,679	127,133	35,091	92,042	0.086
1908	8	16	24	2,004,433	88,910	5,955	82,915	0.044
1909	5	16	19	2,760,604	104,454	6,099	98,255	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
1919	7	9	10	1,570,906	132,312	760	132,252	0.080
1920	11	9	9	1,227,485	122,010	1,485	120,525	0.099
1921	6	7	9	1,344,900	154,405	.....	.....	0.114
1922	8	8	9	1,229,802	150,237	.....	.....	0.122
1923	7	6	10	1,478,135	164,969	.....	.....	0.11
Total	.....	.....	.....	56,653,716	$4,356,541	.....	.....	0.077

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 Company 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 has been produced in commercial quantities by the Michigan Verde Antique Marble Company some miles north and west of Ispheming. The marble is in a bed 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 in 1914 but lack of transportation facilities, labor shortage, etc., hindered operations. A spur line connecting the quarry with the Chicago and Northwestern railroad was completed and blocks of marble were shipped to Marquette where the company has a stone sawing mill. Marble will be cut and polished at this mill, the electric power being supplied by the city of Marquette. In 1920 and 1921 the company shipped broken pieces of green marble to eastern manufacturers of terrazzo which is used as flooring. Lack of available cars prevented 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. Further shipments were made in 1923. Fine blocks of verde antique are reported to be in stock and ready for the finishing plants.

Other projects have been started in the past six years to develop other deposits of marble in this region but the war and post-war business unrest 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 it is possible that 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 graphitic slate nine miles southeast of L'Anse. The graphite rock, which is reported to contain from 32 to 35 per cent of graphite, is ground and used for paint. The production is intermittent, the quarries being operated only as the crude supply becomes depleted, enough being quarried in a year to supply the needs of the companies for several years.

No graphite was produced in 1918, 1919, 1920, 1921, or 1922, but production was again reported in 1923.

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 Company manufactures graphite paint from graphitic slate (see graphite) obtained near L'Anse, Baraga County.

CELESTITE

Celestite or strontium sulphate (SrS04) occurs at several horizons in the Monroe formation in southeastern Michigan. Near Maybee, Monroe County, it occurs in the Bass Island (Lower Monroe) in scattered crystals and masses associated with native sulphur and occurs similarly in the Sylvania sandstone at Rockwood, Wayne County. Near Gibralter, Wayne County, it occurs in disseminated crystals in Detroit River (Upper Monroe) dolomites. In the glass sand pit of the Rockwood Silica Company 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 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_2)	65.25
Alumina (Al_2O_3)	18.60
Iron Oxide (Fe_2O_3)	0.40
Lime ($CaCO_3$)	0.38
Magnesia (MgO)	0.23
Sodium Oxide (Na_2O)	1.99
Potassium Oxide (K_2O)	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.

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.

PRODUCTION AND VALUE OF TRAP ROCK OR BASALT IN MICHIGAN, 1911-1923

Year.	No. of produ-ers.	Crushed stone.				Total tons.	Total value.	Rank value.
		Roadmaking.		Concrete, etc.				
		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	.....	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	12
1917	4	50,420	64,098	†	†	.....	70,197	11
1918	4	23,686	32,605	†	†	.....	53,269	11
1919	1	.....	.....	.....	.....	.....	36,186	11
1920	4	.....	.....	.....	.....	.....	84,273	10
1921	6	17,640	22,174	.....	151,446	.....	173,620	12
1922	.....	57,730	102,884	†	†	94,560	376,788	.....
1923	12	†	†	†	†	109,810	420,524	.....
.....	.....	.....	.....	.....	.....	.....	$1,620,897	.....

†Included in total.

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. The utilization of trap rock for roofing granules in 1921 caused the value of the stock produced to increase from $84,273 in 1920 to $173,620, an increase of $89,347 or 106 per cent.

QUARTZ

Quartz is mined near Ishpeming, Marquette County, and ground for wood filler and paint purposes. Some of the ground product is used in making scouring polish. According to an analysis submitted by the company the quartz rock is practically pure silica, there being but a trace of impurities. The value of quartz sold in 1923 was $31,580.

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 Arvon. 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.

PETROLEUM AND NATURAL GAS

Very little information regarding explorations for oil has been received during the current year. The Manistee Oil and Gas Company has drilled a second well but only a part of the log has been reported. The Jackson County Oil and Gas Company, which obtained a showing of oil in a well near Deerfield last year, has not obtained production from that well or drilled any others. J. C. Gaines reported that a well had begun by him near Port Huron but no further details have been furnished. In Section 7, T. 14 N., R. 3 W. a showing of oil was reported from 1100 feet by the Dow Chemical Company. Details of this drilling are not available.

Reports of gas from the drift overlying the Antrim formation were made by Ruggles and Rademacher, Manistee, who found a flow of gas at 800 feet m a well on the west shore of Manistee Lake; by William Felty of Mount Clemens who struck a flow of gas in a water well at 135 feet; and by H. K. Gustin, who reported a strong flow of gas from a well on the farm of Mr. Wilder, one mile west of Hillman, Montmorency County.

Records of five deep wells reported during the year are given on the following pages:

LANSING (INGHAM COUNTY)

MUNICIPAL TEST WELL

Location: Sec. 23, T. 4 N., R. 2 W. At waterworks, junction of S. Francis St. and Pere Marquette R. R.
Elevation: 820 feet above sea level.
Drilled in 1924 as a deep test for water by Wm. Cater, contractor, Chicago.

	Thickness feet	Depth feet
Pleistocene:		
Sand and gravel	25	25
Boulder clay	10	35
No record	30	65
Pennsylvanian:		
Woodville Formation:		
Gypsum, noted by Mr. Gilchrist, engineer; thickness small and undetermined.		
Saginaw Formation:		
Gray sandstone with a few flakes of coal; considerable mica; some pyrite	15	80
Fine grained very light gray sandstone with mica and a few flakes of coal, shading below to a darker gray very fine grained sandstone with pyrite	180	260
Gray laminated shale	15	275
Fine grained gray sandstone (from above) and gray shale	5	280
Gray shale	30	310
Very fine grained gray sandstone with pyrite	10	320
Grayish black shale with pyrite	5	325
Dark gray shale	55	380
Mississipian:		
Michigan Formation:		
Fine grained white sandstone with flakes of black shale, pyrite, and olive green "soapstone" and dolomite and small amounts of gypsum	80	460
No record	15	475
Same but with larger amounts of gypsum, some pink, and selenite	15	490
Dark gray shale, small amounts of gypsum	15	505
Gypsum, some dark gray shale	15	520
Dark gray shale	10	530
No record	20	550
Gypsum and dark gray shale, some dolomite	25	575
Dark gray shale; some dolomite	10	585
Dark gray shale and sandstone with oolitic coating of cement	5	590
Dark gray shale small amounts of gypsum	10	600

MUSKEGON (MUSKEGON COUNTY)

BRUNSWICK, BALKE, AND COLLENDER WELL

Location: Sec. 20, T. 10 N., R. 16 W. About 4 blocks northeast from the Occidental Hotel.
Elevation: About 634 feet above sea level.
Drilled by Wm. Cater, Chicago, as test for water in 1924.
Partial log and scattered samples from Mr. Cater.

	Thickness feet	Depth feet
Pleistocene:		
Sand (no samples)	100	100
Clay (no samples)	170	270
Mississippian:		
Lower Marshall Formation:		
Light gray sandstone, fine grained, many green grains and some particles of selenite. Some granitic fragments indicate an admixture of drift	3	273
Lower Marshall, Coldwater, and Bedford Formations (Undivided):		
No record	382	655
Gray calcareous shale with small fragmentary fossils, pyrite, gypsum, and quartz	5	660
Gray shale with fine grains of calcite and dolomite (lime sand) and a few much larger grains of quartz	50	710
Same but more calcareous	105	815
No record	115	930
Red highly calcareous shale with a few very small grains of a green mineral and of quartz. Considerable gypsum	10	940
Red and green somewhat calcareous shale with a few grains of quartz	5	945
No record	25	970
Gray calcareous shale	20	990
Gray-green calcareous shale	5	995
Gray calcareous shale	5	1000

POWERS (MENOMINEE COUNTY)

DELTA-MENOMINEE SANATORIUM WELL

Location: Section 16, T. 38 N., R. 26 W.
Elevation: 856 feet above sea level.
Drilled in 1924 for water. Samples furnished by J. W. Towey.

	Thickness feet	Depth feet
Pleistocene:		
No record	80	80
Ordovician:		
Beekmantown Formation:		
White crystalline dolomite with some quartz grains†	20	100
Light gray earthy dolomite with small amounts of quartz and shale	10	110
Gray earthy dolomite with reddish tinge; some quartz grains	5	115
Light buff dolomitic sandstone	55	170
Gray sandy dolomite	10	180
Cambrian:		
Lake Superior Formation:		
Reddish sandstone, shaly, ferruginous, and dolomitic	42	222

†Small scattered grains of a bright green mineral appear in nearly all of the samples.

MANISTEE (MANISTEE COUNTY)

MICHIGAN OIL & DEVELOPMENT COMPANY NO. 2

Location: Sec. 31, T. 22 N., R. 16 W. To the north across the river from East Lake.

Elevation: 583 feet above sea level.

	Thickness feet	Depth feet
Pleistocene:		
No record	600	600
Mississippian:		
Berea Formation:		
Black shale and very fine grained sandstone. Some grains of coarse sand	7	607
Mississippian:		
Bedford Formation:		
Light gray shale at top shading to dark gray at bottom	253	860
Devonian:		
Antrim Formation:		
Black shale	50	910
Traverse Formation:		
Dark gray limestone, some gypsum	35	945
No record	15	960
Gray, brown, and white limestone, some gypsum	15	975
Brown limestone, gypsum, petroleum	125	1100
Oil sand, a brown and white limestone with selenite crystals. Probably a fifth of this sample was gypsum		1100
Brown, gray, and white limestone, with selenite (samples at 1158, 1220, 1335, 1345, 1440, 1465, and 1470)	370	1470

EAST LANSING (INGHAM COUNTY)

MUNICIPAL WELL

Location: Near center of Section 18, T. 4 N., R. 1 W. Near water tower between Orchard and Kedzie Streets.
Elevation: 860 feet above sea level.
Drilled as test for water by Wm. Purcell, contractor, Jackson.
Samples from Mr. Purcell.

	Thickness feet	Depth feet
Pleistocene:		
Brown sand	55	55
Gravel	5	60
Pennsylvanian:		
Saginaw Formation:		
Gray shale with mica	35	95
Fine grained white sandstone with mica	235	330
Gray shale	30	360
White sandstone coarser than the upper sand	20	380
White sandstone, grayish black shale; pyrite	5	385
Grayish black shale	20	405
Gray shale	5	410
Grayish black shale	15	425

[Summary Table of Mineral Products 1919-1923]

SUMMARY TABLE OF THE PRODUCTION AND VALUE OF MINERAL PRODUCTS IN MICHIGAN, 1919-1923.

Mineral Products.	1919. Quantity.	1919. Value.	1920. Quantity.	1920. Value.
Brick and tile products, number of brick	200,359,000	$3,699,929	187,415,000	$3,979,691
Brick, sand-lime, number of brick	42,063,000	513,094	38,810,000	640,744
Bromine; pounds	1,736,633	1,179,834	1,046,165	692,100
Calcium chloride; tons	21,668	256,091	49,937	1,965,013
Cement, Portland; bbls. made, value cement shipped	4,673,244	8,468,196	4,891,457	10,939,633
Clay, tons	568	2,123	5,666	11,295
Coal, tons	996,545	3,864,228	1,489,765	7,346,000
Coke, tons; value sales	....	....	1,485,833	15,731,994
Copper, lbs.	179,092,970	33,096,537	161,343,880	29,220,990
Glass sand	(c)	(c)	(c)	(c)
Graphite	....	(f)	....	(f)
Grindstones, tons	....	(a)	....	(a)
Gypsum, tons mined; value gypsum products sold	339,125	2,390,367	392,212	3,521,028
†Iron ore, shipments long tons, value f. o. b. mine	12,816,304	47,945,800	18,470,354	83,319,770
Iron, pig, long tons made; value pig iron shipped	416,277	(b) 13,418,185	513,920	(b) 16,812,062
Lime, tons made	145,783	1,381,534	140,813	1,396,760
Limestone	....	3,797,522	....	3,943,229
Mineral paints	....	....	....	....
Mineral and spring waters, gallons sold	1,370,906	132,312	1,227,485	122,010
Natural gas, M. cu. ft.	1,098	911	....	(e) 500
Petroleum	....	(a)	....	....
Pottery	....	2,096,874	....	2,592,625
Potash (Pure K_2O) tons produced; value potash sold	166	48,581	56	18,312
Precious stones	....	(a)	....	(a)
Quartz	....	(a)	....	(a)
Salt, bbls	17,800,564	9,456,138	16,163,679	10,698,474
Sand and gravel, tons	3,772,535	1,944,143	4,386,582	2,867,466
Sandstone	19,640	24,413	....	(a)
Silver, fine oz. Troy	425,610	477,054	530,661	518,326
Stone, crushed	....	....	....	....
Traprock	....	36,186	....	84,273
Miscellaneous	....	60,242	....	161,822
Total	....	$121,482,109	....	$181,702,225

Mineral Products.	1921. Quantity.	1921. Value.	1922. Quantity.	1922. Value.	1923. Quantity.	1923. Value.
Brick and tile products, number of brick	193,730,000	$2,417,309	748,608,990	$3,915,318	193,350,663	$3,723,018
Brick, sand-lime, number of brick	33,658,000	403,929	45,558	557,647	64,650,000	777,693
Bromine; pounds	....	(a)	....	(a)	....	(a)
Calcium chloride; tons	18,683	431,402	....	(a)	32,665	578,462
Cement, Portland; bbls. made, value cement shipped	5,777,533	10,300,289	6,243,805	11,145,573	7,619,792	14,038,322
Clay, tons	....	2,355	1,653	4,852	3,617	11,903
Coal, tons	1,141,715	5,555,000	929,390	4,693,000	1,172,075	5,545,000
Coke, tons; value sales	835,973	4,704,141	1,142,059	9,229,093	1,648,773	14,399,742
Copper, lbs.	100,918,001	16,873,992	121,386,726	‡16,387,208	137,952,586	‡‡20,062,984
Glass sand	....	(c)	....	(c)	(c)	(c)
Graphite	....	(f)	....	(f)	....	(a)
Grindstones, tons	....	(a)	....	(f)	1,253	38,212
Gypsum, tons mined; value gypsum products sold	408,224	3,312,096	471,355	2,843,117	586,987	3,252,990
†Iron ore, shipments long tons, value f. o. b. mine	5,230,669	19,970,694	12,433,729	43,760,509	13,962,769	54,256,527
Iron, pig, long tons made; value pig iron shipped	243,433	(b) 5,955,205	595,647	(b) 14,791,041	717,279	(b) 18,327,808
Lime, tons made	48,164	445,386	53,635	484,945	59,629	612,369
Limestone	....	3,387,722	....	4,533,998	10,589,070	5,848,649
Mineral paints	....	(f)	....	(f)	(f)	(f)
Mineral and spring waters, gallons sold	1,344,900	154,405	1,229,802	150,237	1,478,135	164,968
Natural gas, M. cu. ft.	400	300	700	350	700	320
Petroleum	....	(f)	....	(f)	(f)	(f)
Pottery	....	1,781,923	....	1,337,000	....	2,810,619
Potash (Pure K_2O) tons produced; value potash sold	....	(f)	....	(f)	(f)	(f)
Precious stones	....	(f)	....	(f)	(f)	(f)
Quartz	....	(a)	....	(a)	(a)	(a)
Salt, bbls	10,196,179	7,439,445	14,322,037	8,693,604	15,195,800	8,684,148
Sand and gravel, tons	5,515,253	2,916,917	5,962,916	3,222,043	9,601,562	5,096,071
Sandstone	....	(a)	....	(a)	19,030	36,963
Silver, fine oz. Troy	310,727	310,727	361,912	361,912	253,705	208,038
Stone, crushed	1,381,250	1,035,463	....	(g)	(g)	(g)
Traprock	....	173,620	94,560	276,778	109,810	420,524
Miscellaneous	....	292,880	....	627,860	....	200,590
Total	....	$81,872,995	....	$112,325,604	....	$140,758,123

† Figures from State Tax Commission.
‡ Estimated at $.135 per pound, the average price.
‡‡ Estimated at 14.9543 cents per pound, the average price.
a. Included under miscellaneous.
b. Excluded from total; covered by iron ore.
c. Included under sand and gravel.
d. Copper sales.
e. Estimated.
f. No production.
g. Included in limestone.

APPENDIX
DIRECTORY OF THE PRODUCERS OF NON-METALLIC MINERALS IN MICHIGAN, 1923

BRICK AND TILE MANUFACTURERS, 1923

	Office.	Works.
Allegan County		
Allegan Brick Works (Fish & Fish)	Allegan	Allegan.
Veneklasen Clay Products Co.	Hamilton	Hamilton.
Barry County		
Leonard Bros. & Co.	Delton	Delton.
Chippewa County		
Thornton Bros. Brick Co.	Grand Rapids	Rudyard.
Eaton County		
Grand Ledge Clay Product Co.	Grand Ledge	Grand Ledge.
Emmet County		
C. A. DeArment Brick Works	Petoskey	Petoskey.
Gratiot County		
Ashley Tile Company	Ashley	Ashley.
North Star Tile Co.	North Star	North Star.
Riverside Brick & Tile Yard	Sumner	Sumner.
Ingham County		
The Briggs Co.	Lansing	Lansing and Grand Ledge.
Jackson County		
Michigan State Industries	Jackson	Onondaga.
American Vitrified Products Co.	Akron, Ohio, (15 Broad St.)	Jackson and Grand Ledge.
Lenawee County		
Albert A. Comfort	Tecumseh	Tecumseh.
Macomb County		
The Trombley Brick Co.	Detroit, (10546 Gratiot Ave.)	Detroit.
Manistee County		
Jos. Kujawski	Manistee	Manistee.
Mecosta County		
Wm. F. Nehmer	Big Rapids	Big Rapids.
Saginaw County		
Miller City Tile Co.	Saginaw	Paines Station.
National Plate Glass Co.	Detroit	Saginaw.
Sanilac County		
Croswell Brick Co.	Croswell	Croswell.
Shiawassee County		
New Corunna Brick Co.	Corunna	Corunna.
Van Buren County		
Hartford Brick & Tile Co.	Hartford	Hartford.
Wayne County		
Anton Hupprich	Detroit, 4645 51st St.	Detroit.
Jacob Daniel Brick Co.	Detroit, 290 Atkinson Ave.	Springwells.
John McDonald	Detroit, 504 Dime Bk. Bldg.	Detroit.
John S. Haggerty	Detroit, 1815 Dime Bk. Bldg.	Detroit.
Pewabic Pottery & Tile Co.	Detroit, 10125 Jefferson Ave.	Detroit.
Bunte Bros. Tile Co.	Flat Rock	Flat Rock.
Clippert Brick Co.	Detroit, Dewey and Southern	Springwells.
Wm. Clippert Brick Co.	Detroit, Western Ave. and M. C. R. R.	Detroit.
Porath Brothers	Detroit, 305 Free Press Bldg.	Detroit.
Walker & Frank	Detroit, 8810 Dix Ave.	Detroit.
Mercier-Bryan-Larkins Co.	Detroit, Michigan Ave. and Lonyo Road	Detroit.
Egle Brothers Mfg. Co.	Detroit, 169 Sylvester St.	Detroit.

SAND LIME BRICK PRODUCERS, 1923

	Office.	Works.
Genesee County		
Flint Sandstone Brick Co.	Flint	Flint.
Huron County		
Sebewaing Sandstone Brick Co.	Sebewaing	Sebewaing.
Jackson County		
Jackson-Lansing Brick Company	Rives Junction	Rives Junction.
Kent County		
Grande Brick Co.	Grand Rapids, 1456 Sunnyside Ave.	Grand Rapids.
Menominee County		
Menominee Brick Co.	Menominee	Menominee.
Oakland County		
Rochester Brick & Sand Co.	Detroit, 400 Penobscot Bldg.	Rochester.
Saginaw County		
Saginaw Brick Co.	Saginaw, 321 N. Hamilton St.	Saginaw.
Wayne County		
Michigan Pressed Brick Company	Detroit, Cor. Lawton Ave. at M. C. Railroad	Detroit.
Sand Lime Products	Detroit, Foot of Jean St.	Detroit.

CEMENT PRODUCERS, 1923

Operator.	Office.	Works.
Huron Portland Cement Company	1525 Ford Building, Detroit	Alpena.
Alpha Portland Cement Co.	140 S. Dearborn St., Chicago	Bellevue.
Peninsular Portland Cement Co.	Cooley Block, Jackson	Cement City.
Michigan Portland Cement Co.	Chelsea	Four Mile Lake.
Wolverine Portland Cement Co.	Coldwater	Coldwater & Quincy.
Aetna Portland Cement Co.	412 Union Trust Bldg., Detroit	Fenton.
Newaygo Portland Cement Co.	Grand Rapids	Newaygo.
Peerless Portland Cement Co.	Union City	Union City.
Wyandotte Portland Cement Co.	1525 Ford Bldg., Detroit	Wyandotte.
New Egyptian Portland Cement Co.	Fenton	Fenton.
Petoskey Portland Cement Co.	Petoskey	Petoskey.
New Plants		
Aetna Portland Cement Co. (operating)	Fenton	Bay City.
New Egyptian Portland Cement Co. (under construction)	Port Huron	Port Huron.
Peerless Portland Cement Co. (under construction)	Detroit	Detroit.

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. Beaver No. 7	Bay	Chas. Coryell	Bay City	Wm. A. Jones	Bay City.
Beaver Mine	Bay	Chas. Coryell	Bay City	Wm. A. Jones	Bay City.
Wolverine Coal Mining Co. No. 2	Bay	R. M. Randall	Saginaw	Alex Liddle	Bay City.
What Cheer Coal Mining Co. No. 1	Bay	A. N. Pancher	Bay City	Alex Jeffreys	Bay City.
Peoples Coal Mining Co.	Calhoun	W. A. Knapp	Albion	W. C. Sellers	Albion.
Russell Mine	Clinton				
Reed Mine	Eaton				
Robert Gage Coal Co. No. 3	Saginaw	Chas. Coryell	Bay City	Wm. A. Jones	Bay City.
Robert Gage Coal Co. No. 8	Saginaw	Chas. Coryell	Bay City	Wm. A. Jones	Bay City.
Bliss Coal Mining Co.	Saginaw	C. E. Linton	Saginaw	J. T. Phillips	Saginaw.
					Swan Creek.
Banner Coal Mining Co.	Saginaw	Wm. B. Carmichael	Saginaw	Richard Jenkins	Saginaw.
			Swan Creek		Swan Creek.
Community Coal Co.	Saginaw	Alex Jeffreys	Bay City	Wm. Fellis	Bay City.
Consolidated Coal Co. — Riverside No. 2	Saginaw	R. M. Randall	Saginaw	Alex Liddle	Bay City.
Consolidated Coal Co. — Shiawassee	Saginaw	R. M. Randall	Saginaw	Alex Liddle	Bay City.
Consolidated Coal Co. — Uncle Henry No. 2	Saginaw	R. M. Randall	Saginaw	Alex Liddle	Bay City.
Owosso Coal Mining Company	6-Mile Creek		Owosso		
Akron Coal Mining Co. No. 2	Tuscola	Chas. Handy	Bay City, W. S.	Chas. Period	Akron.

CLAY MINERS, 1923

	Office.	Works.
Allegan County		
Allegan Brick Works	Allegan	Allegan.
Barry County		
Leonard Bros. Co.	Delton	Delton.
Ontonagon County		
Thos. Edmond Estate	Rockland	Rockland.
F. A. Jeffs	Rockland	Rockland.
Robinson Clay Products Co.	Akron, Ohio, 1010 E. Market St.	Rockland.
Wayne County		
Clippert Brick Co.	Detroit, 1960 Michigan Ave.	Springwells.

COKE PRODUCERS, 1923

Operator.	Address.	Location of Plant.	No. of ovens.	County.
Consumers Power Co.	Zilwaukee	Zilwaukee	19	Saginaw.
Michigan Alkali Co.	Wyandotte	Plant No. 2	30	Wayne.
Sement-Solvay Co.	Syracuse, N.Y.	Detroit	175	Wayne.
Ford Motor Co.	Detroit	River Rouge	120	Wayne.
Battle Creek Gas Co.	Battle Creek	Battle Creek	11	Calhoun..

GRAPHITE PRODUCERS, 1923

Operator.	Office.	Quarry.
Detroit Graphite Co.	10, 12th Street, Detroit	L'Anse.

GRINDSTONE AND SCYTHESTONE PRODUCERS, 1923

Operator.	Office.	Quarry.
Huron County		
Cleveland Stone Co.	Cleveland, Ohio	Grindstone City and Port Austin.

PRODUCERS OF GYPSUM PRODUCTS, 1923

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.
Alabastine (Michigan Gypsum Co.).	Grand Rapids		Grand Rapids.
Grand Rapids Plaster Co.	Grand Rapids, 427 Mich. Trust Bldg.	Grandville	Grandville.
Beaver Products Co.	Grand Rapids		Grand Rapids.
Certainteed Products Co.	Grand Rapids		Grand Rapids.

LIMESTONE AND LIME PRODUCERS, 1923

Operator.	Office.	Quarry.
Alpena County		
Michigan Alkali Co.	Wyandotte	
Kelly Island Lime and Transport Co.	Cleveland	Rockport.
Cheboygan County		
Campbell Stone Co. (also lime)	Indian River	Afton.
Chippewa County		
Scott Quarry Co.	Sault Ste. Marie	Trout Lake.
Delta County		
Delta Contracting Co.	Escanaba	Escanaba (Hyde)
Bichler Bros.	Gladstone	Pine Ridge.
Dickinson County		
Metronite Co., The	Milwaukee, Wis.	Felch.
McKenna Bros.	Quinnesec	Quinnesec.
Emmet County		
Antrim Lime Co. (also lime)	912 Mich. Trust Bldg., Grand Rapids	Petoskey.
Northern Lime Co. (also lime)	Petoskey	Petoskey.
Petoskey Portland Cement	Petoskey	Petoskey.
Huron County		
Wallace Stone Co.	Bayport	3 mile E. of Bayport.
Mackinac County		
Ozark Stone Quarry	Ozark	Ozark.
Union Carbide Co.	42nd St. Bldg., New York City	Hendricks Quarry.
Fiborn Limestone Co.	Sault Ste. Marie, Ont., Canada	Fiborn Quarry.
Monroe County		
The France Stone Co.	1800 Second National Bank Bldg., Toledo, Ohio	Monroe.
Morris, Sam W.	Monroe	Monroe.
Presque Isle County		
Michigan Limestone & Chemical Co.	55 Liberty St., New York, or Rogers City, Mich.	Calcite.
Schoolcraft County		
The White Marble Lime Co.	Manistique	Blaney, Manistique, and Marblehead.
Wayne County		
Solvay Process Co.	Syracuse, N. Y.	Trenton and Sibley.
Dunbar & Sullivan Dredging Co.	Detroit or River Rouge	Mouth of Detroit River.

MINERAL AND SPRING WATER PRODUCERS, 1923

Operator.	Office.	Spring.
Eastman Springs Beverage Co.	Benton Harbor	Eastmans.
Artic Spring Water Co.	Grand Rapids, 412 Ottawa Avenue	Artic.
Ogemaw Spring Water Co.	Maltby	Ogemaw.
Ponce de Leon Co.	Grand Rapids	Ponce de Leon.
Sharkey, 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.
John Gerick	Denton (Wayne Co.)	John Gerick.

PIG IRON PRODUCERS, 1923

Operator.	Office.	Name of Furnace.	Location of Furnace.
Mitchell-Diggins Iron Co.	Cadillac	Cadillac	Cadillac.
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	Mancelona.
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.
Ford Motor Co.	Dearborn	Henry & Benson	Springwells.
Delta Chemical & Iron Co.	Escanaba	Delta	Wells.
Hanna Furnace Co.	Detroit	A & B	Detroit.

POTTERY PRODUCERS

Operator.	Office.	Works.
Kalamazoo County		
Kalamazoo Sanitary Mfg. Co.	Factory and Alcot Streets, Kalamazoo	Kalamazoo.
Macomb County		
Mt. Clemens Pottery Co.	Mt. Clemens	Mt. Clemens.
Monroe County		
South Rockwood Pottery Co.	South Rockwood	South Rockwood.
Wayne County		
Becker Bros. Flower Pot Co.	Detroit, 4645 51st St.	Detroit.
Champion Porcelain Co.	Detroit, 3154 Leuschner St.	Detroit.
Hygeia Filter Co.	Detroit, 3422 Denton Ave.	Detroit.
Meaker Spark Plug Co.	Detroit, 1366 Antietam Ave.	Detroit.
Pewabic Pottery & Tile Co.	Detroit, 10125 Jefferson Ave.	Detroit.

QUARTZ PRODUCERS, 1923

Operator.	Office.	Mine.
Marquette County		
Michigan Quartz Silica Co.	Milwaukee, Wis.	Ishpeming.

SALT PRODUCERS, 1923

Operator.	Office.	Works.
Bay County		
Hine Lumber Co.	Sta. A., Bay City	W. Bay City.
Manistee County		
Louis Sands Salt & Lumber Co.	Manistee	Manistee.
Ruggles & Rademacher	Manistee	Manistee.
Mason County		
Morton Salt Co.	Ludington	Ludington.
Midland County		
The Dow Chemical Co. (bromine)	Midland	Midland.
Saginaw County		
Mershon, Eddy, Parker & Co.	Saginaw	Saginaw.
Bliss & VanAuken Lbr. Co.	Saginaw, W. S.	Saginaw.
Saginaw Salt Products Co.	Saginaw, W. S.	Saginaw.
Estate of Edward Germain	Saginaw, W. S., Holland Ave. near Genesee Street	Saginaw.
National Plate Glass Co.	Saginaw	Saginaw.
Strable Lumber & Salt Co.	Saginaw	Saginaw.
Saginaw Chemical Co.	Saginaw	Saginaw.
St. Clair County		
Michigan Salt Works	Marine City	Marine City.
Morton Salt Co.	Chicago, Ill., 717 Railway Exch	Port Huron.
Diamond Crystal Salt Co.	St. Clair	St. Clair.
Wayne County		
Inland Delray Salt Co.	Detroit	Detroit.
Solvay Process Co.	Detroit	Delray.
Detroit Rock Salt Co.	Scranton, Pa.	Detroit.
Mulkey Salt Co.	Detroit, 610 Equity Bldg.	Oakwood.
Worcester Salt Co.	New York City, 168 Duane Street	Ecorse.
Michigan Alkali Co.	Wyandotte	Wyandotte.
Pennsylvania Salt Mfg. Co.	Philadelphia, Pa., 115 Chestnut St.	Wyandotte.

SANDSTONE PRODUCERS, 1923

Operator.	Office.	Quarry.
Dickinson County		
Anton Meinch	Iron Mountain	Iron Mountain.
Hofelz and Eisele	Iron Mountain	Iron Mountain.
Huron County		
Cleveland Stone Co.	Cleveland, Ohio	Grindstone.
The Wallace Company	Port Austin	Eagle Mills.
Marquette County		
Marquette Trap Rock Co.	Marquette	Marquette.

SAND AND GRAVEL PRODUCERS IN 1923.

Operator.	Office.	Pit.
Alcona County		
Federal Sand & Gravel Co.	Saginaw, 301½ Federal Ave.	Greenbush.
Allegan County		
F. Buhler	Zeeland, R. F. D. No. 3	Burnips Corners.
Fred W. Sutter	Byron Center	Burnips Corners.
Howard Van Keuren	Allegan	Monterey.
A. J. Powell	Plainwell	Plainwell.
W. G. Fry	South Haven, R. F. D. No. 6	Saugatuck.
Murray Acklin		
Alpena County		
Alpena Gravel Co.	Alpena	Alpena.
Alpena Towing Co.	Alpena	Alpena.
Levi Smith	Alpena	Alpena.
Federal Sand & Gravel Co.	Alpena	Lachine.
Antrim County		
Floyd H. Moore	Central Lake, R. F. D. No. 1	Central Lake.
James B. Gaylord	Mancelona	Mancelona.
Barry County		
Chas Woolston	Hastings	Hastings.
S. J. Palmiter	Bellevue, R. F. D., No. 4	Nashville.
Arthur Penock	Nashville	Nashville.
P. O. Dunham	Nashville, R. F. D. No. 4	Maple Grove.
Hastings Gravel & Construction Co.		
Bay County		
Geo. A. Whitney	Bentley	Bentley.
A. J. Schable, Jr.	Munger	Munger.
Benzie County		
E. Amidon	Bendon	Bendon.
John Dean	Bendon	Bendon.
Wm. Huddleston	Bendon, R. F. D., No. 1	Bendon.
Hubbell Sand Co.	Manistee	Elberta.
Wm. Ferrens		
Berrien County		
Ireland & Leter	Benton Harbor	Benton Harbor.
Albert Noack	Coloma, R. F. D. No. 3	Coloma.
Frank Brewer	Galien	Galien.
Christ Andrews	Galien	Galien.
F. D. Noggle & Son	Galien	Galien.
Broderick Bros.	Benton Harbor	Riverside.
Anton Thar	Coloma	Riverside.
F. J. Thar	Coloma, R. F. D. No. 3	Riverside.
Kerkhikowske Bros	St. Joseph	Riverside.
E. F. Chase & Son	Watervliet	Watervliet.
Branch County		
Mack L. Roe	Bronson, R. F. D. No. 4	Bronson.
J. F. Werner	Bronson	Bronson.
Mrs. Olive A. Barnes	Montgomery	Fremont.
Daniel Haley	Ray, Ind.	Near Ray, Ind.
Andrew Marsh	Union City, R. F. D., No. 5	Union City.
Clifford A. Bishop		
D. H. Rogers		
Calhoun County		
A. C. Behling	Albion	Albion.
Floyd Van Sickle	Albion	Albion.
Willard A. Young	Albion	Albion.
Brownlee Park Gravel & Mat. Co.	Battle Creek, R. 1, Box 83	Brownlee Park.
George W. Greble	Battle Creek	Iron City.
Ralph Cook	Eckford	Marshall.
Michigan Railway Co.	Jackson	Marshall.
Cass County		
Fred Crandall		
Charlevoix County		
Edw. Ward Estate	Charlevoix	Charlevoix.
John Martin		

SAND AND GRAVEL PRODUCERS IN 1923.—Continued.

Operator.	Office.	Pit.
Chippewa County		
William Gough	Pickford	Pickford.
Mrs. Jennie Hudson	Pickford	Pickford.
F. H. Taylor	Pickford	Pickford.
Rye Bros	Sault Ste. Marie, 409 Maple St.	Sault Ste. Marie.
Clinton County		
A. A. Schultz	Laingsburg	Laingsburg.
S. B. Gleason	Ovid	Ovid.
Elmer Stowell	Ovid	Ovid.
George Parmenter	Shepardsville	Shepardsville.
Crawford County		
Federal Sand & Gravel Co.		Roscommon. (near)
Delta County		
Chicago & N. W. Railroad Co.		Escanaba.
Delta County Highway Commissioner	Escanaba	Escanaba.
Bichler Bros.		
Gogebic & Lake Superior		
Dickinson County		
Chicago & Northwestern R. R. Co.		Antoine.
Chicago, Milwaukee & St. Paul R. R. Co.		Iron Mountain.
Eaton County		
Ralph W. Ballentine	Lansing, 309 W. Lapeer	Dimondale.
Genesee County		
Nelson Carpenter	Byron	Byron.
Morehouse Bros.	Fenton	Fenton.
Flint Sandstone Brick Co.	Flint	Flint.
Ford Sales Co.	Flint	Flint.
E. A. Johnson	Swartz Creek	Flint.
Ford Goodrich	Grand Blanc	Goodrich.
Martin Stine	Goodrich	Goodrich.
Alfred Reid	Flint	Grand Blanc.
E. Bowles	Linden	Linden.
Nitz Bros.	Linden	Linden.
Geo. Sandsan	Linden	Linden.
Bayer-Brice Gravel Co.	Flint, 701 Genesee Co. Sav. Bk. Bldg.	Mt. Morris.
Genesee Gravel Co.	Detroit, 1409 Ford Bldg.	Mt. Morris.
City of Flint Gravel Co.	Flint, City Hall	Otisville.
Otisville Gravel Co., Lewis Kuehl	Saginaw	Otisville.
Gogebic County		
Chicago & N. W. R. R. Co.		Blenners.
Gratiot County		
Emery Church	Alma	Alma.
A. Ray Colthorp	Breckenridge, Box 303	Breckenridge.
James Dexter	Shepherd	Summerton. (near)
Elmon J. Evey	Sumner	Sumner.
A. E. Tomlin	Sumner	Sumner.
Wm. Wiles	Sumner, R. F. D. No. 2	Sumner.
Willis Plank		
Hillsdale County		
Chas. Coler	Camden	Camden.
New York Central R. R. Co.	Cleveland, Ohio	Jonesville.
L. W. Thompson	Waldron	Waldron.
Nelson Wolcott	Hillsdale	Hillsdale.
Huron County		
Garey, Conley Co.	Saginaw, 405 Bearinger Bldg.	Port Austin.
Port Crescent Sand & Gravel Co.		
Ingham County		
Central Michigan Gravel Co.	Lansing	Lansing.
Heller Bros.	Lansing	Lansing.
Frank Leonard & Co.	Charlotte	Lansing.
F. M. Stockman	Lansing	Lansing.
Hoyt Woodman	Lansing	Lansing.
Hugh Campbell & Son	Bay City, 1516 6th St.	Mason.
Charles Couch	Mason	Mason.
J. Hazel	Mason	Mason.
William Hazelton	Mason	Mason.

SAND AND GRAVEL PRODUCERS IN 1923.—Continued.

Operator.	Office.	Pit.
Ingham County—Continued		
A. E. Sheltraw	Saginaw	Mason.
Michigan Railway Co.		Mason and Haslett.
Lansing Sand & Gravel Co.		
F. P. Leonard		
Michigan Central R. R. Co.		
Ionia County		
Fred W. Green	Ionia	Ionia.
J. I. Hazelitt	Ionia, R. F. D	Ionia.
E. J. Elvert	Muir	Muir.
Glick's Gravel Co.	Lowell, R. F. D. No. 3	Saranac.
Goode Bros	Caledonia	Saranac.
S. L. McIntyre	Lowell, R. F. D. No. 3	Saranac.
Iron County		
Chicago Mil. & St. Paul R. R. Co.		Crystal Falls.
Jackson County		
Alfred Cooper	Horton	Horton.
Wm. Blake	Jackson, R. F. D. No. 6	Jackson.
Jackson Gravel Co.	Jackson	Jackson.
Kalamazoo County		
Michigan Railway County		Augusta.
Wm. A. Balch	Kalamazoo, 1425 Forbes St.	Kalamazoo.
County Road Commissioner	Kalamazoo	Kalamazoo.
Kalamazoo-Greenville Gravel Co.		Kalamazoo.
Peter Molhock	Kalamazoo	Kalamazoo.
Casper Haas	Kalamazoo	Kalamazoo.
Nelson Concrete Culvert Co.	Kalamazoo	Kalamazoo.
Isaac Quick	Kalamazoo, 824 Parker St.	Kalamazoo.
John Rysenga	Kalamazoo, 432 Drexel Blk.	Kalamazoo.
Kent County		
Kent County Road Commissioner	Grand Rapids	Grand Rapids.
Percy Reed	Alpine	Alpine.
G. P. Scharl (County Pit)		
Mr. Neuman	Caledonia	Caledonia.
Richard J. Slater	Ada, R. F. D. No. 1	Cascade.
Rufus Overholt & Son	Byron Center	Dutton.
Battjes Fuel & Mat. Co.	Grand Rapids	Grand Rapids.
G. W. Bunker Co.	Grand Rapids	Grand Rapids.
Grand Rapids Gravel Co.	Gd. Rapids, 329 Mich Trust Bldg.	Grand Rapids.
Harrison Land Co., Ltd.	Gd. Rapids, Cor. Pine and 4th	Grand Rapids.
Michigan Railway Co.		Grand Rapids.
Valley City Stone & Gravel Co.	Gd. Rapids, 135 E. Fulton St.	Grand Rapids.
Walker Ave. Gravel Pit	Gd. Rapids, 1518 Walker Ave.	Grand Rapids.
Wyoming Sand & Gravel Co.	Grand Rapids, R. R. No. 8	Grand Rapids.
John N. Coalter	Kent City	Kent City.
Fred Geers	Kent City	Kent City.
M. Kreggers	Kent City	Kent City.
High Ridge Gravel Co.	Rockford	Rockford.
Jos. Deiss	Sparta, R. F. D. 2	Sparta.
Belmont Sand & Gravel Co.		
Township of Paris		
Pere Marquette Railroad Co.		
Lapeer County		
Aug. W. Broecker	Goodrich	Hadley.
Fred Miteen	Goodrich	Hadley.
John F. Smith	Goodrich	Hadley.
M. Caley	Hunters Creek	Hunters Creek.
Clayton Michael		
Willis Van Alstine		
Lenawee County		
Frank Lowe	Hudson	Hudson.
Geo. Evans	N. Morenci	N. Morenci.
R. P. Gillespie Estate	Tecumseh	Clinton.
Lenawee Sand & Gravel Co.	Tecumseh	Tecumseh.
Tecumseh Gravel Co.	Tecumseh	Tecumseh.
Puritan Sand & Gravel Co.		
Livingston County		
Detroit Greenville Gravel Co.		Brighton.
Grand River Washed Sand & Gravel Co.	Ann Arbor	Brighton.
Ohio & Mich. Sand & Gravel Co.	Toledo, Ohio, 1021 Nicholas Bldg.	Chilson.
Chas. R. Horton	Detroit, 7054 Burwell Ave.	Hamburg.

SAND AND GRAVEL PRODUCERS REPORTING IN 1923—Continued

Operator.	Office.	Pit.
Macomb County		
Detroit Gravel & Ballast Co.	Detroit, 808 Det. Savings Bank Bldg.	Armada.
Cadillac Builders Supply Co.	Detroit, 26 Campau Bldg.	Dredged from the lake.
Peters Bros.	Mt. Clemens	Mt. Clemens.
Lake Side Ice & Coal Co.	Mt. Clemens	Mt. Clemens.
H. Jacob Wacker	Mt. Clemens, 111 Rose St.	Mt. Clemens.
Frank Yates	Rochester	Rochester.
Detroit Sand & Gravel Co.	Detroit, 35 McGraw Bldg.	Utica.
Manistee County		
Hubbell Sand Co.		Manistee.
George Szymanski	Manistee, R. F. D. No. 2	Manistee.
M. A. Farr & Co.	Chicago, Ill., 140 S. Dearborn St.	Onekama.
Manistee Sand Company		
Marquette County		
Champion Gravel Co.	Marquette	Champion.
Lake Superior & Ishpeming		
Mason County		
Marion N. Fitch	Scottsville, R. F. D. No. 4	Amber.
William A. Tobey	Free Soil	Free Soil.
Hubbell Sand Co.		Ludington.
C. C. Dodge & Son	Walhalla	Walhalla.
H. B. Dunbar	Tallman	Tallman.
Mecosta County		
Midland Gravel Co.	Midland	Millbrook.
Menominee County		
Board of County Road Commissioners	Menominee	Various Places.
F. C. Nowack Co.	1316 Main Street	Menominee.
John A. Schoen	Powers, R. F. D. No. 1	Wilson.
The Donner Company		
Montcalm County		
Belknap Cement Products Co.	Greenville	Greenville.
H. Anderson	Greenville	Greenville.
Alexander Kenny	Pierson	Pierson.
Frank H. Stark	Pierson	Pierson.
James Tuttle	Edmore	Edmore.
Muskegon County		
Muskegon County Highway Dept.	Muskegon	Casnovia.
Oakland County		
Dodge Bros.	Detroit	Oxford and Rochester.
Julius Porath	Detroit, 35 McGraw Bldg.	Oxford.
United Fuel & Supply Co.	Detroit, Free Press Bldg.	Oxford.
A. H. Park & Son	Birmingham, R. F. D. No. 2	Birmingham.
J. Calverts Sons	Detroit, McGraw Bldg.	Clarkston.
Charles Munzel	Farmington	Farmington.
Warner R. Thompson & Co.	Detroit, 604 Kerr Bldg.	Goodison.
Standard Gravel Co.	Pontiac	New Hudson.
Detroit-Oxford Gravel & Stone Co.	Oxford	Oxford.
Ward Sand & Gravel Co.	Detroit, Penobscot Bldg.	Oxford.
Boice Bros.	Pontiac, 974 Orchard Lake Ave.	Pontiac.
Fred Parker	Pontiac, R. F. D. No. 6	Pontiac.
C. L. Rockwell	Pontiac, 180 Franklin Rd.	Pontiac.
Rochester Sand & Brick Co.	Detroit	Rochester.
M. D. Ward		
Fuller Becker Co.		
Oceana County		
A. O. Aldrich	Hart	Crystal Valley.
Twp. Board of Newfield	Hesperia	Hesperia.
Frank Wherle	Muskegon, 191 Grand Ave.	Rothbury.
Osceola County		
Pere Marquette R. R. Co.		
Federal Sand & Gravel Co.		Evart.
Crescent Gravel Co.	Reed City	Hersey.
Hersey Gravel Co.	Hersey	Hersey.
Ogemaw County		
John Finerty	West Branch	West Branch.

SAND AND GRAVEL PRODUCERS REPORTING IN 1923—Continued

Operator.	Office.	Pit.
Ottawa County		
John Holtrop	Ferrysburg	Ferrysburg.
Construction Materials Co.	Muskegon	Grand Haven.
I. Van Welden & Co.	Grand Haven, 609 Fulton St.	Grand Haven.
C. W. Bunce	Ravenna	Harrisburg.
Wallinger Bros.		
D. J. Scharpshorn		
Tom Johnson Gravel Co.		
Presque Isle County		
Alpena Gravel Co.		
Saginaw County		
H. C. Buckhardt	Bridgeport	Bridgeport.
Bridgeport Sand & Coal Co.	Saginaw	Orville.
Valley Sand Co.	Bay City, 612 Webster St.	Saginaw River.
Saginaw Brick Co.		
St. Clair County		
Superior Sand & Gravel Co.	Detroit, 926 Dime Bank Bldg.	Marine City.
C. A. Westrick & Son	Marine City	Marine City.
Reynolds & Bailey	Marysville	Marysville.
Mrs. Helena Baker	Memphis	Memphis.
Jas. Chapman	Memphis	Memphis.
Michigan Moulding Sand Co. (W. B. Sickler)	Port Huron, 1928 Seventh St.	Port Huron.
Warner R. Thompson Co.		Port Huron.
L. Recor	Marine City	St. Clair River.
Frank & Chester Kinney	Port Huron, R. F. D. No. 1	Wadham.
McLouth Estate		
Thompson Tug Co.	Port Huron	Port Huron.
Sanilac County		
Handy Bros. Mining Co.	Bay City	Decker.
George Carney	Sandusky, R. F. D.	Sandusky.
William Dawson	Sandusky	Sandusky.
Shiawassee County		
Bert Martenis	Bancroft	Bancroft.
George Clark	Byron, R. F. D. No. 2	Byron.
William Dyer	Bancroft	Byron.
John Graham	Highland Park, 88 Geneva Ave.	Byron.
Allen Hathaway	Byron	Byron.
E. R. Darling	Carland	Carland.
John Frischke	Owosso	Owosso.
F. Hoyes		
Tuscola County		
Tom Hile	Caro, R. F. D. No. 2	Caro.
Cass City Sand & Gravel Co.	Cass City	Cass City.
Tuscola Sand & Gravel Co.	Cass City	Cass City.
Gilbert Baker	Kingston	Kingston.
Lewis DeGrow	Kingston	Kingston.
Benson Whittaker	Kingston, R. F. D. No. 2	Kingston.
A. C. Hess		
Van Buren County		
James Dowhens	Breedsville	Breedsville.
John Sherburn	Decatur	Decatur.
Dade & Bennett	Hartford	Hartford.
J. E. Wright	Lawrence	Lawrence.
Bennett & Parks		
Washtenaw County		
Board of County Road Commissioners	Ann Arbor, Box 124	Ann Arbor.
Geo. Eddie	Ann Arbor, R. F. D. No. 8	Ann Arbor.
Fred Fiegel	Ann Arbor, R. F. D. No. 3	Ann Arbor.
William Schiller	Ann Arbor, R. F. D. No. 3	Ann Arbor.
Mich. Central R. R. Co.	Detroit	Osborn Pit.
Fenkbeiner Bros.	Saline, R. F. D.	Saline.
Cadillac Sand & Gravel Co.	Toledo, Ohio, 1021 Nicholas Bldg.	Ypsilanti.
Ann Arbor Sand & Gravel Co.		

SAND AND GRAVEL PRODUCERS REPORTING IN 1923—Concluded

Operator.	Office.	Pit.
Wayne County		
Birmingham Sand & Gravel Co.	Detroit, 2690 E. Atwater St.	Detroit.
Cameron Steamship Co.	Detroit, Foot of Chene	River near Detroit.
F. D. Gleason Coal Co.	Detroit	Detroit.
W. J. Jaques Co.	Detroit, 1222 Parkview Ave.	Detroit.
Ontario Gravel Freighting Co.	W. Windsor, Ontario, 228 Sandwich St.	Detroit.
Michigan Pressed Brick Co.	Detroit, 4500 Lawton	Goodison.
Rockwood Silica Co.	Rockwood	Rockwood.

TRAP ROCK (BASALT) PRODUCERS, 1923

Operator.	Office.	Quarry.
Dickinson County		
McKenna Bros.	Quinnesec	Quinnesec.
Iron County		
Iron Co. Road Commissioners	Crystal Falls	N.W. of N.E. Sec. 7, 43-32
W. S. Peters	Wakefield	Wakefield.
Oakland County		
Standard Gravel Co.	Pontiac	Pontiac.
Ontonagon County		
Blumgren, J. E. Estate	Norway	Bergland.
Marquette County		
City of Negaunee	Negaunee	Negaunee.
Olivine Co.	Marquette	Marquette.
Beaver Granulith Co.	Negaunee	Negaunee.
City of Ishpeming	Ishpeming	Ishpeming.
Advance Industrial Supply Co.	Chicago, Ill.	Marquette.
City of Marquette	Marquette	Marquette.
Marquette Co. Road Commissioners	Marquette	Marquette.
Garvey Weyenberg Construction Co.	Appleton, Wis.	Marquette.