

Pick machines are operated by air and the difficulty and trouble of laying air pipes forms a serious objection to their use. The chain breast and short wall machines are electrically operated and the work of stringing the necessary power wires is comparatively easy. The latter machines on account of their compactness and ease of manipulation are especially adapted to the room and pillar method and to the close and narrow workings obtaining in most of the mines in Michigan.

Formerly so much slack was produced that it became a drug on the market. Modern manufacturing concerns, equipped with mechanical stokers, preferred to use slack from Ohio, West Virginia, and elsewhere which was of better quality and could be obtained very cheaply. To improve the quality of the slack a washery was established at Saginaw by the Consolidated Coal Company to wash the slack from their mines. This so improved the quality that the present demand for Michigan washed slack far exceeds the supply. Much more coal could be recovered if washing plants were established by the other large operators.

Prospective Development.—Most of the proven coal areas are in Bay and Saginaw counties, but Genesee and Tuscola counties are known to possess large reserves of minable coal. The largest group of developed and undeveloped coal areas occurs between Midland and Bay City, the second most important group is between Saginaw and St. Charles, a third in the northern part of Bay county, and a fourth in the vicinity of Flint, Genesee county. Important areas have also been located in northeastern Tuscola county.

Coal beds from three to five feet in thickness have been struck in many places around the southern margin of the Coal Basin, but as yet little systematic drilling has been done to determine the extent of such beds except near Albion. In this part of the Basin the beds are shallow and the drift is thin, but the coal apparently occurs principally in troughs of very limited extent. Coal beds probably containing areas of minable coal occur in the northwestern half of the Coal Basin, but the great depth of the drift and the abundance of water and quicksand are effective barriers against exploration or mining operations in this region.

Mines have been opened in most of the known coal deposits in Saginaw county but only a few of the proven coal areas in Bay county have been developed as yet. There are a dozen or more of undeveloped coal areas between Midland and Bay City and new mines will probably be opened in these as fast as the present mines become exhausted. The development of the reserves in the northern part of Bay county will probably be slower as they are relatively distant from means of transportation.

From the fact that the local price of coal is generally much higher than that of competitive markets small isolated mines supplying

merely the local trade have been operated with success at various times and places as at Jackson, Williamston and Grand Ledge. A small mine is being opened at the present time near Albion, Calhoun county, to supply local markets.

Markets.

From the central position of the Coal Basin Michigan coals should command the markets of the state with the exception of the extreme southern portion in close proximity to the Ohio and Indiana fields. In the portion of the state north of a line from Port Huron, Lansing, and Grand Rapids Michigan coal has a natural protection in differential freight rates varying from \$.75 to \$1.40 per ton for coals from Ohio fields and about 25 cents per ton more for coals from West Virginia. The cost of mining coal in Michigan, however, is upwards of \$1.00 per ton more than in Ohio and West Virginia and this counterbalances most of the advantage in lower freight rates. In addition much of the Michigan coal is inferior in grade to the average from those states, hence Michigan coal must compete at a lower average price. From these facts the market for Michigan coals is restricted chiefly to the Coal Basin itself and to the northern portions of the state.

Production.

Although coal mining began as early as 1835 it was not until 1860 that any records were kept. In that year Michigan is credited with an output of 2,320 tons. Ten years later the production had increased to a little over 28,000 tons, and in 1880 and the two following years it exceeded the 100,000 ton mark. After this there was a sharp decline, less than 37,000 tons being mined in 1884. The production gradually increased until 1895 when the 100,000 ton mark was again passed. In 1897 with the discovery and opening of the Saginaw and Bay county fields the production was nearly a quarter of a million tons. Two years later it was nearly 625,000 tons, and in 1901 it approached 1,250,000 tons, but a strike of the miners in Saginaw Valley in 1902 caused a sharp decrease to less than 1,000,000 tons. In 1906 another strike caused a decline in production but in the following year the maximum output of 2,035,858 tons was attained. In 1908 a pronounced decline in production set in and this continued until 1912 when the output totalled only 1,206,230 tons. In 1913 there was a slight increase, the production being 1,231,786 tons.

According to the State Department of Labor, nearly complete figures for 1914 give a total production of 1,153,869 tons and it appears very probable that the final figures will not exceed 1,161,000 tons.

MINERAL RESOURCES OF MICHIGAN.

PRODUCTION OF COAL AND COST OF MINING, ETC., IN MICHIGAN BY COUNTIES AND MONTHS FOR 1914.

County.	Number of active mines.	Number of employees.	Average number of hours worked per day.	Average number of days worked per week.	Average daily wages.	Aggregate amount paid in wages.	Number of mines.	Number of powder.	Number of kegs of powder used.	Number of tons of picked coal mined.	Number of tons of machine coal mined.	Total number of tons of coal mined.	Average cost per ton.	Total cost of output.
January.														
Bay.....	7	1,194	8	22.1	\$3 52	\$93,148 18	7	1,427	17,419	41,449	58,868	\$2 12	\$124,940 42	
Saginaw.....	8	974	8	22.8	3 22	67,896 80	8	1,474	19,450	30,668	50,118	1 88	94,351 93	
Other counties..	6	230	8	23.3	2 69	14,420 00	3	359	4,478	2,114	6,592	2 88	19,010 23	
Total.....	21	2,352	8	22.4	\$3 32	\$175,465 74	18	3,260	41,347	74,231	115,578	\$2 06	\$238,302 58	
February.														
Bay.....	7	1,187	8	17.5	\$3 60	\$74,906 26	7	1,139	10,455	36,067	46,522	\$2 20	\$102,556 30	
Saginaw.....	8	974	8	20.3	3 25	64,273 10	8	1,299	16,370	33,125	49,495	1 75	86,985 22	
Other counties..	7	249	8	21.6	3 21	17,263 68	2	413	4,602	1,761	6,363	2 74	17,409 47	
Total.....	22	2,410	8	19.0	\$3 41	\$156,443 04	17	2,851	31,427	70,953	102,380	\$2 01	\$206,950 99	
March.														
Bay.....	8	1,205	8	20.4	\$3 69	\$90,758 29	8	1,306	14,666	43,853	58,519	\$2 07	\$121,532 49	
Saginaw.....	8	979	8	22.3	3 28	71,784 70	8	1,388	18,499	35,264	53,763	2 01	97,865 74	
Other counties..	7	220	8	22.0	3 14	15,893 70	2	222	4,491	3,478	7,969	2 64	21,036 15	
Total.....	23	2,404	8	21.4	\$3 46	\$178,436 69	18	2,916	37,656	82,595	120,251	\$1 91	\$240,454 38	

NON-METALLIC MINERALS.

County.	Number of active mines.	Number of employees.	Average number of hours worked per day.	Average number of days worked per week.	Average daily wages.	Aggregate amount paid in wages.	Number of mines.	Number of powder.	Number of kegs of powder used.	Number of tons of picked coal mined.	Number of tons of machine coal mined.	Total number of tons of coal mined.	Average cost per ton.	Total cost of output.
April.														
Bay.....	7	880	8	14.1	\$3 59	\$45,109 83	6	600	8,634	22,464	31,088	\$2 11	\$65,665 09	
Saginaw.....	7	968	8	18.8	2 95	53,779 69	7	930	9,240	31,782	41,022	2 01	82,695 62	
Other counties..	6	209	8	18.6	3 21	12,481 28	1	78	1,480	1,270	2,750	4 66	12,825 48	
Total.....	20	2,066	8	16.7	\$3 22	\$111,371 10	14	1,608	19,364	55,516	74,880	\$2 15	\$161,186 19	
May.														
Bay.....	7	851	8	18.7	\$3 54	\$66,401 79	6	815	10,292	26,746	37,038	\$2 05	\$76,274 98	
Saginaw.....	7	951	8	18.4	3 36	58,891 54	7	1,032	9,621	30,509	40,130	1 91	76,931 59	
Other counties..	6	192	8	20.5	3 50	13,787 62	1	74	726	3,327	4,053	3 01	12,184 25	
Total.....	20	1,994	8	18.7	\$3 46	\$139,080 95	14	1,921	20,639	60,582	81,221	\$2 03	\$165,390 82	
June.														
Bay.....	6	638	8	14.0	\$3 52	\$31,054 64	5	634	9,361	11,542	20,903	\$2 12	\$44,449 04	
Saginaw.....	6	837	8	13.8	3 46	40,069 22	6	616	8,951	22,240	31,191	1 92	60,161 53	
Other counties..	4	175	8	26.9	3 14	14,810 16	1	123	1,745	5,387	7,132	2 41	17,171 14	
Total.....	16	1,650	8	15.2	\$3 42	\$85,950 52	12	1,373	20,057	39,169	59,226	\$2 05	\$121,781 71	
July.														
Bay.....	5	469	8	18.9	\$3 43	\$30,346 58	3	563	8,219	13,680	21,899	\$1 44	\$41,619 27	
Saginaw.....	7	889	8	15.3	3 59	48,941 73	7	768	11,196	26,430	37,626	1 84	69,254 78	
Other counties..	4	191	8	24.7	3 01	14,233 12	1	99	3,181	3,031	6,212	2 39	14,860 47	
Total.....	16	1,549	8	17.6	\$3 36	\$93,521 43	11	1,430	22,596	43,141	65,737	\$1 75	\$125,734 52	

Adapted from statistical data, compiled and published in the Annual Report of the State Department of Labor for 1914.

MINERAL RESOURCES OF MICHIGAN.

PRODUCTION OF COAL AND COST OF MINING, ETC., IN MICHIGAN BY COUNTIES AND MONTHS FOR 1914.—*Concluded.*

County.	August.										Total cost of out-put.	
	Number active mines.	Number of employees.	Average number of hours worked per day.	Average number of days worked per week.	Average daily wages.	Aggregate amount paid in wages.	Number of mines using powder.	Number of kegs of powder used.	Number of tons of picked coal mined.	Number of tons of machine coal mined.		Total number of tons of coal mined.	Average cost per ton.
Bay.....	8	1,180	8	15.9	\$3.51	\$66,017.58	7	878	15,613	25,416	41,029	\$2.21
Saginaw.....	7	929	8	22.4	3.43	71,527.80	7	1,278	15,019	39,405	54,424	1.75
Other counties...	5	193	8	24.8	3.16	15,152.95	1	115	2,461	4,355	6,816	2.34
Total.....	20	2,302	8	19.2	\$3.45	\$152,699.33	15	2,271	33,093	69,176	103,269	\$1.97
September.												
Bay.....	7	1,048	8	20.3	\$3.41	\$72,728.40	7	1,275	15,881	33,548	49,429	\$2.03
Saginaw.....	8	942	8	20.7	3.33	64,066.08	7	1,173	13,514	33,743	47,257	1.76
Other counties...	5	207	8	23.6	3.06	19,915.42	1	134	2,479	4,127	6,606	2.24
Total.....	20	2,197	8	20.7	\$3.37	\$152,699.90	15	2,582	31,874	71,418	103,292	\$1.92
October.												
Bay.....	8	1,162	8	20.9	\$3.38	\$82,142.06	7	1,391	18,720	37,353	56,053	\$1.94
Saginaw.....	8	967	8	21.7	3.03	63,666.20	8	1,281	15,963	31,990	47,953	2.21
Other counties...	5	220	8	20.5	3.59	16,174.81	1	127	4,488	2,133	6,621	2.12
Total.....	21	2,349	8	21.5	\$3.20	\$161,983.07	16	2,799	39,171	71,456	110,627	\$2.07
November.												
Bay.....	8	1,196	8	19.6	\$3.57	\$83,803.93	7	1,235	15,814	40,141	55,955	\$1.99
Saginaw.....	8	996	8	19.0	3.31	62,647.87	8	1,094	13,279	30,960	44,239	1.91
Other counties...	5	219	8	23.7	3.13	16,170.62	1	108	4,843	2,171	7,014	2.18
Total.....	21	2,411	8	19.7	\$3.43	\$162,622.42	16	2,437	33,936	73,272	107,208	\$1.97
December.												
Bay.....	6	1,078	7.8	23.4	\$3.56	\$89,806.04	6	1,093	15,159	47,857	63,016	\$1.79
Saginaw.....	8	815	7.9	20.2	3.32	65,801.84	8	1,020	6,734	41,193	47,927	1.72
Other counties...	3	19	8	26.7	2.95	1,301.00	.....	.....	257	.....	257	6.74
Total.....	17	2,072	7.9	24.7	\$3.49	\$157,168.88	14	2,113	22,150	89,050	111,200	\$1.78
Average per mo.....	.....	2,146	8.0	19.9	\$3.35	.....	.....	2,400	29,487	66,712	96,155	.....
State total.....	.....	.....	.....	.....	.....	\$1,717,352.71	.....	27,561	353,310	800,559	1,153,869	\$1.99
Total for Cos.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bay.....	.....	.....	.....	.....	.....	\$816,223.58	.....	12,356	160,223	393,177	540,319	.....
Saginaw.....	.....	.....	.....	.....	.....	734,306.87	.....	13,353	157,864	387,309	545,165	.....
Other counties...	.....	.....	.....	.....	.....	166,804.36	.....	1,852	35,231	33,154	68,385	.....

*Figures incomplete for December.

Bay.....	8	1,196	8	19.6	\$3.57	\$83,803.93	7	1,235	15,814	40,141	55,955	\$1.99	\$111,415.54
Saginaw.....	8	996	8	19.0	3.31	62,647.87	8	1,094	13,279	30,960	44,239	1.91	84,516.41
Other counties...	5	219	8	23.7	3.13	16,170.62	1	108	4,843	2,171	7,014	2.18	19,313.54
Total.....	21	2,411	8	19.7	\$3.43	\$162,622.42	16	2,437	33,936	73,272	107,208	\$1.97	\$211,245.49
December.													
Bay.....	6	1,078	7.8	23.4	\$3.56	\$89,806.04	6	1,093	15,159	47,857	63,016	\$1.79	\$113,007.85
Saginaw.....	8	815	7.9	20.2	3.32	65,801.84	8	1,020	6,734	41,193	47,927	1.72	82,645.09
Other counties...	3	19	8	26.7	2.95	1,301.00	.....	.....	257	.....	257	6.74	1,736.45
Total.....	17	2,072	7.9	24.7	\$3.49	\$157,168.88	14	2,113	22,150	89,050	111,200	\$1.78	\$197,389.39
Average per mo.....	.....	2,146	8.0	19.9	\$3.35	.....	.....	2,400	29,487	66,712	96,155	.....	\$191,580.11
State total.....	.....	.....	.....	.....	.....	\$1,717,352.71	.....	27,561	353,310	800,559	1,153,869	\$1.99	\$2,298,960.49
Total for Cos.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bay.....	.....	.....	.....	.....	.....	\$816,223.58	.....	12,356	160,223	393,177	540,319	.....	\$1,102,010.27
Saginaw.....	.....	.....	.....	.....	.....	734,306.87	.....	13,353	157,864	387,309	545,165	.....	1,020,615.89
Other counties...	.....	.....	.....	.....	.....	166,804.36	.....	1,852	35,231	33,154	68,385	.....	176,334.33

PRODUCTION, COST OF MINING, AND VALUE OF COAL IN MICHIGAN, 1900-1914.

Year.	*Number active mines.	Average number employees per month.	**Average daily wage.	Total tons of coal mined.	Total cost of coal mined.	Average cost per ton.	***Total tons of coal mined.	***Total value of coal mined.	***Average price received per ton.	Profit made per ton
1900	31	1,676	\$2 34	871,588	\$1,209,228	\$1.387	849,475	\$1,259,683	\$1.483	\$0.096
1901	30	1,847	2 44	1,016,496	1,442,415	1.419	1,241,241	1,753,064	1.412	.007
1902	32	1,616	2 75	899,967	1,284,342	1.427	964,718	1,653,192	1.714	.287
1903	34	3,014	2 91	1,601,984	2,529,027	1.579	1,367,619	2,707,527	1.979	.400
1904	33	2,753	3 01	1,408,375	2,266,098	1.609	1,342,840	2,424,935	1.806	.197
1905	38	2,776	2 96	1,413,507	2,244,434	1.588	1,473,211	2,512,697	1.705	.117
1906	38	2,106	2 40	1,367,385	2,090,489	1.529	1,346,338	2,427,404	1.803	.274
1907	37	2,897	3 24	1,911,201	3,162,837	1.655	2,035,858	3,660,833	1.798	.143
1908	38	3,115	3 02	1,842,778	3,089,759	1.677	1,835,019	3,322,904	1.811	.134
1909	36	2,907	2 93	1,736,573	2,865,083	1.650	1,784,692	3,199,351	1.793	.143
1910	34	2,471	3 07	1,462,276	2,626,342	1.796	1,534,967	2,930,771	1.909	.103
1911	32	1,539	3 39	1,389,585	2,623,244	1.887	1,476,074	2,791,461	1.891	.004
1912	26	1,886	3 19	1,160,768	2,170,076	1.869	1,201,280	2,399,451	1.989	.120
1913	24	2,076	3 49	1,138,163	2,250,559	1.977	1,231,786	2,455,227	1.993	.016
1914	23	2,146	3 35	1,153,869	2,285,281	1.99				

*Compiled and adapted from reports of State Coal Mine Inspector, Ann. Repts. State Department of Labor.
 **For year beginning Dec. 1 and ending Nov. 30.
 ***From Mineral Resources of United States, U. S. G. S.

PRODUCTION OF COAL BY COUNTIES, 1899-1914.

	Bay.	Eaton.	Ingham.	Jackson.	Saginaw.	Shia-wassee.	Tuscola.	Other counties.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
*1914	540,319	82	1,376	1,287	545,165	903	145,195	.....
*1913	579,123	155	2,953	457	521,848	2,170	31,480	453
*1912	607,740	374	3,874	.....	489,198	4,532	59,252	.....
1911	766,470	100	.....	.....	667,282	13,000	66,427	19,000
1910	766,470	100	.....	.....	667,282	.....	.....	101,215
1909	822,577	558	.....	1,500	859,434	.....	.....	100,623
1908	782,503	2,286	.....	5,539	999,338	.....	.....	45,353
1907	962,574	5,982	.....	5,645	1,047,927	.....	.....	13,730
1906	481,398	18,507	.....	8,658	835,475	.....	.....	2,300
1905	544,154	4,058	.....	9,196	915,803	.....	.....	.....
1904	410,634	9,057	.....	16,860	906,289	.....	.....	.....
1903	325,021	7,393	.....	23,307	1,011,898	.....	.....	.....
1902	248,645	8,800	.....	23,889	670,304	.....	.....	13,400
1901	253,821	4,803	.....	20,288	938,042	.....	.....	24,284
1900	190,814	4,530	.....	23,317	601,112	.....	.....	.....
1899	104,588	3,421	.....	21,600	455,607	.....	.....	39,492

*Compiled from Annual Report of State Department of Labor.
 †Incomplete returns, tonnage approximate.

PRODUCTION OF COAL IN MICHIGAN, 1860-1914, IN SHORT TONS.

Year.	Quantity. Tons.	Year.	Quantity. Tons.	Year.	Quantity. Tons.	Year.	Quantity. Tons.
1860.....	2,320	1871.....	32,000	1882.....	135,339	1893.....	45,979
1861.....	3,000	1872.....	53,000	1883.....	71,296	1894.....	70,022
1862.....	5,000	1873.....	56,000	1884.....	36,712	1895.....	112,322
1863.....	8,000	1874.....	58,000	1885.....	45,178	1896.....	92,882
1864.....	12,000	1875.....	62,000	1886.....	60,434	1897.....	223,592
1865.....	15,000	1876.....	66,000	1887.....	71,461	1898.....	315,722
1866.....	20,000	1877.....	69,197	1888.....	81,407	1899.....	624,708
1867.....	25,000	1878.....	85,322	1889.....	67,431	1900.....	849,475
1868.....	28,000	1879.....	82,015	1890.....	74,977	1901.....	1,241,241
1869.....	29,980	1880.....	100,800	1891.....	80,307	1902.....	964,718
1870.....	28,150	1881.....	112,000	1892.....	77,990	1903.....	1,367,619

*Approximate, returns incomplete. Report of State Coal Mine Inspector, State Department of Labor.

Quantity.
Tons.
1,342,840
1,475,211
1,346,538
2,832,838
1,523,019
1,524,622
1,474,367
1,476,074
1,194,373
1,138,639
1,133,869

Year.
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
*1914

Quantity.
Tons.
45,979
70,022
112,322
92,882
223,592
315,722
624,708
849,475
1,241,241
964,718
1,367,619

Year.
1893
1894
1895
1896
1897
1898
1899
1900
1901
1902
1903

Quantity.
Tons.
135,339
71,296
36,712
45,178
60,434
71,461
81,407
67,431
74,977
80,307
77,990

Year.
1882
1883
1884
1885
1886
1887
1888
1889
1890
1891
1892

Quantity.
Tons.
32,000
53,000
56,000
58,000
62,000
66,000
69,197
85,322
82,015
100,800
112,000

Year.
1871
1872
1873
1874
1875
1876
1877
1878
1879
1880
1881

Quantity.
Tons.
2,320
3,000
5,000
8,000
12,000
15,000
20,000
25,000
28,000
29,980
28,150

LIMESTONE.

The limestone industry in Michigan has made a relatively rapid growth since 1899, but the period of most rapid growth was after 1904. In 1899, the total value of the product including lime was \$281,769, while in 1914 the total value exclusive of lime, which amounted to \$287,648, was \$1,457,961. The gain in 1914, however, was small, the increase amounting to only \$49,258 as against \$269,143 in 1913. The cause of the small increase in 1914 was due to the general business depression throughout the country.

The chief increases were in stone for blast furnace flux, sugar making, and fertilizer; the chief decreases, in the output of crushed stone for road making and railroad ballast, and of stone for the manufacture of soda ash. The large increase in flux stone made in spite of the depressed condition of the iron trade is chiefly owing to the fact that large deposits of high grade limestone near water transportation and very suitable for blast furnace use have been extensively developed in the northern part of the state in the past three or four years, and this stone is successfully invading the flux stone market formerly dominated by limestone from other states. The use of pulverized or ground limestone as a fertilizer and soil rectifier is growing very rapidly and the increase in value of this product in 1914 was more than 57 per cent.

Twenty-five quarries were in operation in 1914. Some quarries, chiefly small ones, were idle but the loss was compensated for by the opening of new or the reopening of old quarries. The crushing plant of the France Stone Co. of Monroe was destroyed by fire the first of the year, but the company rebuilt at once, and now have a new plant completely equipped with modern machinery for producing crushed stone for roadmaking, railway ballast and concrete. The Great Lakes Stone & Lime Co. were unable to complete their crushing plant at Rockport before the close of the 1914 season, but according to reports they will begin active operations in 1915. Their stone is very high calcium limestone, bituminous and very fossiliferous. The Cheboygan Limestone Products Co. opened a quarry near Mackinaw City in high calcium beds belonging to the Dundee limestone.

Owing to the purity and favorable situation of the limestone deposits near water, in which the more recent and larger quarries have been opened, it is very probable that the limestone industry in Michigan will continue to make a steady and rapid growth. With the return of more normal conditions in the iron industry, the season of 1915 promises to be the greatest in the history of the limestone industry in Michigan.

During a portion of the field season of 1913 and 1914, R. A. Smith of the State Geological Survey made an examination of the limestone resources of the state and a complete report is now in preparation.

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1899-1914.

Year.	Rough building. Value.	Dressed building. Value.	Paving. Value.	Curbing. Value.	Flagging. Value.	Rubble. Value.	Riprap. Value.	Crushed stone.	
								Road making.	
								Tons.	Value.
1899	\$80,299	*	\$82,815	*	\$380	\$5,098	\$1,111	.....	.....
1900	32,362	*	105,266	*	799	3,710	799	.....	.....
1901	47,785	*	*	*	200	3,101	5,740	.....	\$31,605
1902	58,707	*	49,000	\$489	5,150	2,800	800	.....	56,261
1903	56,528	*	37,665	250	.....	2,800	2,405	.....	61,342
1904	52,941	805	.....	160	.....	744	1,568	.....	58,655
1905	17,071	.....	.....	75	.....	4,654	1,204	.....	112,113
1906	9,368	641	90,723	.....	.....	1,433	1,234	.....	78,437
1907	19,120	100	56,500	.....	.....	15,907	1,574	.....	131,708
1908	7,216	.....	10,825	300	100	1,572	3,615	.....	132,902
1909	4,450	7,445	35,500	.....	.....	2,205	908	.....	110,184
1910	7,522	.....	.....	.....	.....	165	380	.....	224,307
1911	7,529	.....	.....	.....	.....	380	75	.....	603,553
1912	9,897	.....	.....	.....	.....	3,511	610	.....	532,311
1913	8,274	.....	.....	.....	.....	1,651	6,727	.....	266,316
1914	3,537	.....	.....	.....	.....	.....	.....	.....	242,839
Total	\$324,793	.....	.....	.....	.....	\$43,931	\$28,750	.....	\$1,873,895

*Included in total for year.

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1899-1914.—Continued.

Year.	Crushed stone.				For blast furnace flux.		To sugar factories. Value.	To alkali works. Value.
	Railroad ballast.		Concrete.		Tons.	Value.		
	Tons.	Value.	Tons.	Value.				
1899.....								
1900.....						\$27,512		
1901.....		\$18,200				3,200		
1902.....		40,810	\$75,643			13,488		
1903.....		35,340	49,430			32,246		
1904.....		57,100	48,504			15,502		
1905.....		43,649	60,745			62,586		
1906.....		103,442	107,396			109,883		
1907.....		46,516	61,852			81,517		
1908.....		33,900	97,762			109,429	\$224,356	
1909.....		42,445	73,200			56,841	22,234	
1910.....		42,358	112,829			91,915	32,594	
1911.....	91,713	34,998	178,318			100,149	25,845	
1912.....	54,327	28,368	137,285	306,385	341,027	186,046	65,141	\$308,044
1913.....	116,000	48,400	185,423	185,423	293,941	137,812	36,944	320,961
1914.....	38,000	20,600	292,616	292,616	1,202,817	494,495	38,215	320,961
			166,959	362,209	1,604,240	565,012	69,477	269,087
Total.....		\$596,126	\$1,413,186			\$2,087,633	\$584,453	

*Concealed—included in total.

PRODUCTION AND VALUE OF LIMESTONE IN MICHIGAN, BY USES, 1899-1914.—Concluded.

Year.	To carbonic acid plants. Value.	To paper mills. Value.	Fertilizer.		Other purposes.	To lime burners.	Rank of state. Value.	Total. Value.
			Tons.	Value.				
1899.....								
1900.....					\$2,375			\$281,769
1901.....					124,220			330,847
1902.....					101,389			429,771
1903.....					68,194			413,148
1904.....					4,343			390,473
1905.....					5,323			501,708
1906.....					142,790			544,754
1907.....					278,297			656,269
1908.....					253,490			760,333
1909.....					227,371			669,017
1910.....					239,309			750,589
1911.....					440,857			842,126
1912.....		\$12,558	\$3,003		303,896			1,005,751
1913.....		8,150	3,447		303,874			1,139,560
1914.....		10,723	7,048		39,523			1,408,703
	\$53,138	8,307	10,907					1,457,961
Total.....		\$39,738		\$24,602	\$2,498,031			\$11,582,779

LIME.

In the last ten years the lime industry in Michigan has made very little growth in comparison with the limestone industry. This is due largely to several causes, viz.: (1) the growing scarcity of cheap wood fuel for burning lime, (2) the substitution of concrete for stone and lime mortar in construction work, (3) the rapidly growing use of gypsum wall plaster and plaster substitutes, and (4) the unfavorable location of suitable limestone deposits. Formerly, owing to the abundance of wood fuel, lime was burned at many localities in the state, but now lime is produced only at Menominee, Manistique, Marblehead, and Rexton in the Northern Peninsula, and at Alpena, Afton, Petoskey, Bay Shore, and Charlevoix, and near Omer, and no lime is burned in the southern half of the Southern Peninsula. Most of the limestone deposits are in the northern part of the state relatively distant from large markets and the consequent high transportation charges make it difficult for Michigan burners to compete with lime producers in Indiana, Ohio, and Illinois, situated near cheap coal fuel supplies.

Concrete mortar owing to the ease and rapidity with which it can be handled has largely replaced stone and sand-lime mortar in construction work, and gypsum plasters and plaster board similarly have replaced sand-lime mortar for plastering.

Most of the lime produced is of the "hot" variety, but considerable mild magnesian lime is burned at Manistique, Marblehead, Petoskey, and Bay Shore. Hydrated lime is produced at Manistique and Charlevoix.

The total lime burned in 1914 was 66,507 tons valued at \$287,648 as compared with 77,088 tons valued at \$331,852 in 1913. This represents a decrease in amount of 10,851 tons and in value of \$44,204, or a loss of 13.7 per cent in amount and 13.3 per cent in value. The average price per ton was \$4.33 as against \$4.05 in 1913.

PRODUCTION AND VALUE OF LIME IN MICHIGAN, 1904-1914.

Year.	Total lime burned.		Average price per ton.	No. of plants operating.	Rank of state. Production.
	Quantity, tons.	Value.			
1904.....	63,601	\$256,955	\$4 04	.....	.....
1905.....	48,089	192,844	4 01	.....	.....
1906.....	68,133	281,465	4 13	13	.....
1907.....	65,822	276,534	4 20	12	16
1908.....	68,050	282,023	4 14	10	15
1909.....	83,108	354,135	4 26	12	13
1910.....	72,345	303,377	4 19	10	14
1911.....	80,709	352,608	4 37	14	14
1912.....	74,720	311,448	4 17	11	16
1913.....	77,088	331,852	4 05	10	14
1914.....	66,507	287,648	4 33	10	14
Total.....	768,172	\$3,230,889	.....	.....	.....

SANDSTONE.

The value of the annual output of sandstone in Michigan has decreased from \$188,073 in 1902 to only \$12,983 in 1911. In 1912 and 1913 there were slight increases, the total value of the output in each of these years was \$16,438 and \$19,224 respectively. In 1914 the industry almost ceased to exist, there being but one operator.

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

Quarries were formerly operated in Coal Measure sandstones near Ionia and Grand Ledge 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 uniformly or in spots to an unsightly yellow color. The sandstone near Ionia, however, though soft and friable is streaked and mottled with red, orange, and yellow and makes a pleasing appearance in buildings. No quarries are now operating in sandstone of the Coal Measures or the Upper Marshall, but some rubble and riprap are produced in connection with the quarrying of grindstone from the Lower Marshall in Huron County.

All of the output of sandstone for 1914 was derived from the Jacobsville sandstone, apparently the local equivalent of the Lake Superior or Upper Cambrian sandstone. Extensive quarrying operations have been carried on for a number of years near Jacobsville but the Portage Entry Redstone Co. is now the only active operator. The "redstone"

or "brownstone" of the Jacobsville is well cemented, permanent in color and pleasing in appearance, but the great distance of the deposits from large markets has been and will continue to be a serious obstacle in the way of their development.

Formerly much sandstone was quarried for foundations but now concrete has largely replaced block stone for such purposes on account of the cheapness of concrete materials and the rapidity and ease with which concrete can be handled. Front and fancy brick, owing to their cheapness and to the artistic effects which can be obtained by their use, have largely supplanted stone as a building material, and apparently the sandstone industry in Michigan except the quarrying of grindstones will not again attain its former importance.

*PRODUCTION AND VALUE OF SANDSTONE IN MICHIGAN, 1899-1914.

Year.	Rough building. Value.	Dressed building. Value.	Curbing. Value.	Flagging. Value.	Rubble. Value.	Riprap. Value.	Crushed stone.		Other. Value.	Total. Value.
							Read making. Value.	Concrete. Value.		
1899.	\$102,447	\$51,682	\$109	a					\$23,800	\$178,038
1900.	73,850	58,800			\$26,519					172,450
1901.	128,909				27,393	b			19,000	174,428
1902.	136,280	23,600			15,554	\$800				188,473
1903.	89,931	10,365			10,657					171,857
1904.	47,593	14,818			10,332			\$3,450		171,857
1905.	64,056	36,035			10,403			400		174,898
1906.	35,272	18,950			7,900	770				123,167
1907.	33,561	10,918			5,190	96				45,333
1908.	15,100	18,813		\$528	5,190					38,103
1909.	12,985	16,805			6,294					36,084
1910.	13,312	15,416			2,505					31,233
1911.	5,682	2,809			3,068	1,140			286	12,983
1912.	c	c			c	c			a	16,433
1913.	c	c			c	c			c	19,224
1914.										
Totals.			\$109						\$3,850	

a Included under curbing.
b Included under rubble.

c Included in total.

d Figures not given—only one operator.

* Exclusive of sandstone made into grindstones and scythestones

TRAP ROCK.

Almost inexhaustible resources of trap rock occur in the western half of the Northern Peninsula, chiefly in the iron and copper bearing regions, but trap rock is quarried on an extensive scale only in the vicinity of Marquette. Large quantities of amygdaloid trap rock, however, are taken out in connection with copper mining in the Keweenaw peninsula. The trap rock from Marquette county is harder, tougher, and much less altered than the amygdaloid trap of the Copper Range. The inferior wearing qualities of the latter for road purposes, however, are partly compensated for by most superior cementing powers.

Most of the product is crushed for road making and concrete. On account of its hardness, toughness, and high cementing power trap rock is unexcelled as a road material. The great distance from markets with the consequent high transportation charges and the high cost of quarrying prevents the extensive development of the trap rock resources for concrete and road making in competition with the more easily accessible and cheaply obtained materials—limestone and gravel.

In 1914 the trap rock industry in Michigan suffered from the general depression in trade conditions and as a result there was a large decrease, the total value falling from \$92,201 in 1913 to only \$34,406 in 1914—a little more than one-third that of the year preceding. The decreases, however, were in crushed trap for concrete and in riprap, while there were slight increases in both the amount and value of crushed stone for road making. A new quarry was opened in the vicinity of Negaunee and the rock is reported to be gabbro rather than trap.

PRODUCTION AND VALUE OF TRAP ROCK IN MICHIGAN, 1911-1914.

Year.	No. of producers.	Crushed stone.				Riprap. Value.	Total. Value.	Rank. Value.
		Road making.		Concrete.				
		Quantity.	Value.	Quantity.	Value.			
		Tons.		Tons.				
1911.....	3			45,250	\$38,429		\$51,000	8
1912.....	5	21,805	\$18,366	11,355	9,340	\$8,500	36,206	8
1913.....	5	24,920	23,369	*	*	*	92,201	10
1914.....		25,690	24,863	4,448	4,771		34,406	
Total.....		72,415	\$66,598				\$213,813	

*Included in total.

GRINDSTONES AND SYTHESTONES.

Although Michigan ranks second to Ohio in the production of grindstones and scythestones, the production of the latter state is five or six times that of Michigan. The "grit or grindstone" occurs in the lower part of the Marshall formation in Huron county. The Wallace Company of Port Austin and the Cleveland Stone Company operate quarries at Eagle Mills and Grindstone City respectively, where the gritstone occurs in low-lying and thinly drift covered ledges near the shore of Lake Huron. The surface deposits are removed by stripping and channeling machines cut the stone into square blocks eight feet or more in thickness. These are split with wedges along the bedding planes into thinner slabs which are loaded on cars by derricks, then taken to the mills.

The grindstones produced vary in size from very small ones up to those seven feet in diameter with a 14 inch face. The broken stone is worked up into scythestones.

As there are but two producers no tables of production and value can be given.

SAND AND GRAVEL.

Owing to the general use of sand and gravel in the building trades, no other industry reflects general business conditions better than that of sand and gravel. As a consequence of the general industrial depression prevailing throughout the country during 1914 there was a large falling off in the output of sand and gravel particularly in building sand, and gravel for concrete. The total production in 1914 was 3,757,979 tons as compared with 6,422,818 tons in 1913, a net decrease of 2,664,839 tons or nearly 42 per cent. The decline in total value, however, was relatively less, the value falling from \$1,528,892 in 1913 to \$1,143,771 in 1914, a decrease of \$385,121, or about 25 per cent. In 1914 the production of building sand in Michigan was 1,088,650 tons valued at \$360,152. This represents a decrease in amount of 237,466 tons and in value \$55,585. In 1914, 2,140,359 tons of gravel valued at \$530,338 were produced as against 3,928,874 tons valued at \$915,205 in 1913. This represents a decrease in amount of 1,788,515 tons or about 45.5 per cent and in value of \$384,867 or over 42 per cent.

Michigan has enormous sand and gravel resources. The most important deposits occur in the form of ridges known as eskers or hogbacks, in irregular hills called kames, in outwash plains and deltas and in old beach ridges, features resulting from the last or Wisconsin glacial invasion.

Only a small portion of the sand and gravel resources have been developed and the chief developments are in the vicinity of cities,

in river channels and along the lake shores where means of transportation are favorable. The localities and counties in order of importance in production are Detroit and St. Clair rivers, Jackson, Macomb, Kent, Oakland, Ingham, Manistee, Livingston, Washtenaw, Ottawa and Lenawee counties, and the shores of Lake Michigan and Lake Huron.

PRODUCTION AND VALUE OF SAND AND GRAVEL IN MICHIGAN, 1904-1914.

Year.	Glass sand.		Molding sand.		Building sand.		Fire sand.		Engine sand.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.		Tons.		Tons.	
1904			167,147	\$76,299	69,656	\$30,898				
1905			19,382	13,247	263,315	148,065	5,000	\$2,500		
1906	600	\$3,000	61,387	26,108	403,199	127,937			4,000	\$400
1907	4,300	8,600	54,172	24,190	451,646	157,150	6,000	3,000	1,534	153
1908	17,000	34,000	4,584	2,892	474,238	228,395			1,991	319
1909	65,000	79,000	53,226	20,756	1,090,419	327,247	4,000	2,000	12,415	1,493
1910	16,212	25,675	93,812	24,004	1,151,588	334,336	5,000	3,000	22,270	2,172
1911	*	*	68,878	17,901	833,729	247,997	*	*	25,392	4,447
1912	*	*	152,433	40,145	902,556	294,115			18,575	4,774
1913	*	*	50,763	17,493	1,326,016	415,737	4,542	4,524	4,447	647
1914	26,035	32,593	53,400	36,583	1,088,650	360,152			6,357	1,066
Totals			779,185	299,618	8,055,012	2,672,029			96,981	15,471

Year.	Furnace sand.		Paving sand.		Other sand.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.	
1904						
1905					50,187	\$14,476
1906	5,000	\$2,500			51,005	12,140
1907	3,858	3,133			173,724	12,187
1908	3,329	3,828			29,187	6,850
1909	3,183	3,660			295,612	50,953
1910	3,185	4,924			372,880	57,385
1911	*	*	152,144	\$29,650	114,801	52,005
1912			68,453	16,898	130,624	54,746
1913	†	†	533,261	108,328	113,318	20,342
1914	†	†	320,322	74,866	115,291	107,392
Totals			1,074,180	\$229,742	1,446,629	\$388,476

Year.	Railroad ballast.		Gravel.		Total.		Rank.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.		Tons.		Tons.	
1904					236,803	\$107,197		
1905			76,625	\$32,321	414,509	210,609	10	11
1906			72,598	25,614	597,789	197,699	12	13
1907			329,407	81,182	1,024,641	289,595	10	11
1908			312,262	94,081	842,591	370,365	8	9
1909			695,902	200,523	2,219,757	685,632	8	8
1910			1,197,791	364,841	2,862,738	816,337	7	8
1911			935,072	203,218	2,185,165	565,969	9	10
1912			1,409,180	407,925	2,681,821	818,603	9	8
1913			3,928,874	915,205	6,422,818	1,528,892	4	5
1914	7,565	\$781	2,140,359	530,338	3,757,979	1,143,771	8	7
Total	7,565	\$781	11,098,070	\$2,855,248	23,246,611	\$6,734,660		

*Included under other sand. †Included under fire sand.

SALT.

The amount and value of salt produced in Michigan in 1914 were greater than in any previous year. The total quantity of salt in 1914 was 11,670,976 barrels, or 142,176 barrels more than in 1913. The total value was \$3,299,005, which represents a gain of only \$5,973. The small gain was due to slightly lower prices, the general average price per barrel being \$0.283 per barrel as compared with \$0.285 in 1913. During the period from 1905 to the present the average price has risen from \$0.196 to \$0.283 per barrel.

From 1880 to 1892 inclusive Michigan held first rank in the amount of salt produced. In 1893 New York assumed the lead and held it continuously with the exception of 1901 until 1905 when Michigan regained the leadership. Excepting the years of 1910 and 1911, Michigan has since held first place as a salt producer with New York as a close second.

Thirty years ago the center of the salt industry was in Saginaw Valley, chiefly along Saginaw River from Saginaw to Bay City. The industry was carried on in connection with the lumber mills and waste steam and fuel from the mills were utilized by more than a hundred lumber concerns in evaporating natural brines obtained from the Upper Marshall sandstone at depths varying from about 600 feet in Saginaw to nearly 1,000 feet in Bay City. With the decline of the lumber industry in Saginaw Valley the salt industry has become unimportant, there being but eight producers in 1914, one in Bay City and seven in Saginaw. Less than three per cent of the total output of salt in the state for 1913 and only 3.6 per cent for 1914 was produced in this district.

The chief salt producing districts are along the Detroit-St. Clair Rivers and at Ludington and Manistee. In these districts artificial brines are used for the manufacture of salt. The brine is obtained by forcing water through casings down to rock salt beds and then back to the surface. Rock salt is also mined. Over 96 per cent of the state output of salt for 1913 and 1914 came from these two districts.

The salt industry in Wayne county has made a most remarkable growth. 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 1914 it was 6,593,816 barrels. 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. The Solvay Process Co. at Delray, the Michigan Alkali Co. at Ford City and Wyandotte, and the Pennsylvania Salt Co. of Wyandotte use great quantities of brine in the manufacture of such products.

In St. Clair county the chief salt producing centers are Port Huron, St. Clair and Marine City. The output of St. Clair county in 1914 was only 19 per cent of the state output, yet the value was 42.88 per cent of the total value for the state. The exceptionally high value of the product from this county is due to the fact that much of the salt produced is of the better grades, 59.2 per cent being table and dairy salt.

Rock salt is mined at Oakwood, a small suburb on the western side of Detroit by the Detroit Rock Salt Co. A drill hole at the shaft showed the presence of salt aggregating more than 450 feet in thickness, but present mining operations are in a 20 foot bed at the depth of 1,040 feet. A large part of the product is shipped to Chicago and St. Louis, and other large cities, where it is used chiefly in curing fish, meats, and hides, and in the manufacture of ice cream and for general refrigeration.

In the Manistee-Ludington district salt is made at Manistee, Filer City, and East Lake, all situated on Manistee Lake, Manistee county; and at Ludington. Mason county. In this district the salt industry is still largely carried on in connection with the lumber industry, utilizing waste steam and waste fuel for evaporating artificial brines. This district produced 2,420,334 barrels of salt or 20.82 per cent of the state output. Nearly all of the product is packer's salt, i. e., common fine and common coarse, only one company manufacturing table and dairy salt.

Bromine and bromides are produced from the natural brines of the Marshall sandstone at Midland and Mt. Pleasant, and calcium chloride at Mt. Pleasant and Saginaw.

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

at Royal Oak and Dearborn is greater than to the southeast along Detroit River. In southeastern Michigan the salt beds are very numerous and some of them very thick. There is an upper, thick, and apparently persistent bed from 60 to 125 feet in thickness and a lower very thick and continuous one having a maximum thickness of over 350 feet. The average aggregate thickness of the salt beds along Detroit and St. Clair rivers is about 400 feet thick, but at Royal Oak and Dearborn 609 and 556 feet of salt respectively were penetrated and at the former place the bottom of the Salina apparently was not reached.

In Alpena and Presque Isle counties the salt area while undoubtedly very large is of unknown extent. Rock salt was struck at Onaway, Grand Lake, and Alpena in great force, and the greatest aggregate thickness of rock salt yet penetrated in Michigan and Ontario is at Onaway, Presque Isle county. A test hole drilled for oil at this place penetrated over 800 feet of rock salt in a distance of 1,200 feet, and the lowest bed was 225 feet in thickness. At Grand Lake over 300 feet of salt were penetrated in a deep well without reaching the bottom of the rock salt formation.

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

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

The total area of the rock salt districts in Michigan is unknown, but it is undoubtedly several thousand square miles and present evidence, while not conclusive, indicates that the three known rock salt districts are but parts of one and the same great rock salt area.

PRODUCTION AND VALUE OF SALT IN MICHIGAN AND UNITED STATES,
1860-1914.

Year.	U. S. production. Quantity, bbls.	Michigan production.		Per cent of total. Michigan.	Rank quantity.	Michigan.	
		State Salt Inspectors.* Quantity, bbls.	U. S. G. S.† Quantity, bbls.			Value. Michigan.	Rank Value.	Price, bbl.
1860		4,000					
1861		125,000					
1862		243,000					
1863		466,000					
1864		529,073					
1865		477,200					
1866		407,997				\$734,395	\$1.80
1867		474,721				840,255	1.77
1868		555,690				1,028,027	1.85
1869		561,288				786,835	1.58
1870		621,352				820,185	1.32
1871		728,175				1,063,135	1.46
1872		724,481				1,057,742	1.46
1873		821,346				1,127,984	1.37
1874		1,026,970				1,220,094	1.19
1875		1,081,856				1,190,042	1.10
1876		1,482,729				1,556,865	1.05
1877		1,660,997				1,411,847	0.85
1878		1,855,884				1,577,501	0.85
1879		2,058,040				2,099,200	1.02
1880	5,961,060	2,676,588	2,485,177	41.69	1	2,271,931	0.75
1881	6,200,000	2,750,299	2,507,517	44.35	1	2,418,171	0.85
1882	6,412,373	3,037,317	3,037,317	47.36	1	2,126,122	0.70
1883	6,192,231	2,894,672	2,894,672	46.74	1	2,344,684	0.81
1884	6,514,937	3,161,806	3,161,806	48.53	1	2,392,648	0.757
1885	7,038,653	3,297,403	3,297,403	46.84	1	2,967,663	0.900
1886	7,707,081	3,667,257	3,667,257	47.58	1	2,426,989	0.661
1887	8,003,962	3,944,309	3,944,309	49.17	1	2,291,842	0.581
1888	8,055,881	3,866,228	3,866,228	47.99	1	2,261,743	0.585
1889	8,005,565	3,846,979	3,856,929	48.17	1	2,088,909	0.541
1890	8,776,991	3,838,637	3,838,632	43.72	1	2,302,579	0.600
1891	9,987,945	3,927,671	3,966,748	39.52	1	2,037,289	0.513
1892	11,698,890	3,812,504	3,829,478	32.81	1	2,046,963	0.523
1893	11,897,208	3,514,485	3,057,898	25.70	2	888,837	0.287
1894	12,968,417	3,138,941	3,341,425	26.53	2	1,243,619	0.375
1895	13,669,649	3,529,362	3,343,395	24.46	2	1,048,251	0.315
1896	13,850,726	3,336,242	3,164,238	22.89	2	718,408	0.229
1897	15,973,202	3,622,764	3,993,225	24.99	2	1,243,619	0.313
1898	17,612,634	4,171,916	5,263,564	29.88	2	1,628,081	0.311
1899	19,708,614	4,732,669	7,117,382	36.14	2	2,205,924	0.309
1900	20,869,342	4,738,085	7,210,621	34.55	2	2,033,731	0.282
1901	20,566,661	5,580,101	7,729,641	37.58	1	2,437,677	0.328
1902	23,849,231	4,994,245	8,131,781	34.10	2	1,535,823	0.188
1903	18,968,089	4,387,982	4,297,542	22.65	2	1,119,984	0.260
1904	22,030,002	5,390,812	5,425,904	24.62	2	1,579,206	0.309
1905	25,966,122	5,671,253	9,492,173	35.24	1	1,851,332	0.196
1906	28,172,380	5,644,539	9,936,802	36.31	1	2,018,760	0.203
1907	29,704,128	6,298,463	10,786,630	35.39	1	2,231,129	0.208
1908	28,822,062	6,247,073	10,194,279	35.34	1	2,458,303	0.241
1909	30,107,646	6,055,661	9,966,744	33.10	1	2,732,556	0.274
1910	30,305,656	5,597,276	9,452,022	31.18	2	2,231,262	0.236
1911	31,183,968	.....	10,320,074	33.10	2	2,633,155	0.255
1912	33,324,808	.....	10,946,739	32.84	1	2,974,429	0.277
1913	34,393,227†	.....	11,528,800	33.52	1	3,293,032	0.285
1914	34,402,772	.....	11,670,976	33.92	1	3,299,005	0.283
Tot'l.	.....	.....	209,217,812	.....	.....	\$89,897,763	.....

*Office of State Salt Inspector abolished in 1911.

†In cooperation with the Michigan Geological Survey after 1909.

‡Includes production of Porto Rico.

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY GRADES, 1906-1914.

Year.	Table and dairy.		Packers.			
			Common fine.		Common coarse.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.		Barrels.		Barrels.	
1906 . . .	509,905	\$362,368	2,927,478	\$757,470	2,021,287	\$618,727
1907 . . .	657,509	392,641	3,601,270	914,154	1,743,540	471,378
1908 . . .	584,452	620,647	3,454,062	968,617	2,020,956	610,286
1909 . . .	585,370	732,907	3,330,303	1,125,095	2,103,719	647,878
1910 . . .	798,434	565,653	2,216,181	734,828	1,992,465	596,301
1911 . . .	817,486	742,702	2,362,075	698,203	2,070,745	745,720
1912 . . .	905,593	920,782	2,225,337	645,092	2,086,492	835,673
1913 . . .	1,028,000	1,037,402	2,704,936	852,135	2,259,164	896,521
1914 . . .	1,092,344	1,025,164	2,668,989	911,016	2,380,378	870,715

Year.	Packers.		Other, rock, etc.		Brine and other.*	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.		Barrels.		Barrels.	
1906 . . .	91,098	\$33,733			4,387,043	\$246,462
1907 . . .	119,459	48,455			4,664,552	235,729
1908 . . .	134,726	53,669			3,991,083	205,084
1909 . . .	93,357	3,983			3,648,395	185,051
1910 . . .	92,426	43,942			4,104,934	211,317
1911 . . .	105,401	45,421	576,595	\$181,865	4,387,772	219,244
1912 . . .	223,866	84,638	763,908	250,680	4,737,038	236,852
1913 . . .	50,557	25,371	727,364	244,172	4,756,779	237,431
1914 . . .	†	†	712,530	252,024	4,816,735	240,086

Year.	Total.	
	Quantity.	Value.
	Barrels.	
1906 . . .	9,936,802	\$2,018,760
1907 . . .	10,786,630	2,062,357
1908 . . .	10,194,270	2,458,303
1909 . . .	9,966,744	2,732,556
1910 . . .	9,452,022	2,231,262
1911 . . .	10,320,074	2,633,155
1912 . . .	10,946,739	2,974,429
1913 . . .	11,528,800	3,293,032
1914 . . .	11,670,976	3,299,005

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

PRODUCTION AND VALUE OF SALT IN MICHIGAN BY COUNTIES IN 1914.

County.	Table and dairy.		Packers.			
			Common fine.		Common coarse.	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
Bay						
Isabella						
Mason	*	*	1,026,419	\$277,191	290,328	\$82,852
Midland						
Manistee			*	*	*	*
Saginaw			360,633	175,362	30,795	15,065
St. Clair	837,559	\$884,112	687,683	267,402	671,979	237,181
Wayne	204,647	114,729	342,613	61,516	606,800	183,669
Total barrels . . .	1,092,344	\$1,025,164	2,668,989	\$911,016	2,380,378	\$870,715
Tons	152,928		373,659		333,253	

County.	Other grades.		Rock salt.		Brine.	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
	Barrels.		Barrels.		Barrels.	
Bay						
Isabella						
Mason	*	*			*	*
Midland						
Manistee	*	*				
Saginaw	*	*			*	*
St. Clair	*	*			*	*
Wayne	*	*	*	*	*	*
Total barrels . . .	34,180	\$9,038	*	*	4,816,735	\$240,086
Tons	4,785		*	*	674,343	

County.	Total.		Quantity, per cent.	Value, per cent.
	Barrels.	Value.		
Bay				
Isabella				
Mason	1,421,617	\$388,555	12.18	11.78
Midland				
Manistee	1,040,634	422,346	8.92	12.80
Saginaw	398,067	191,068	3.40	5.79
St. Clair	2,216,842	1,414,668	19.00	42.88
Wayne	6,593,816	882,368	56.50	26.75
Total barrels . . .	11,670,976	\$3,299,005		
Tons	1,633,937			

*Included in total.

CEMENT.

Growth of Industry.

In 1895 less than 1,000,000 barrels of Portland cement were manufactured in the United States, less than quarter of the present production of Michigan. At this date the rotary kiln, burning powdered coal, was successfully introduced and inaugurated the present era of concrete construction. From 1895 to 1907 the growth was phenomenal, nearly 48,000,000 barrels being produced in the latter year. The general financial depression in 1907 caused a temporary check, but the growth was resumed in 1908 and continued until 1913 when over 92,000,000 barrels were made. In 1914, however, there was a decrease of more than 3,865,000 barrels, owing to the unsettled business conditions largely engendered by the present European war.

In Michigan as early as 1878 a vertical kiln plant was erected near Kalamazoo for the manufacture of Portland cement from marl and clay but the enterprise was a failure on account of the high cost of production and the plant was abandoned in 1882. The Peerless Portland Cement Co. in 1896 erected a vertical kiln plant at Union City, Branch county, and began the successful manufacture of cement from marl and shale. In 1902, however, the old vertical kilns were replaced by modern rotary types. In 1897 the Bronson Portland Cement Co. erected a mill at Bronson, Branch county, and the next year the Coldwater Portland Cement Co., now the Wolverine Portland Cement Co., was formed, a plant being built at Coldwater and later another at Quincy, Branch county.

The "boom" years in Michigan were between 1899 and 1901, twenty companies being organized during this period for the manufacture of cement from marl. Some of the companies made very elaborate plans but never got beyond this stage; only ten ever reached the productive stage and but five of these are now in operation. In all, since 1896, 34 cement plants have been projected or built in Michigan, only eleven of which were in operation in 1914 and one, the Egyptian Portland Cement Co. at Fenton, Genesee county, was reorganized and the plant rebuilt in preparation for active operations in 1915.

Raw Materials.

In Michigan the principal raw materials for the manufacture of Portland cement are marl and limestone, and clay and shale. Gypsum is also used but in relatively small amounts. Nearly all of the early companies organized planned to utilize marl and clay or shale, but the high cost of driving off the large amount of water contained in marl

has caused some of them to change to limestone. At present six of the companies are using marl and clay, and four limestone and shale or clay. According to reports, the reorganized Egyptian Portland Cement Co. at Fenton will use marl and shale.

The following table shows that Michigan produced 4,285,345 barrels of Portland cement in 1914, as against 4,186,236 barrels in 1913. This represents an increase of over 99,109 barrels or 2.36 per cent as compared with an increase of 691,615 or 19.79 per cent in 1913. Shipments increased from 4,081,281 barrels in 1913 to 4,218,429 barrels in 1914, a gain of 137,148 barrels or 3.36 per cent. In both production and shipments the totals were the largest in the history of the industry in Michigan. Owing to lower average prices, however, the value of cement sold decreased from \$4,228,879 in 1913 to \$4,064,781 in 1914, a loss of \$164,098 or 3.88 per cent.

Of the total shipments 2,970,524 barrels were sold in Michigan and 1,314,821 barrels in other states and in Ontario. Of the extra-state shipments 368,722 barrels were shipped to Ohio, 293,923 barrels to Indiana, 273,225 barrels to Minnesota, 235,012 to Wisconsin, 134,588 to Illinois, and the remainder to Kentucky and Ontario.

During the latter part of 1912 and throughout 1913, cement operators enjoyed the highest prices since 1907. This accounts for the great increases in production, shipments, and total value in 1913. In 1914, however, prices were on the average considerably less though the demand was reported nearly equal to that in 1913. The average price per barrel fell from \$1.036 in 1913 to \$0.964 in 1914, a loss of \$0.072 per barrel.

PRODUCTION, VALUE, ETC., OF PORTLAND CEMENT IN MICHIGAN AND UNITED STATES, 1896-1914.

Year.	No. of plants in operation.	Michigan Rank.	No. of kilns.	No. 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	1	1	1	4,000	1,543,223	1,543,223	0.25	275.0	\$7,000	\$2,424,011	\$2,424,011	0.29	.....	\$1.75	\$1.57
1897	2	1	2	2	17,000	2,677,775	2,677,775	0.50	413.3	26,250	4,315,891	4,315,891	0.6	.....	1.73	1.61
1898	2	1	2	2	77,000	2,692,584	2,692,584	2.11	346.2	134,750	5,970,773	5,970,773	2.3	.....	1.747	1.62
1899	4	1	4	4	343,566	3,652,266	3,652,266	6.1	93.4	513,849	8,074,371	8,074,371	6.36	.....	1.492	1.43
1900	6	2	6	6	664,750	8,482,020	8,482,020	7.8	.....	830,990	9,286,525	9,286,525	8.9	.....	1.25	1.09
1901	10	3	10	10	1,025,718	12,711,225	12,711,225	8.0	54.1	1,128,290	12,532,360	12,532,360	9.0	.....	1.10	0.99
1902	10	3	10	10	1,572,006	17,230,644	17,230,644	9.1	53.7	2,134,396	20,864,078	20,864,078	10.2	.....	1.353	1.21
1903	12	3	12	12	1,917,183	22,242,973	22,242,973	8.7	23.9	2,674,780	27,713,319	27,713,319	9.7	.....	1.367	1.24
1904	16	4	16	16	2,247,160	25,503,881	25,503,881	8.8	14.9	2,865,636	33,352,119	33,352,119	10.1	.....	1.052	0.88
1905	16	5	16	16	2,773,283	35,246,812	35,246,812	7.9	23.4	2,921,507	33,243,867	33,243,867	8.7	.....	1.033	0.94
1906	14	4	14	14	3,747,525	46,462,424	46,462,424	8.06	35.5	4,814,965	52,466,186	52,466,186	9.2	.....	1.284	1.13
1907	14	4	14	14	3,572,668	48,785,300	48,785,300	7.3	4.6	4,384,731	53,992,551	53,992,551	8.1	.....	1.227	1.11
1908	15	4	15	15	3,502,568	51,072,619	51,072,619	5.6	10.0	2,556,215	43,547,679	43,547,679	5.8	.....	0.883	0.85
1909	12	7	12	12	3,312,751	61,992,431	61,992,431	4.9	11.6	2,619,239	52,858,354	52,858,354	4.9	.....	0.815	0.813
1910	12	8	12	12	3,687,719	76,549,951	76,549,951	4.8	11.7	3,378,940	68,208,800	68,208,800	4.9	.....	0.916	0.801
1911	11	8	11	11	3,686,716	78,528,637	78,528,637	4.69	0.03	3,024,676	66,248,817	66,248,817	4.56	506,758	0.82	0.843
1912	11	8	11	11	3,484,621	82,438,006	82,438,006	4.23	5.21	3,145,001	69,109,800	69,109,800	4.55	370,956	0.861	0.813
1913	11	8	11	11	4,289,236	92,097,131	92,097,131	4.21	19.70	4,228,879	88,680,377	88,680,377	4.77	473,663	1.036	1.005
1914	11	7	11	11	4,283,343	88,230,170	88,230,170	4.83	2.37	4,064,781	86,437,956	86,437,956	4.70	538,846	0.904	0.927

*Minus sign indicates decrease.

GYPSUM DEPOSITS IN MICHIGAN.

OCCURRENCE AND DEVELOPMENT.

Gypsum in Michigan occurs chiefly in the Michigan Series or Lower Grand Rapids of the Mississippian and in the Lower Monroe and the Salina of the Silurian. The Grand Rapids group immediately underlies the interior coal basin and outcrops at many places in a nearly continuous belt around it. On the southeastern side of the coal basin, the gypsum bearing series is absent or present only locally, either having been removed by erosion or never deposited. The Monroe formation outcrops only in the extreme southeastern portion of the state and in the St. Ignace peninsula and adjacent islands. The Salina does not come to the surface in southern Michigan and has not been certainly differentiated from the Monroe formation in St. Ignace peninsula.

The gypsum deposits of Michigan are all of the massive rock variety. In the Michigan Series gypsum occurs in lenticular beds intercalated in shales and shaly limestones. The beds vary in thickness from a fraction of an inch up to 25 feet or more. Some, particularly the thinner ones are of very local extent, while some of the thicker ones have been traced over areas many square miles in extent. In some localities there are numerous beds of gypsum, in others none. Drillings, however, indicate that gypsum beds are generally present throughout much of the formation, but that within the limits of the coal basin they are largely replaced by anhydrite and are too deep to be of commercial importance at present.

The gypsum rock is generally very pure especially in the thicker beds and it is usually white to reddish in color.

In the Lower Monroe and the Salina of southeastern Michigan the gypsum is largely anhydrite, or anhydrous calcium sulphate and occurs in association with dolomite and rock salt beds. The beds are very numerous and some of them are very thick, thicknesses of over 50 feet having been reported. The areas in southern Michigan underlain by anhydrite apparently cover thousands of square miles but this mineral has no commercial value at present. Though the beds were gypsum instead of anhydrite, their generally great depth would render them of little value.

The deposits of gypsum have been developed in three areas, the Grand Rapids-Grandville in Kent county, the Alabaster in south-

eastern Iosco county, and the St. Ignace in Mackinac county, but operations ceased in the last district many years ago. Large but undeveloped deposits are known to occur in western Iosco county, southeastern Ogemaw, and southern Arenac county. Gypsum beds 5 to 30 feet in thickness are reported to occur at comparatively shallow depths at Ionia, Ionia county, and also in Saginaw county. Beds 6 to 12 feet thick were encountered in shallow wells at Bellevue and Eaton Rapids, in Eaton county. The wide spread occurrence of gypsum beds in the Michigan Series is indicated not only by the numerous deposits of gypsum near the margin of the formation but also by the striking of thick beds of gypsum within the limits of the Coal Basin in deep wells at Grayling, Gladwin, Bay City, Midland, Saginaw, Mt. Pleasant, Alma, and St. Johns. These beds are probably too deep for development under present conditions.

The Grand Rapids-Grandville gypsum area, as developed, extends in a belt three or four miles in width along the valley of Grand River from the northern part of Grand Rapids southwest through Grandville and into eastern Ottawa county, a distance of 10 miles or more. Although the productive area extends in a general northeast-southwest direction, the strike of the gypsum bearing rocks in Kent county is northwest-southeast. The valley of the Grand varies in width from one to one and one-fourth miles at Grand Rapids to three or four miles at Grandville, the bluffs along the valley being formed by drift material and rising 100 to 150 feet above the river flats. Exploration and development were naturally confined to the valley and its tributaries where the rock is covered by only a few feet of river silt or sand and gravel. Further exploration along creek valleys to the northwest and to the southeast along the strike of the formation will probably show that the gypsum beds have a much greater extent in these directions than now known. The known productive portion of the Grand Rapids-Grandville area is estimated at about 25 square miles. In the district there are several beds of gypsum of minable thickness, three of which, and probably five, have been developed on a commercial scale. At Grand Rapids, the first bed, six feet in thickness is quarried, the second, a twelve foot bed is both quarried and mined, and the third a 22 foot bed, about 60 feet below the second is mined. The upper bed is absent in many places, having been removed by erosion, and the second is locally very thin, or even entirely wanting, apparently from solution. When the twelve foot bed is mined the six foot bed is generally left for the roof of the mine. The 22-foot bed is divided near the middle by a shale parting one foot or less in thickness. Until a few years ago only the two upper beds at Grand Rapids were worked for it was supposed that water would be very troublesome in mining, but when

a shaft was sunk to this bed mining conditions were found to be ideal, the mine entries being perfectly dry.

At Grandville the upper bed is about 11 feet in thickness and is overlain by eight to ten feet or more of gravel and soil. This bed is quarried, the overburden being removed by stripping. The floor of the quarry consists of four feet of hard limestone which rests directly on the second bed of gypsum, 14 feet in thickness, which is mined. These two beds of gypsum may be the equivalent of the 22-foot "split" in west Grand Rapids, the four feet of limestone corresponding to the shale parting. More evidence, however, is needed before definite correlations are warranted.

North of the river near Grand Rapids the mines enter the bluffs at the level of the mills but down an incline. The mines are locally known as "caves." South of the river, near Plaster creek, the bottom of the lowest bed quarried is about ten feet above the river. At Grandville the quarries are about a mile south of the river and but little above it. From their slight elevation above the water the quarries on the river flats have much trouble from water and several quarries have been abandoned from this cause.

The overburden in the vicinity of the quarries varies from a few feet to more than 20 feet of sand and gravel. Near the Plaster creek quarries surface materials are relatively thin but there is 12 to 15 feet of shale above the six foot bed of gypsum. The heavy cost of removing the overburden and water has caused the gradual abandonment of quarries and the opening of mines.

The Alabaster quarry and mill are located in the southeastern part of Iosco county, six miles south and west of Tawas City, and three-fourths of a mile from the shore of Saginaw Bay. The bed of gypsum is from 18 to 23 feet in thickness, and near the Bay it was covered by five to eight feet of gravel, but farther west the overburden is a tough boulder clay 9 to 14 feet or more in thickness, which is removed by steam shovels. The base of the bed is about 15 feet above the level of the Bay. A large area has been worked out and the face which has been developed in the form of a horse shoe is nearly a mile in length. This is not only the largest quarry in the state but one of the largest in the United States.

The Alabaster bed is known to be of commercial thickness over an area of 25 to 30 square miles in southeastern Iosco county and northwestern Arenac county, but its surface exposure is of limited extent. The bed dips gently to the south-southwest, where it is buried under other strata. In the western part of Iosco county and southern Ogemaw county gypsum outcrops in numerous places or occurs at shallow depths. Drillings north and west of Alabaster show the

presence of at least five workable beds below the Alabaster bed, the thickness of the beds ranging from 4 to 22 feet.

In Arenac county in the vicinity of Turner and in the northeastern part of the county a persistent bed of gypsum 50 to 100 feet above the Alabaster bed has been discovered in wells. This is known as the Turner* bed. There are two areas in the county in which this bed is thick enough for mining, one in the vicinity of Turner and the other in the northeastern part of the county. The combined area of the two territories is 20 to 25 square miles, but further exploration will probably increase the minable area of the Turner bed very greatly.

Gypsum occurs at various places in the St. Ignace peninsula† and on adjacent islands. In 1850 a quarry was opened near Pt. Aux Chenes seven miles west of St. Ignace. A dock was built and gypsum was shipped to mills in Chicago. Owing to various troubles, chief of which were water in the quarry and a scourge of smallpox, the quarry was operated more or less interruptedly for a number of years and finally, when an ice floe carried away the dock, the enterprise was abandoned. Nothing further was done until 1894 when test holes were put down two miles west of the old quarry. According to reports a ledge of gypsum a few feet in thickness was found under light cover and beds totalling 60 feet in aggregate thickness were penetrated by the borings. In a deep well two miles north of St. Ignace some gypsum was struck at 35 feet, 13 feet of gypsum at 174 feet and five feet at 255 feet. Drillings on a bench at the foot of Rabbit's Back Peak, a high limestone spur projecting into the lake four miles north of St. Ignace, showed some gypsum a few feet below the surface, a 21 foot bed at about 30 feet, and a nine foot bed at 57 feet. The surface of the land on which the drillings were made is only 10 to 15 feet above the lake. In some places gypsum was found under only about 14 inches of soil and near the extremity of Rabbit's Back Point a bed outcrops close to the water's edge and can be seen beneath the water near the shore. Gypsum is found on adjoining tracts of land and at Gross Point four miles farther north. From this point eastward outcrops of gypsum occur along the shore for several miles. On St. Martins Island directly east of Gross Point, gypsum is struck in shallow wells over a large part of the southern portion of the island and may be seen in the water along the shore. The top ledge, said to be three feet thick, is near the surface, and other beds occur lower down. According to analysis the rock is very pure, containing over 98 per cent of gypsum. Present evidence indicates the presence of seven easily accessible heavy beds of gypsum in St. Ignace peninsula and adjacent islands, but whether or not water

*W. M. Gregory, Geological Rept. Arenac county, Pub. 11., Geol. Ser. 8, pp 54-55.

†G. P. Grimsley, Vol. IX, p. 83, Mich. Geol. Survey.

would be generally troublesome in quarrying or mining is uncertain.

According to Lane there are many signs of gypsum deposits in the northern part of the Beaver Island group in Lake Michigan.

HISTORY.*

In 1827 gypsum was discovered on Plaster creek which flows into Grand River in the southwestern part of Grand Rapids and it was first calcined some years later by James Clark who used an old Indian corn mill for grinding the rock and a caldron kettle for calcining. The first mill was built on Plaster creek in 1841 near the crossing of the Grandville road. The machinery consisted of one run of millstones and a thick bottomed two-barrel caldron kettle. Most of the gypsum, however, was ground into land plaster, and 10 years later 60 tons were produced daily. In 1843 gypsum was discovered on the north side of Grand River and in 1849 a mill was built near the site of the present Eagle Mill No. 1 of the Grand Rapids Plaster Co. A second mill, now the Eagle Mill No. 2 of this company, was erected on neighboring property in 1869.

In the early 60's gypsum was discovered south of Grandville, six miles southwest of Grand Rapids, through the overturning of an old tree by high wind, and two mills were built, one in 1873 and the other in 1874. Other mills were built and quarries opened later at various times but owing to the keen competition and faulty methods of calcining many of the ventures were unsuccessful. About 1901 consolidation of the various interests began and at present the seven mines and quarries and eight mills in the Grand Rapids-Grandville district are owned or controlled by four companies.

Gypsum had been discovered by the Indian traders at Alabaster before 1841 but it was not until 1862 that a quarry was opened, supplying small mills at Winona and Bay City, Bay county, and Monroe, Monroe county, with gypsum for the manufacture of land plaster. Later a mill was built and at present this quarry, operated by the U. S. Gypsum Company, is one of the largest in the United States. Another quarry was opened in 1870 about three miles south of Alabaster but trouble with water caused its abandonment.

In 1823 Dr. J. J. Bigsby made the first discovery of gypsum in Michigan on St. Martins Island. In the 50's a gypsum quarry was opened near Pt. Aux Chenes seven miles west of St. Ignace, Mackinac county, and supplied mills at Chicago with gypsum. Water was very troublesome and after a few years, when an ice gorge carried away the dock the quarry was abandoned and no attempt has been made to reopen the quarry since.

*Vol. IX, Pt. II. The Gypsum of Michigan by G. P. Grimsley. Mich. Geol. Surv.

PRODUCTION.

From 1860 to 1890 inclusive the annual production of gypsum in Michigan never reached 75,000 tons. In 1891 the production increased to nearly 98,000 tons and the next year reached 139,557 tons. The industry suffered severely from the general financial depression in the country in 1892-1893 and three years later, in 1895, the production had decreased to only 66,519 tons or less than half the production of 1892. By 1899 the industry had recovered from the effects of the depression and entered a period of growth and development which continued almost without interruption up to the close of 1913. In 1913 the total quantity of gypsum mined was 423,896 tons, the largest in the history of the industry, but, in 1914, owing to the industrial depression prevailing throughout the United States, there was a marked decrease, the production falling to 393,006 tons, or about 30,000 tons less than in the previous year. The value of gypsum products in 1914, however, was \$705,841 or only \$15,484 less than in 1913.

From 1868 to 1887 more than half of the gypsum output was ground and sold as land plaster. Since 1887 the grinding of land plaster has become relatively of less and less importance, the production in 1913 and 1914 being respectively only 9,604 and 9,322 tons. The rapid and steady growth of the gypsum industry since 1898 is due largely to the invention of various mixed gypsum wall plasters, plaster board and calcimines and to the increased use of gypsum in the manufacture of Portland cement. The mining and quarrying operations of the gypsum industry have become relatively unimportant in comparison with the manufacturing of gypsum products.

PRODUCTION OF GYPSUM IN MICHIGAN, 1868-1914.

Year.	Ground into land plaster. Tons.	Gypsum calcined into plaster. Tons.	Sold crude. Tons.	Total production. Tons.	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	234,054		
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	18,929		68,499	349,710		
1881.....	33,178	20,145		53,323	293,872		
1882.....	37,821	24,136		61,957	344,374		
1883.....	40,082	28,410		68,492	377,567		
1884.....	27,888	27,959		55,847	335,382		
1885.....	28,184	25,281		53,465	286,802		
1886.....	29,373	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	67,634	146,424		
1897.....	7,193	71,680	16,001	94,874	193,576		
1898.....	13,345	77,852	1,984	93,181	204,310		
1899.....	17,196	88,315	39,266	144,776	283,537		
1900.....	10,354	86,972	33,328	129,654	285,119	2	2
1901.....	9,808	129,256	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	24,284	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	491,928	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	63,819	384,297	621,547	2	3
1913.....	9,604	278,368	60,706	423,896	721,325	3	3
1914.....	9,322	249,648	61,227	393,006	705,841	3	3
Totals..	1,232,477	4,185,635	928,289	6,894,576	\$18,244,311		

PRODUCTION OF GYPSUM IN MICHIGAN, 1911-1914.

Year.	Gypsum sold crude.									
	Crude gypsum mined.		To Portland cement mills.		As land plaster.		For other purposes.		Total sold crude.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1911.....	Tons.		Tons.		Tons.		Tons.		Tons.	
1912.....	347,296	\$69,497	15,548	\$15,706	13	\$52	79,050	\$85,255		
1913.....	384,297	52,420	10,103	9,375	5	50	63,819	61,845		
1914.....	423,896	*	9,604	10,222	10,320	9,011	60,706	55,969		
	393,006	*	9,322	10,761			61,227	51,242		

Gypsum sold calcined.

Year.	As mixed wall plaster.		As plaster of Paris, etc.		As stucco.		As dental plaster.		To plate glass works.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	1911.....	Tons.		Tons.		Tons.		Tons.		Tons.
1912.....	146,920	\$381,362	47,989	\$88,168	82,010	\$168,734	20	\$110	11,370	\$19,031
1913.....	146,099	368,676	47,937	3,222	85,402	202,675	3	12	6,214	8,078
1914.....	166,711	437,720	*	*	83,780	173,172	*	*	*	*
	163,972	475,638								

*Included in total.

PRODUCTION OF GYPSUM IN MICHIGAN, 1911-1914.—Concluded.

Year.	Gypsum sold calcined.						Kettles in mill.	Daily capacity of mill.	Shifts run by mills during year.	No. mines and quarries.	No. mills.
	For other purposes.		Total sold calcined.		Total value.						
	Quantity.	Value.	Quantity.	Value.	Total No.	Hrs. in shift.					
1911.....	Tons.		Tons.		Tons.		Tons.				
1912.....	8,393	\$10,973	206,299	\$488,671	29	8 x 10	2,200	1,850	8	8	
1913.....	9,897	15,850	243,656	559,702	28	8 x 10	2,740	1,368	6	6	
1914.....	1,811	5,433	278,368	665,356	28	8 x 10	1,785	1,368	7	7	
			249,648	654,599	28	8 x 10	1,860	2,043	8	8	

CLAY.

The clays of Michigan are of three general classes, viz., (1) morainic or drift clays (2) lake clays and (3) river silts. Deposits of kaolin or china clays are unknown in Michigan and the chances for the occurrence of commercial deposits of such clays appear to be small. Deposits of kaolin have been reported at various places in the Northern Peninsula, but these as far as investigated proved to be white highly calcareous lake clays of the slip variety. The morainic clays—boulder and till clays, are always calcareous, some of them being exceptionally high in lime. The lake clays are generally less calcareous but locally, as in limestone areas, they may contain a large percentage of lime. The river silts are the least calcareous but they are usually gritty. On account of the generally high content of lime most of the clays burn white. In many deposits, however, there is an upper portion relatively free from lime which burns red, and a lower one very high in lime which burns white or cream color. The absence of lime in the upper zone is due to leaching.

The morainic or drift clays contain stone and pebbles, hence the name "boulder clay," and locally lime concretions. This necessitates screening. Screening and washing have been resorted to in some cases but the extra expense is generally prohibitive except in districts where good clays are wanting or where the clays possess exceptional burning qualities. The lake clays are comparatively free from pebbles and coarse sand but they may contain much very fine grit. These clays are generally suitable for making common brick and tile, and there are inexhaustible supplies of such clays in the eastern portion of the Southern Peninsula from Arenac county south to the Ohio boundary. Large areas of lake clays also occur in Chippewa and Ontonagon counties.

The morainic or boulder clays have been developed for the manufacture of common brick and tile at many places in the state but generally on a small scale. The lake clays in the vicinity of West Detroit have been developed very extensively for brick making and more than 82 per cent of the common brick produced in Michigan in 1914 were made in the vicinity of Detroit. Important developments have also been made near Paines and West Saginaw, Saginaw county, and at numerous places in Lenawee, Monroe, and Macomb counties.

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

Most of the surface clays in Michigan are low grade and generally the mining of such clays is merely incidental to the manufacturing of common brick and tile. Nearly all of the clay sold as clay in Mich-

igan is slip clay mined chiefly near Rockland, Ontonagon county, and shipped to potteries in Ohio for glazing purposes. The great distance of the slip clay deposits from ready markets, however, makes development slow and difficult. A small amount of clay is sold for medicinal purposes.

PRODUCTION OF CLAY IN MICHIGAN, 1910-1914.

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
Total..	8,314	\$26,219					8,404	\$26,915

POTTERY.

From 1899 to 1904 the development of the pottery industry in Michigan was erratic, increasing from \$29,741 in 1899 to \$83,098 in 1902, and then decreasing to \$40,621 in 1904. From the latter year, however, the industry has made a substantial growth every year to 1914 when the production was the largest in its history. In 1909 the total value was \$95,439, in 1913 \$222,133, and in 1914 \$265,194, the value nearly trebling in five years. The production in 1914 represents a gain of \$43,061, or 17.8 per cent over that for 1913.

The principal products are red earthenware, chiefly flower pots, and porcelain electrical supplies. Of the five pottery firms three, the Detroit Flower Pot Co., Anton Hupprich of Detroit, and the Ionia Pottery Co, manufacture flower pots almost exclusively. The Jeffery-DeWitt Co., Detroit, manufactures various porcelain products—sanitary ware, insulators, tumbling jars, crucibles, etc., and the Pewabic Pottery & Tile Co., also in Detroit, art tile and miscellaneous ware. A new pottery firm, The Mount Clemens Pottery Co., according to reports, began operation in January, 1915, and will produce decorated ware.

Clays suitable for the manufacture of red earthenware are obtained in Michigan but the clays used for porcelain electrical supplies and white ware are imported from other states or countries.

VALUE OF POTTERY PRODUCTS IN MICHIGAN, 1899-1914.

Year.	Rank of state.	No. firms.	Red earthen-ware, value.	Porcelain electrical supplies, value.	C. C. ware, value.	Miscellaneous, value.	Total value.	Gain per cent.	Per cent. of total product in U. S.
1899	18	4	\$29,641		\$100		\$29,741	15.4	17
1900	17	4	\$3,317				34,317	30.2	17
1901	16	4	42,403			\$2,400	44,865	87.4	20
1902	14	4	43,098			6,000	83,098	-42.2	41
1903	19	4	42,007			3,000	48,007	9.1	19
1904	17	4	40,621*			7,000	43,621	4.5	17
1905	17	6	43,510			7,600	45,961	11.2	16
1906	16	6	54,474			7,100	51,110	18.5	16
1907	16	6	61,659			7,750	61,574	1.5	20
1908	13	6	60,393			34,500	62,409	52.9	25
1909	13	6	80,480			13,300	95,439	18.1	31
1910	13	6	80,480				112,697	15.8	33
1911	13	6	63,000				130,490	49.3	38
1912	10	5	63,555				194,892	20.8	53
1913	10	5	106,452				222,133	20.8	59
1914	9	5					265,194	33.0	75
Totals							\$1,525,548		

*Included in the total.

BRICK AND TILE PRODUCTS.

Raw Materials.—Most of the surface clays (see Clay) in Michigan are low grade in character and are of three general classes, (1) morainic or drift clays, (2) lake clays and, (3) river silts. The morainic clays are generally high in lime and also contain sand and pebbles; the content of the latter giving rise to the term boulder clay. The lake clays are generally less calcareous, and likewise the river silts. Owing to the general gritty character or the high lime content, the clays are adapted chiefly for making common brick and tile. Due to their calcareous nature the clays burn cream or white in color. In some deposits however the lime has been removed by leaching to the depth of a few feet, and clay from this surface portion burns red.

Clay or shale deposits suitable for the manufacture of fire, vitrified and front brick, vitrified tile, fire-proofing, and other higher grade products are not abundant. Near Rockland, Ontonagon county, some of the clays belong to the slip varieties and are used for glazing purposes. At Grand Ledge, Jackson, Corunna, and near Bay City and Flushing shales belonging to the Coal Measures have been developed for vitrified and front brick, vitrified tile, sewer pipe, conduits, fire proofing, etc. A project for the development of shale deposits at Williamston for the manufacture of front brick is now under way, and during 1914 a new company, the Baker Clay Products Co., at Grand Ledge built a modern plant equipped with continuous kilns for the manufacture of vitrified products. According to reports the plant is now in operation.

Deposits of shale belonging to the Coldwater occur in the southeastern part of Huron county and in the vicinity of Coldwater, and some of these probably are suitable for making high grade products. The deposits are undeveloped as yet. Some of the shales associated with coal in the mines in Saginaw and Bay counties are apparently adapted for making vitrified products, but these have been exploited only near Bay City. Deposits of soft blue shale in the Traverse formation have been exposed in limestone quarries near Charlevoix and in the vicinity of Rockport, Alpena county, but these have not been developed. Numerous outcrops of these shales are also reported in the central part of Cheboygan county. The black shales of the Antrim exposed in a number of places in Alpena, Cheboygan and Charlevoix counties are probably too bituminous for making high grade clay products.

Production.—In 1914 the value of brick and tile products in Michigan exclusive of pottery was \$2,434,872 as compared with \$2,451,242 in 1913. This was a decrease of \$25,370 or 1.08 per cent from 1913 in spite of the fact that substantial gains were made in the production

and value of common and front brick, drain tile, and fire proofing. The chief losses were in the production of vitrified brick and fire brick, and miscellaneous products.

In 1914 Michigan ranked sixth in the number of common brick produced, sixth in value, and tenth in the total value of brick and tile products, exclusive of pottery.

The manufacture of common brick has made a great development in the vicinity of Detroit where suitable lake clays occur in great abundance. In 1914 Michigan produced 269,154,000 common brick of which 222,085,000, or 82.5 per cent were made in Wayne county. Drain tile is next to common brick in importance with a reported value of \$421,941, and vitrified brick or block third with a value of \$120,562. Sewer pipe is manufactured on a large scale at Grand Ledge and Jackson, but there are only two producers, hence no figures of production and value are given. Grand Ledge is also the chief center in the state for the production of drain tile.

ANNUAL PRODUCTION OF BRICK AND TILE PRODUCTS IN MICHIGAN, 1899-1914.

Year.	Common brick.		Average price per M.	Front brick.		Average price per M.	Vitrified brick.		Average price per M.	Fire brick.		Average price per M.
	Quantity.	Value.		Quantity.	Value.		Quantity.	Value.		Quantity.	Value.	
1899	200,144,000	\$933,176	\$4 66	4,290,000	\$58,920	\$13 73	*	*	.....	.....	.....	.....
1900	180,892,000	863,250	4 77	8,421,000	48,411	5 75	*	*	.....	.....	.....	.....
1901	215,836,000	1,095,254	5 07	9,476,000	64,031	6 76	*	*	.....	.....	.....	.....
1902	237,254,000	1,331,752	5 61	5,684,000	42,792	7 53	*	*	.....	.....	.....	.....
1903	215,791,000	1,251,572	5 80	2,225,000	19,000	8 54	*	*	.....	.....	.....	.....
1904	205,196,000	1,116,714	5 44	1,080,000	7,500	6 94	*	*	.....	.....	.....	.....
1905	211,558,000	1,152,505	5 45	693,000	5,995	8 65	6,112,000	\$81,706	13 28	.....	.....	\$13 00
1906	206,583,000	1,178,202	5 70	1,474,000	14,162	9 61	6,229,000	81,814	13 37	.....	.....	10 37
1907	200,817,000	1,181,015	5 88	3,956,000	32,116	8 12	7,911,000	94,601	13 13	.....	.....	12 00
1908	181,049,000	994,525	5 49	1,896,000	19,496	10 28	6,165,000	76,630	11 96	.....	.....	.....
1909	219,820,000	1,250,787	5 69	2,379,000	18,654	7 84	10,473,000	129,283	12 43	.....	.....	.....
1910	232,551,000	1,369,816	5 86	2,209,000	27,533	12 46	9,080,000	116,446	12 82	.....	.....	.....
1911	252,465,000	1,301,998	5 16	2,498,000	31,572	12 64	5,597,000	78,336	14 00	.....	.....	.....
1912	271,189,000	1,592,283	5 87	3,934,000	41,476	10 54	6,600,000	92,062	13 94	.....	.....	.....
1913	273,571,000	1,626,287	5 94	5,505,000	5,941	11 76	8,571,000	126,062	14 71	.....	.....	.....
1914	269,154,000	1,633,216	6 07	1,488,000	21,121	14 19	7,733,000	120,562	15 59	.....	.....	.....
Totals.....	3,573,870,000	\$19,865,852	.....	52,208,000	\$458,720	.....	74,471,000	\$997,440	.....	.....	.....	.....

*Concealed, less than three producers.

Year.	Stove linings.		Drain tile.	Sewer pipe.	Fire-proofing.	Tile (not drain.)	Miscellaneous.		Hollow building tile or blocks.	Per cent of total product in U. S.	Rank of state.	No. of firms operating.	Total value.
	Value.	Value.					Value.	Value.					
1899.....			\$140,171	\$50,300	\$5,900		\$22,709			1.68	13	196	\$1,254,256
1900.....			114,747	57,916	2,350		406			1.50	17	189	1,147,378
1901.....			98,972	*	1,880		637			1.71	14	180	1,497,169
1902.....			96,645	*	3,290					1.69	13	182	1,660,942
1903.....			129,028	*	*			\$19,138		1.58	14	178	1,662,414
1904.....			208,088	*	*			8,080		1.58	14	168	1,670,892
1905.....			205,445	*	*			3,585		1.41	16	154	1,719,746
1906.....			314,098	*	*			4,280		1.38	16	142	1,793,367
1907.....			289,868	*	4,100		1,500	6,386		1.39	17	136	1,786,190
1908.....			327,630	*	*		40,100			1.54	16	122	1,666,381
1909.....			364,006	*	*		66,128			1.44	16	122	1,947,059
1910.....			348,205	*	*					1.53	15	118	2,083,525
1911.....		\$3,971	313,072	*	*					1.53	15	111	1,953,442
1912.....		*	387,945	1,461	*		228,530			1.73	13	101	2,350,606
1913.....		*	415,543	*	*		350,000			1.73	13	95	2,451,242
1914.....		*	421,941	3,752	*		234,280			1.88	10	90	2,434,872
Totals.....			\$4,175,404										\$29,079,481

*Concealed under miscellaneous; less than three producers.

SAND LIME BRICK.

The first sand-lime brick plant in the United States was started at Michigan City, Indiana, in 1901. The sand-lime brick industry was a "boom" industry and within two years nine plants were projected, building or in operation in Michigan. Under the erroneous impression that sand-lime brick satisfactory for all purposes could be made much more cheaply than ordinary brick, many plants were erected all over the country regardless of markets, transportation facilities, and competition with clay brick. The industry naturally suffered from the many failures consequent.

The sand-lime brick industry is more adapted to regions where good brick clays are absent and sand abundant. In Michigan most of the sand-lime brick plants were started in widely separated localities far from large clay working industries or near large cities which afforded a ready market for a limited output, hence the industry did not experience numerous failures and has maintained a relatively steady growth.

The growth has not been in an increased number of plants but in the average output per plant. In 1904 ten plants were in operation and produced nearly 10,000,000 common brick and 600,000 front and fancy brick valued at \$69,765. In 1905 twelve plants were in full operation and the production of common brick increased to 24,844,000 and face brick to 1,577,000 with a total value of \$169,302. Since 1905 the number of plants has remained about the same, fluctuating between ten and thirteen, but the production and value have greatly increased, reaching the maximum of 49,373,000 common brick and a total value of \$321,245 in 1913. In 1914, however, due to the general business depression throughout the country the production of common brick fell to 41,456,000 and the total value to \$255,784. This represents decreases of 7,817,000 in common brick and \$65,461 in total value. Of the twelve firms operating in 1914 eight reported decreases in sales and nine poorer to much poorer trade conditions owing to the great decrease in building operations in the state.

The production of front and fancy brick has fluctuated greatly, the former increasing from about 600,000 in 1904 to 2,000,000 in 1907, then decreasing the following year to 900,000 and reaching the maximum of 3,255,000 in 1910. During the last two years less than three companies manufactured front and fancy brick, hence figures have not been given. The evidence indicates that front or fancy sand-lime brick as manufactured are not as satisfactory for general purposes or cannot be produced as cheaply as clay front brick.

Since 1904 Michigan has held first rank in number of plants and total

production, and first in value with the exception of 1906 when it was exceeded by New York. For a number of years Michigan has produced nearly or more than twice as many sand-lime brick as any other state. In 1913 twelve plants were in operation as against five each for New York and California, the nearest competitors. In 1914, the number was the same, the Manistee Brick Company which went out of business being compensated for by a new firm, the Fairview Brick Company of Detroit. Two plants are located at Detroit and one each at Flint, Grand Rapids, Kalamazoo, Menominee, Ripley (Houghton county), Rives Junction (Jackson county), Rochester (Oakland county), Saginaw, Sebewaing (Huron county) and Sibley (Wayne county).

ANNUAL PRODUCTION AND VALUE OF SAND-LIME BRICK IN MICHIGAN AND UNITED STATES, 1904-1914.

Year.	No. of operating firms reporting - Mich.	No. of operating firms reporting - U. S.	Michigan production.				Fancy brick.		Total value Michigan.	Change per cent - Michigan.	Total value United States.	Per cent of total production of U. S.	Rank.	
			Common brick.	Front brick.	Average price per thousand.	Quantity (thousands).	Value.	Quantity (thousands).					Value.	Production.	Value.
1904	10	57	9,886	\$64,034	\$6.64	580	\$5,234	\$9.02	19	\$497	\$69,765	142.7	6	1
1905	12	84	24,841	155,883	6.28	1,577	12,893	8.17	24	526	169,302	3.3	4	1
1906	11	87	27,281	182,870	5.97	1,796	12,022	6.69	27	20	174,821	3.3	0	1
1907	13	94	25,488	158,606	6.22	*2,000	14,234	7.17	7		172,840	-1.3	0	1
1908	10	87	21,997	131,827	5.99	*900	6,982	7.76			138,800	-19.7	0	1
1909	11	74	34,217	207,082	6.05	*1,600	11,144	6.97			240,646	57.5	0	1
1910	10	76	37,648	218,627	5.81	3,256	22,022	6.76			210,001	10.3	0	1
1911	10	66	32,889	192,224	5.84	2,726	17,777	6.52			216,732	-12.7	0	1
1912	11	71	48,129	307,106	6.38	1,163	9,626	8.27			316,732	50.8	0	1
1913	12	68	49,373	315,882	6.38	†	†	†	†	†	331,245	9.7	0	1
1914	12	62	41,456	238,113	5.98	†	†	†	†	†	255,784	-24.4	0	1
Total	123	629	353,205	\$2,162,263	\$6.12	...	...	...	...	...	\$2,288,274	...	...	...

*Estimated.

†Included in total.

MINERAL AND SPRING WATERS.

The amount and value of mineral and spring waters produced in Michigan are subject to large fluctuations from year to year. The chief factors which influence the production are (1) business conditions and (2) local conditions affecting the quality of the municipal water supplies. The most pronounced decreases in production in Michigan occurred during the general depression in business in 1906 and 1907, and during the past two years there have been large decreases in great part due to poor trade conditions throughout the country. In certain cities the municipal water supplies are unsafe and as a consequence a thriving business of vending mineral and spring waters has grown up in these cities. During the past two or three years the municipal water supply in some cities has been greatly improved in quality through the development of new sources or the installation of filtration plants, as at Marquette and Grand Rapids.

Due to various causes, but largely to the gradual improvement in municipal water supplies, there has been a general though intermittent decrease in the production of mineral and spring waters since 1902, the production falling from 8,653,690 gallons in that year to only 884,893 gallons in 1913 valued at \$52,642. In 1914 there was a slight increase, the total output being 931,343 gallons valued at \$70,310. In 1914 there were 22 active springs as against 20 in 1913 and 28 in 1902.

PRODUCTION AND VALUE OF MINERAL WATERS IN MICHIGAN, 1900-1914.

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	16	902,528	73,357			0.081
1907.....	8	15	19	1,472,679	127,133	35,091	92,042	0.086
1908.....	8	16	24	2,004,433	88,910	5,995	82,915	0.044
1909.....	5	16	19	2,760,694	104,454	6,099	98,355	0.035
1910.....	9	17	17	1,454,020	69,538	100	69,438	0.048
1911.....	11	24	23	1,713,401	72,253	12,156	60,097	0.042
1912.....	12	19	17	1,420,465	75,611	777	74,834	0.053
1913.....	17	24	20	884,893	52,642	3,605	49,037	0.059
1914.....	16	20	22	931,343	70,310	12,252	58,058	0.075
Total.....				45,605,802	3,213,798	\$108,975	\$823,064	\$0 070

NATURAL GAS.

Natural gas is produced chiefly in southeastern Michigan in Oakland, Macomb, and St. Clair counties, and in Manistee county. In the first two counties the gas occurs at shallow depths in the surface deposits in association with water. Apparently the source of the gas is from the underlying bituminous and petroliferous Devonian formations. The gas usually occurs in small volume and under small pressure, a well generally being sufficient to furnish only a farmhouse or two with heat and light for a few years. The average life of the wells is from six to ten years but some have been known to last 20 years or more; many others, however, play out in a few weeks or months. In Oakland, Macomb and Washtenaw counties some 25 or 30 of such wells are utilized by farmers for domestic purposes. According to reports many of the gas wells in the vicinity of Warren, Macomb county; and Royal Oak, Oakland county, have been declining rapidly in both volume and pressure during the past year.

Around Portage Lake, Manistee County, there are many artesian wells in the drift, which is locally 500 to 600 feet or over in depth. A number of these wells yield gas in association with water and one, the Onekama well, drilled by W. W. Davis in 1913 on the Northern Transportation Co. property near the fish hatchery yielded a large volume of gas at the depth of 437 feet under a pressure of 185 to 190 pounds per square inch. As far as known this well has not been utilized. Some of the other wells yield gas sufficient for heating and lighting a single dwelling and others only enough for a few lights.

At Port Huron many of the oil wells yield in addition to the oil very considerable quantities of gas known as "casing gas." The G. B. Stock wells, owned and operated by the Michigan Development Co., yield more than enough gas for pumping the wells. Some of the Michigan Central Oil & Gas Co. wells, two miles west of North Port Huron, are reported to yield from 20,000 to 40,000 cubic feet of gas per day and the work of laying a pipe line from the wells to Campau, a subdivision on the west side of Port Huron, is under way. At present the gas from two of the nine wells is much more than sufficient to fire the boiler used in drilling and to operate the gas engine for pumping the oil wells. The other wells are capped to prevent the loss of the gas. Some of the wells are reported to develop a rock pressure of over 250 pounds per square inch and when blown for some time, the pressure falls considerably but after closing the valves it requires but little over an hour for the wells to develop the maximum pressure. Recently the G. B. Stock Xylite Grease and Oil Co. drilled three oil wells on the Hoyt and Boyce plats about one-half mile southeast of the Stock

wells and all yield gas. One yields a very considerable quantity and the gas from the three wells is more than sufficient for operating purposes.

At the Draper Manufacturing Co. plant in North Port Huron opposite the entrance to St. Clair River a well was drilled in the winter of 1914 for oil and a small flow of oil and gas was struck at 564 feet. The gas is utilized in heating the boiler and, it is stated, furnishes daily heat equivalent to about 1,200 pounds of coal. The pressure is low, the maximum being only about 45 pounds which can be reduced to only about one pound in a few hours, if the burners are opened to their maximum capacity.

Several other wells in various parts of Port Huron yield small to considerable quantities of gas. Some are utilized for domestic purposes, but others have been abandoned, the gas being allowed to go to waste. In one or more instances the casings have been pulled and the wells abandoned without plugging. Water is thus allowed to enter the oil bearing rock and sooner or later serious injury must result to the oil field.

The gas and oil occur in the top of the Dundee limestone known locally as the "Lower Lime." The depth to the oil horizon in the Port Huron field ranges from about 500 to 710 feet. In some wells the gas occurs a few feet above the oil horizon, while in other wells the gas appears to be absorbed in the oil.

PRODUCTION OF NATURAL GAS IN MICHIGAN, 1911-1914.

Year.	No. of producers.	Domestic.		Industrial.		Other.		Total.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		M. cu. ft.		M. cu. ft.		M. cu. ft.		M. cu. ft.	
1911...	22	930	\$930			800	\$400	1,730	\$1,330
1912...	17		1,020	900	\$450			900	1,470
1913...								1,805	1,405
1914...								2,442	*1,642
Total..								6,877	\$5,847

*Figure subject to revision.

PETROLEUM.

Although oil has been struck in Michigan in small quantities in the vicinity of Port Huron, Allegan, Saginaw, and other places only at the former place have the quantities proved to be of commercial importance. A group of small oil wells have been operated in Port Huron for many years and during the past two or three years a considerable number of new wells have been drilled in various parts of the Port Huron field by different parties in further developing the local oil and gas possibilities.

*PORT HURON FIELD.

The early explorations for oil and gas in the Port Huron district were the direct results of the discoveries of oil in western Ontario. The Petrolia and Oil Springs fields were discovered in the early 60's. The longer axes of these fields are roughly parallel and extend in a nearly northwest-southeast direction. A third pool was discovered in 1886 in Euphemia township southeast of the Petrolia and Oil Springs pools and parallel to their longer axes. A line projected from the Euphemia pool northwest through the Oil Springs pool would pass in the vicinity of Sarnia and Port Huron and upon the supposition that other pools might be discovered along this line, explorations were made in Sarnia and Port Huron. In 1886-87 C. A. Bailey drilled a number of wells in the western part of the city. Small quantities of oil and gas were struck in the Dundee limestone, the top of which was struck at depths ranging from about 540 to 575 feet. The wells were not considered worthy of operation, and were abandoned. In 1887 F. L. Wells put down a test hole 1,685 feet in depth on the bank of Black river opposite Kerns Brewery and near Seventh Street Bridge. Only a show of oil and gas was struck.

No further attempts were made to develop the field until 1898 when G. B. Stock, an operator from the Ontario oil fields, organized the Michigan Development Company and drilled a number of wells in and about Port Huron. Most of the wells were drilled on what is known as the Goodrich property, a tract of about 15 acres in the western part of the city between the Grand Trunk railroad and Howard street. Oil in small but commercially important quantities were struck in all of the wells in the top of the Dundee which occurs in this part of the city at a depth of about 520 feet. At first some of the wells yielded two or three barrels per day, but gradually all of them decreased until

*C. H. Gordon, Ann. Rept. Mich. Geol. Surv. for 1901, pp. 269-281.

the average daily production was only about one-half barrel per well. The decrease in many cases is due to the caving of the "soapstone" or soft calcareous shale of the Traverse formation, immediately overlying the Dundee.

With such shallow and cheap drilling the field was considered worthy of further development and new wells* were drilled from time to time until there were some 21 wells on the Goodrich property ranging in depth from about 500 to 650 feet. Owing to caving and other causes, only about 15 of the wells are now in operation. All of the wells in addition to the oil yield more or less gas known as "casing gas" and it is more than sufficient to furnish motive power for a 25-horse power gas engine which pumps the wells.

The energetic example of Mr. Stock and the showings of oil in nearly all of the test wells incited other men to further explorations. A number of wells were drilled at various places in St. Clair county as at Abbottsford and in North Port Huron. Some of the holes were dry but most of them yielded small amounts of oil and gas, comparable in quantity to the Stock wells. About 1907 the Black River Oil & Gas Co. began explorations on the Henry May and Lawrence Gillette farms (Secs. 32 and 33, T. 7 N, R. 17 E.) on the north side of Water Street two miles west of North Port Huron and about two miles north-northwest of the Stock wells. Three or four wells were drilled and according to reports small quantities of both oil and gas were obtained. In 1912-1913 the Black River Oil & Gas Co. leases were taken over by the Michigan Central Oil & Gas Co. and more wells were drilled from time to time until at present there are nine wells on the May and Gillette farms. According to statements of officials of the company, all of the wells yield oil in small quantities varying from one-fourth to three barrels per day, and also very considerable quantities of gas. A number of the wells are said to yield from 20,000 to 40,000 feet of gas per day under a rock pressure varying from 125 to 250 pounds. After the wells have been blown some time the pressure is materially decreased but the maximum is regained in about one and one-quarter hours after the valves are closed.

On account of the small individual production of the wells pumping machinery and tankage were not installed until the spring of 1915. Up to the first of June only three wells had been put under operation and the total production from these to the above date was about 300 barrels. All of the wells are capped to prevent the escape of the "casing" gas and the supply of gas from two wells is stated to be more than sufficient for firing the boiler used for drilling and in operating a

*For the record of these and other wells in the Port Huron field, see Publication 14, Geological Series 11, The Occurrence of Oil and Gas in Michigan, Chapter III; also Appendix, Ann. Rept. for 1901.

20 H. P. gas engine for pumping the oil wells. The quantity of gas from all of the wells has been deemed sufficient to warrant utilizing for village purposes and the work of laying a small pipe line is under way to furnish Campau, a small subdivision containing about 300 houses in the western part of Port Huron, with gas for heating.

The G. B. Stock Xylite Grease and Oil Co. in 1913 drilled three wells on the Boyce and Hoyt plats in the western part of Port Huron directly east of the Bailey and about one-half mile southeast of the Stock wells. The Boyce well according to statements of the officials of the company made an initial production of six or seven barrels per day but fell off rapidly to about two barrels or less. Of the two Hoyt wells one yields only a little oil but considerable gas and the other the most oil of the three wells. The gas is said to be more than sufficient for operating purposes.

In 1914 the Draper Manufacturing Co. of Port Huron drilled a test well at their plant near the foot of Church street in North Port Huron. In the Draper well some gas was struck in the Dundee limestone at 534 feet and a small quantity of oil at 564 feet. The gas was piped to the boiler and furnishes fuel equivalent to about 1,200 pounds of coal per day. The pressure is low, the maximum being only about 45 pounds and this can be reduced in a few hours to less than one pound if the burners are turned on to full capacity. The yield of oil is estimated at about one-eighth barrel per day. Mr. Thomas Draper, general manager of the company drilled a well on his farm, formerly known as the D. H. Bryce farm on the west side of Black River in the S. W. $\frac{1}{4}$, Sec. 27, T. 7 N., R. 17 E. The well was on the river flats 500 or 600 feet west of the entrance of the Black River drainage canal. The elevation of the top of the casing was about eight feet above the river or about 590 feet above sea level. According to Mr. Draper the Dundee limestone was struck at the depth of 549 feet or at a slightly lower elevation than in the Draper No. 1 at the plant to the southeast, or in the May and Gillette wells to the west. This indicates the presence of a shallow syncline. No oil or gas was struck though the well reached a depth of 700 feet and probably penetrated completely through the Dundee into the Monroe dolomites below. The Dundee was found to be composed of very hard gray to buff close grained limestone.

A careful log of the Draper No. 1 well was kept and a good set of samples preserved and Mr. Thos. Draper, manager of the company, kindly presented a copy of the record and a nearly complete duplicate set of samples to the Survey from which the following record was compiled:

Draper Mfg. Company Well No. 1.

Port Huron, Mich.

Location: About 50 feet east of the boiler house of the Draper Mfg. Company's plant, located near the foot of Church street, North Port Huron, and 300 feet from and directly opposite the head of St. Clair River. Well began in January and finished February 20, 1914. Record by R. A. Smith from samples and log furnished by Thos. Draper, President of the Draper Mfg. Co.

ELEVATION OF TOP OF CASING 587 FEET A. T.

	Thickness feet.	Depth feet.
Pleistocene or surface deposits:		
Sand and coarse gravel, heavily water bearing	40	40
Blue calcareous clay; vig. eff.	67	107
Sand and gravel, water bearing	1	108
Antrim shale:		
Brownish black bituminous shale, micaceous and pyritic	52	160
Grayish black bituminous shale, micaceous and pyritic	20	180
Traverse (Hamilton) formation:		
Hard cherty very pyritic, fossiliferous and finely crystalline ("top lime") limestone with "shells". Shells probably chert and seams of pyrite; viol. eff. <i>Atrypa reticularis</i> . Chert nodule at or just above 180 feet.	5	185
Soft gray and very calcareous shale or "soapstone" viol. eff.	40	225
Hard white and light gray crystalline limestone; viol. eff. <i>Atrypa reticularis</i>	3	228
Limestone (sample missing)	17	245
Hard gray and white crystalline limestone; viol. eff. <i>Atrypa reticularis</i>	15	260
Limestone (sample missing)	15	275
Very calcareous gray shale "soapstone" and gray argillaceous limestone	5	280
Limestone (sample missing)	15	295
Very calcareous gray shale "soapstone" and gray argillaceous limestone	5	300
"Soapstone," very calcareous gray shale (sample missing)	50	350
Very calcareous gray shale, "soapstone"	5	355
"Soapstone," very calcareous gray shale (sample missing)	45	400
Very calcareous gray shale, "soapstone"	5	405
"Soapstone," very calcareous gray shale (sample missing)	5	410
Dary gray argillaceous limestone, pyritic and fossiliferous (<i>Atrypa</i> and corals)	5	415
"Soapstone," calcareous shale (sample missing)	30	445
Very calcareous gray shale, "soapstone," viol. eff.	5	450
"Soapstone," calcareous shale (sample missing)	15	465
Very calcareous gray shale, "soapstone" and hard gray crystalline limestone	5	470
"Soapstone," calcareous shale (sample missing)	25	495
Very calcareous gray shale	5	500
"Soapstone," calcareous shale	11	511
Dundee (Onondaga, Corniferous) limestone:		
Light buff densely crystalline limestone; viol. eff. "Lower Lime"	17	528
Limestone (sample missing). Considerable gas at 534 ft.	6	534
Hard light buff dense grained limestone; viol. eff.	16	550
Grayish buff dense grained limestone; viol. eff. Oil at 564 ft.	18	568
Light grayish buff and white limestone; viol. eff.	7-6"	575-6"

"Well shot with two tight shots one just above and one just below the oil at 564 feet." Well yields gas equal to 1,200 lbs. of coal in firing the boiler, and about one-eighth barrel of oil per day. Well develops gas pressure of about 45 lbs. upon standing about 12 hours but this is reduced to less than one lb. after the valves of the gas jets have been open for a few hours.

Recently a well was put down by the Reed Wrecking Co. near their dry dock in South Port Huron, a record of which is given below. This

well is reported to yield much gas in spite of a heavy flow of water encountered in the top of the Dundee. According to reports attempts were made to case or plug off the water but these were unsuccessful.

Reed Wrecking Company Well.

Port Huron, St. Clair Co.

Location: At Reed's dry dock in South Port Huron. Well completed in July, 1914. Driller's record.

ELEVATION ABOUT 590 (?) FEET A. T.

	Thickness feet.	Depth feet.
Pleistocene or glacial drift:		
Clay (12 inch hole)	90	90
Antrim shale:		
Black shale (four and five-eighth inch hole)	90	180
Traverse (Hamilton) formation:		
Soap	21	201
Gray rock	11	212
Soap	8	220
Lime	12	232
Soap	21	253
Hard pan	7	260
Soap	3	263
Hard pan	7	270
Soap	12	282
Lime	7	289
Bell (Marceilus) shale:		
Soap	195	484
Dundee (Onondaga, Corniferous) limestone:		
Hard pan	3	487
Lime (white) "Lower lime"?	3	490

"At ninety feet struck heavy flow surface gas and fresh water. Water came within 10 feet of surface. At 487 feet struck heavy flow of gas and salt water. We could not exhaust water by pumping, plugged last foot drilled but water still rose 450 feet. I think water is coming in with gas or else is coming from salt block which is about one mile from here. Gas pressure after water came within 50 feet of surface was 159 lbs. Gas was escaping at head. The gas attained a pressure of over 400 lbs. Finished in July, 1914."

Mr. C. M. Van Curen, President of the Michigan Central Oil & Mineral Company (formerly the Michigan Central Oil & Gas Company), kindly furnished the following record which is said to be representative of their wells on the May and Gillette farms.

Gillette Well No. 3.

Port Huron.

Location: Near the west line of the Lawrence Gillette farm about 1,200 feet north of Water Street, about two miles west of Port Huron, in southwest one-fourth of Sec. 33, Port Huron Township (T. 7 N., R. 17 E.), St. Clair Co. Owners, Michigan Central Oil & Mineral Co. (C. M. Van Curen, Pres.; G. W. Van Curen, Mgr.) Record by Mr. Holme, driller.

ELEVATION ABOUT 620 FEET A. T.

	Thickness feet.	Depth feet.
Pleistocene or glacial deposits:		
Clay	115	115
Gravel	6	121
Antrim shale:		
Black shale	82	203
Brown soft shale	27	230
Sharp gray rock	5	235
Soap	15	250
Lime (7 feet hard)	10	260
Soap	14	274
Hard pan	6	280
Soap	7	287
Hard pan	3	290
Soap	1	291
Middle lime	25	316
Bell (Marcellus) shale:		
Soap	239	555
Hard pan	7	562
Soft oil rock	15	577
Oil rock harder	23	600
White lime	7	607
Oil rock (hard)	26	633

Several other wells in Port Huron drilled many years ago yield gas sufficient for domestic purposes and some of them have been utilized in this way. A well drilled a number of years ago by G. B. Stock on the G. F. Howe property near Kewahdin Beach in the northwest one-fourth, northeast one-fourth Sec. 22, Fort Gratiot Township north of Port Huron is reported to yield sufficient gas for several families. Gas in association with water was struck in the Traverse formation at the depth of 395 feet. The Dundee occurs at 574 feet or about 20 feet above sea level, or considerable lower than at the Draper No. 1 in North Port Huron or in the May and Gillette wells west of the city.

G. F. Howe Well.

North Port Huron.

Location: On Geo. F. Howe's property near Keewahdin Beach on northwest one-fourth, northeast one-fourth, Sec. 22, Fort Gratiot (T. 7 N., R. 17 E.) Township, St. Clair county. Drilled for oil and gas in 1903 by Wm. May. Record by R. A. Smith from driller's log furnished by Geo. F. Howe in 1915.

ELEVATION APPROXIMATELY 595 FEET A. T.

	Thickness feet.	Depth feet.
Pleistocene or glacial deposits:		
Sand and gravel	14	14
Marl clay	50	64
Sticky blue clay	45	109
Surface gas. Six inch casing, five one-half inch drill.		
Antrim shale:		
Black shale	12	121
Brown shale	8	129
Traverse (Hamilton) formation:		
Brown limestone	65	194
White soapstone	8	202
Black sandstone	4	206
Brown limestone	16	222
Gray limestone	12	234
Soapstone	14	248
Gray limestone	26	274
White limestone	80	354
Soapstone	8	362
Gray limestone	16	378
Soapstone	8	386
Gray limestone	9	395
With gas and water.		
Soapstone	53	448
Gray limestone	13	461
Soapstone	23	484
Five inch casing, four one-half inch drill.		
Gray limestone	20	504
Soapstone	10	514
Brown limestone	8	522
Hard sandy shale	20	542
Dark sandy shale	32	574
Dundee (Onondaga, Corniferous) limestone:		
Brown limestone	7	581
Limestone "oil rock"	21	602

Well shot twice. Well is artesian and yields considerable gas which is utilized for domestic purposes. Pressure estimated at 40 to 50 lbs.

A report on the Port Huron oil field was published by C. H. Gordon in the Annual Report of the Michigan Geological Survey for 1901, and a second in 1911, by R. A. Smith in Publication 14, Geological Series 11. From the well records then available it appeared that a low anticlinal fold crossed St. Clair River from Sarnia through the southern part of Port Huron and then veering to the north-northwest through the western part of the city extended along Black River valley. The Bailey and Stock wells appeared to be near the crest of the anticline.

The more recent explorations by the Michigan Central Oil & Gas Company, now the Michigan Central Oil & Mineral Company, the Draper Manufacturing Co., the G. B. Stock Xylite Grease & Oil Co., and the Reed Wrecking Co. verify the above conclusions. The records of the above and older explorations show that an asymmetrical anticline crosses St. Clair River from Sarnia and, after passing through the southern part of Port Huron, veers toward the north-northwest through the western part of the city in the vicinity of the Bailey, Stock, and May and Gillette wells. The axis of the anticline if projected northward

would pass near Gardendale three miles north of the May and Gillette wells. Further explorations by the Michigan Central Oil & Mineral Co. are being made in this direction along the apparent crest of the anticline.

The western limb of the anticline (see fig. 24) is relatively steep, the dip from the Stock wells southwest to the Grand Trunk Junction well being more than 60 feet per mile. The eastern limb, however, is very gentle and extends into a shallow syncline running northeast in the vicinity of the Draper No. 2 and the G. F. Howe wells. The synclinal structure possibly accounts for the absence of oil in this well but the hard close grained character of the Dundee limestone encountered at this point would also account for this.

The surface deposits in the Port Huron field vary in depth from about 100 to 125 feet, and are chiefly clay with thin beds of sand and gravel which locally yield small quantities of gas. At the Draper Manufacturing Co. plant, however, 40 feet of very coarse gravel and heavily water bearing quicksand was penetrated before reaching the clay.

Directly beneath the drift there is also 80 to 180 feet of black bituminous shale belonging to the Antrim formation. The shale is thinnest along the crest of the anticline and it thickens rapidly to the west, southwest and south as shown by the Fair,* Grand Trunk Junction, and Port Huron Salt Co. wells. According to Mr. Thos. Draper samples of black shale from the Draper No. 1 well were tested by a refining company at Petrolia, Ontario, and the yield of oil was reported to be about six and one-half gallons per ton. The Antrim shale from the Draper No. 1 well is less black and apparently less bituminous and petroliferous than in the May and Gillette well about three miles west.

The Traverse formation lies directly below the Antrim shale and consists of a series of limestones and soft calcareous blue shales from 270 to 350 feet in thickness, 325 feet being the average for the Stock, and May and Gillette wells. The top of the formation is a limestone known locally as the "Top lime." Near the center there is another well defined limestone horizon, the "Middle lime," and, at the base of the formation there is a heavy blue shale called the "Lower soap-rock." The "Top lime" locally yields considerable quantities of odorless gas. The "Soapstone" while comparatively soft is firm and "stands up" well in drilling but upon exposure to air and water it slacks quickly and caves. Until recently most of the wells have not been cased through the shale and as a consequence caving has ruined some of the wells and interfered greatly with the operation of others.

*See Publication 14, Geol. Series 11, pp. 56-63. Mich. Geol. Surv.

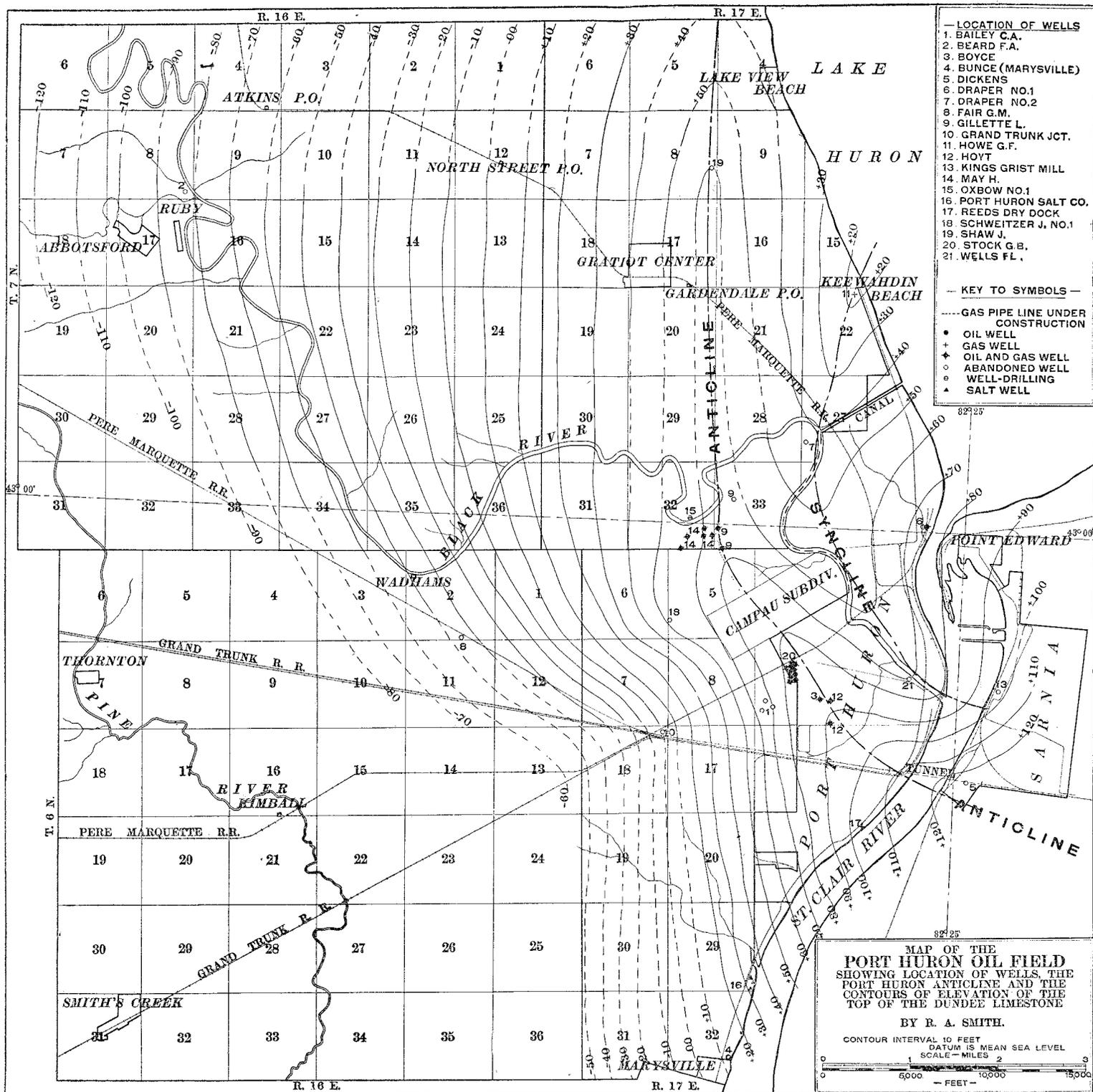


FIG. 24.

Experience has shown that all wells should be cased through the shale.

The Dundee in the Port Huron field is a hard gray to buff bituminous limestone—the “Lower lime” of drillers, and the oil formation. Locally the Dundee is about 125 feet in thickness and the oil is generally struck in the upper 50 or 60 feet. Salt water is nearly always encountered in the lower part of the formation and sometimes very close to the top. The Draper No. 1 and some of the May and Gillette wells yield small quantities of brine along with the oil. According to reports, in the Reed Dry Dock well a heavy flow of brine was struck almost at the top of the Dundee.

The oil occurs in softer and more porous strata but the pores are generally small and scarcely visible to the naked eye. In the Port Huron field the Dundee contains a large amount of bituminous matter and oil, and if more open grained and porous areas could be discovered very probably good flows of oil would be obtained. The gas in some wells is struck a short distance above the oil horizon but in other places it is associated with the oil, apparently being absorbed in it.

According to Mr. Thos. Draper the oil tests about 34° Baume and is dark green in color and smells strongly of sulphur. It is a natural lubricant and is used by the G. B. Stock Xylite Grease & Oil Co. in the manufacture of a superior grade of lubricants.

Figure 24 is a map showing the contours of elevation for the top of the Dundee and the local structures in the rock strata.

Cadillac.

In 1914 the Cadillac Oil & Gas Co. attempted to test out the oil and gas possibilities of the Trenton at Cadillac. The drift was so thick and so much quicksand and water were struck that the greatest difficulty was experienced in getting down to rock. According to reports rock, a gray sandstone, apparently the Upper Marshall was struck at 795 feet. The enterprise was then abandoned.

If the depth to rock as reported is correct it is the greatest depth of drift yet penetrated in Michigan, 715 feet at Manistee being the greatest depth previously reported.

Dearborn.

At Dearborn, near Detroit, Mr. Henry Ford of the Ford Motor Co. of Detroit is drilling a very deep well for scientific purposes. Actual drilling began June 14, 1915, and by October 18 a depth of over 4,035 feet had been reached. The boring was started with a 14 inch casing and according to reports it is planned to drill to the depth of 5,000 feet or more, if possible. A careful log is being kept and samples taken

at every five feet. This well when completed will furnish definite information as to the character, thickness and depth of the various rock formations, and the location of the water, brine, salt, gas, oil and other mineral horizons down to the pre-Cambrian rocks which should, however, be struck at a depth considerably less than 5,000 feet.

QUARTZ.

Vein quartz is mined near Ishpeming by the Michigan Quartz Silica Company of Milwaukee and ground chiefly for wood filler and paint. Some of the ground product is used in making polishes. The quartz rock is practically pure silica with only a trace of impurities and a little moisture. The mills are located at Ishpeming and Milwaukee.

MINERAL PAINTS.

Soft iron ore is mined in Iron county and sold by Pickands Mather Company of Cleveland for the manufacture of paint. The Acme White Lead & Color Company of Detroit manufactures a large amount and a variety of mineral paints but the two firms given above are the only producers, hence statistics of production and value are not given.

RELATIVE TO POSSIBLE POTASH DEPOSITS IN MICHIGAN.

For the past fifteen years Prof. A. W. Grabau of the department of geology of Columbia University, who is one of the foremost geologists and paleontologists in America, has been making a study of the Devonian and Silurian formations in Michigan. In 1900 Dr. Grabau began his work on the Traverse (Hamilton-Marcellus) formation of Michigan and the following year published the results of his investigations in the Annual Report of the Geological Survey of Michigan for 1901. In 1909 he and Dr. W. H. Sherzer published a joint report on the Monroe Formation, the Upper Silurian of Michigan. Since that date Dr. Grabau has been actively engaged in studying the Dundee (Onondaga) limestone and has a manuscript of nearly 600 pages on the Devonian formations of Michigan practically ready for the printer.

As a result of his long study of the Devonian and Silurian formations Dr. Grabau has concluded that there is a strong possibility that the Salina or Middle Silurian, the rock salt bearing formation, may contain potash bearing salts. Recently he communicated his belief in this possibility in a letter to R. C. Allen, State Geologist, from which the following is an excerpt:

"The present is a good time for the discovery of potash salts in Michigan. As I read the Silurian history, the lowest salt beds under Detroit ought to carry the potash salts similar to those found at Stassfurt the history being the same. This is true only for the lowest bed. If that does not contain it, then there is no potash in the deposits in the East [i. e. east of the Rocky Mountains]. I believe it is really worth making a test of this bed."

Potash salts are most extensively used in the United States in the

manufacture of fertilizers, glass, soaps, explosives, bleaching powder, dyestuffs and chemicals, and certain industries, notably the fertilizer industry, are vitally dependent upon these salts. The fertilizer and chemical industries have grown to enormous magnitude, yet they are dependent upon foreign sources for their supply of potash salts. Nearly all of the potash used in America is imported from Stassfurt, Germany, where potash salts occur in association with enormous deposits of rock salt. The present European war has cut off this supply and many fertilizer and chemical manufacturers have had to close or to curtail their output for want of raw material.

The importance of a reliable source of potash salts has become so great as to engage the attention of Congress, which in 1911 made specific appropriations to the United States Geological Survey for "determining the geological conditions favorable to the presence of potash salts" and to the Bureau of Soils for determining "a possible source of supply of potash, nitrates and other natural fertilizers." An examination of all of the brine and salt deposits was made but without success. A geologic study of ancient lake beds in the Great Basin was begun upon the theory that the salts contained in the waters of these lakes must have been deposited in their deepest portions, when the lakes were completely evaporated. By the close of 1913 seven test holes totalling more than 10,000 feet had been drilled in the ancient lake basins of Nevada without finding noteworthy traces of the coveted salts. A deposit of alunite, a potash bearing mineral, was discovered in Utah, but the amount of this substance available is relatively unimportant, being sufficient to furnish only a small fraction of the amount needed annually.

In southeastern Michigan from St. Clair to Monroe county and in western Ontario there are enormous deposits of rock salt. Several thousand square miles are known to be underlain with rock salt beds, which in the Detroit-St. Clair river area have an average aggregate thickness of nearly 400 feet. Rock salt is also known to occur in Manistee and Mason and in Alpena and Presque Isle counties. In the first two counties the salt beds have a total thickness of only about 40 feet but in the latter two the rock salt beds have their greatest known thickness, over 800 feet of rock salt having been penetrated in a deep well at Onaway, Presque Isle County. In southeastern Michigan the depth to the first salt beds varies from about 750 feet at Detroit to 1,500 or 1,600 feet at Port Huron, in Manistee and Mason counties, 1,975 to 2,300 feet, and in Alpena and Presque Isle counties, 1,000 to 1,630 feet. From geological considerations it is more than probable that the three known rock salt areas noted above are but parts of one

great rock salt area, covering most of the northern and eastern portions of the Southern Peninsula and western Ontario.

The beds of rock salt vary in thickness from a few inches to over 350 feet but the heaviest bed occurs near the bottom of the series and it is this bed which Dr. Grabau considers as a possible source of potash salts. The depth to this bed in Oakwood, a suburb of west Detroit, is 1,437 feet, at Wyandotte, about 1,100 feet; at Delray, 1,365 feet; at Fort Wayne, 1,445 feet; and at Royal Oak, 2,200 feet.

While the chances for finding potash in the salt beds of Michigan are apparently small, the great rewards for the successful explorer makes the proposition worthy of serious consideration, particularly in the light of Prof. Grabau's investigations and conclusions.

SUMMARY TABLE OF THE PRODUCTION AND VALUE OF

	1910.		1911.	
	Quantity.	Value.	Quantity.	Value.
Brick and tile products, number of brick.....	244,403,000	\$2,083,525	260,560,000	\$1,953,442
Brick, sand-lime, number of brick.....		240,649	35,615,000	210,001
Bromine.....	(a)	(a)	(a)	(a)
Calcium chloride.....	(a)	(a)	(a)	(a)
Cement, Portland; bbls. made, value cement shipped.....	3,687,719	3,378,940	3,686,716	3,024,676
Clay, tons.....		4,394	2,202	5,437
Coal, tons.....	1,534,967	2,930,771	1,476,074	2,791,461
Copper, lbs.....	221,462,984	28,125,799	218,185,836	27,273,155
Graphite.....		(a)		(a)
Grindstones, tons.....		(a)		(a)
Gypsum and gypsum products, tons mined.....	357,174	668,201	347,296	573,926
*Iron ore, long tons.....	13,303,906	41,393,585	8,944,393	23,808,935
Iron, pig; long tons made; value pig iron shipped.....	307,975	(b)5,119,074	304,654	(b)4,672,799
Lime, tons made.....	72,345	303,377	80,709	352,608
Limestone.....		842,126		1,001,535
Mineral paints.....	(a)	(a)	(a)	(a)
Mineral and spring waters, gallons sold.....	1,454,020	69,538	1,713,401	72,253
Natural gas, M. cu. ft.....		820		1,330
Petroleum.....		(a)		(a)
Pottery.....		112,697		130,490
Precious stones.....		(a)		(a)
Quartz.....		(a)		(a)
†Salt, bbls.....	9,452,022	2,231,262	10,320,074	2,633,155
Sand and gravel, tons.....	2,862,738	816,337	2,185,165	565,969
Sandstone.....		31,233		12,985
Silver, fine oz. Troy.....	262,200	141,600	507,700	274,100
Trap rock.....				51,000
Miscellaneous.....		278,442		161,030
Total.....		\$80,581,377		\$65,077,232

*Figures from Iron Trade Review.

†Exclusive of bromine and calcium chloride.

(a)Included under miscellaneous.

(b)Excluded from total, covered by iron ore.

MINERAL PRODUCTS IN MICHIGAN, 1910-1914.

	1912.		1913.		1914.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
281,741,000	\$2,350,606	282,664,000	\$2,451,242	278,384,000	\$2,434,872	
49,292,000	316,732	50,065,000	321,245	42,465,000	255,784	
(a)	(a)	(a)	(a)	(a)	(a)	
(a)	(a)	(a)	(a)	(a)	(a)	
3,651,094	3,145,001	4,081,281	4,228,879	4,218,429	4,064,781	
2,043	6,173	1,710	6,504	1,463	4,572	
1,206,230	2,399,451	1,231,786	2,455,227			
218,138,408	35,992,837	183,853,409	28,442,806	158,009,748	21,426,122	
	(a)		(a)		(a)	
	(a)		(a)		(a)	
384,297	621,547	423,896	721,325	393,006	705,841	
12,649,296	29,003,163	12,677,466	31,947,214	8,835,274	18,965,058	
459,975	(b)6,579,048	447,188	(b)6,568,920	379,619	(b)5,229,948	
74,720	311,448	77,088	331,852	66,507	287,648	
	1,139,560		1,408,708		1,457,961	
(a)	(a)	(a)	(a)	(a)	(a)	
1,420,465	75,611	884,893	52,642	931,343	70,310	
900	1,470	1,805	1,405	2,442	1,642	
	(a)		(a)		(a)	
	194,892		222,883		265,194	
	(a)		(a)		(a)	
	(a)		(a)		(a)	
10,946,739	2,974,429	11,528,800	3,293,032	11,670,976	3,299,005	
2,681,821	818,603	6,424,168	1,529,142	3,647,790	1,118,978	
	16,438		19,224		(a)	
528,453	324,999	295,173	178,284	413,500	228,665	
	36,206		92,201		34,406	
	522,141		540,626		565,147	
Total.....	\$79,931,757		\$77,860,192		\$55,185,986	

APPENDIX.

DIRECTORY OF THE PRODUCERS OF NON-METALLIC
MINERALS IN MICHIGAN, 1914.

BRICK AND TILE MANUFACTURERS, 1914.

Operators.	Office.	Works.
<i>Allegan County:</i>		
Allegan Brick Works.....	Allegan.....	Allegan.
Cady, L. Y.....	Allegan.....	Allegan.
Zeeland Brick Co.....	Zeeland.....	Zeeland.
<i>Barry County:</i>		
Leonard, Wm.....	Delton.....	Delton.
<i>Bay County:</i>		
Michigan Vitrified Brick Co.....	Bay City.....	Bay City.
<i>Berrien County:</i>		
Mamer Brick Co.....	Benton Harbor.....	Benton Harbor.
<i>Branch County:</i>		
Reynolds & Son, Lorenzo D.....	Quincy.....	Algansee.
<i>Charlevoix County:</i>		
Boyne City Brick Co.....	Boyne City.....	Boyne City.
East Jordan Clay Products Co.....	East Jordan.....	East Jordan.
<i>Chippewa County:</i>		
Rudyard Brick Works.....	Rudyard.....	Rudyard.
<i>Dickinson County:</i>		
Vulcan Brick Works.....	Vulcan.....	Vulcan.
<i>Eaton County:</i>		
American Sewer Pipe Co.....	Broad St., Akron, Ohio.....	Grand Ledge.
Grand Ledge Clay Products Co.....	Grand Ledge.....	Grand Ledge.
<i>Emmet County:</i>		
De Arment, C. A.....	Petoskey.....	Petoskey.
<i>Genesee County:</i>		
Gale Bros.....	Atlas.....	Atlas.
Oliff, Thomas.....	Clio.....	Clio.
Uptegraff & Co., W. H.....	Flint.....	Davison.
Duffield Brick & Tile Works.....	Duffield.....	Duffield.
McCann, Fred'k W.....	Gaines.....	Gaines.
Otter Lake Brick & Tile Co.....	Otter Lake.....	Otter Lake.
Sharp, Frank.....	R. D. No. 1, Linden.....	South Mundy.
<i>Gladwin County:</i>		
Korkoske, Christ.....	Gladwin.....	Gladwin.
<i>Grand Traverse County:</i>		
Traverse City Brick Co.....	Traverse City.....	Keystone.
<i>Gratiot County:</i>		
Ashley Tile Co.....	Ashley.....	Ashley.
Stevenson & Sons, David.....	Ashley.....	Ashley.
Ithaca Brick & Tile Yards.....	Ithaca.....	Ithaca.
Lee, Chas.....	North Star.....	North Star.
Peet, C. D.....	North Star.....	North Star.
Smith & Sons, Wm. H. H.....	St. Louis.....	St. Louis.
Riverside Brick & Tile Co.....	Sumner.....	Sumner.
<i>Hillsdale County:</i>		
Jerome Brick & Tile Co.....	Jerome.....	Jerome.
Gish & Connor.....	Waldron.....	Waldron.
<i>Ingham County:</i>		
Clippert, Spaulding & Co.....	Lansing.....	Lansing.
<i>Ionia County:</i>		
Brown, Albert.....	Saranac.....	Saranac.
Van Der Heyden, Fred H.....	Ionia.....	Ionia.

BRICK AND TILE MANUFACTURERS, 1914.—Continued.

Operators.	Office.	Works.
<i>Isabella County:</i>		
Kane Bros.....	Mt. Pleasant.....	Mt. Pleasant.
<i>Jackson County:</i>		
Simpson, Nathan F., Warden Michigan State Prison.....	Jackson.....	Jackson.
American Sewer Pipe Co.....	Akron, Ohio.....	Jackson.
<i>Kalamazoo County:</i>		
Zeeland Brick Co.....	Zeeland.....	Brownell.
<i>Kent County:</i>		
Grand Rapids Brick Co.....	Mich. Ave. and Fuller St., Grand Rapids.....	Grand Rapids.
Sparta Clay Works.....	Sparta.....	Sparta.
<i>Lenawee County:</i>		
Laurenson & Saunders.....	Addison.....	Addison.
Wilt, C. H.....	Blissfield.....	Blissfield.
Britton Pressed Brick Co.....	Ann Arbor.....	Britton.
Atkin, Wm. T.....	Deerfield.....	Deerfield.
Woodford & Son, B. F.....	Jasper.....	Jasper.
Ellis, G. D.....	Macon.....	Macon.
American Brick & Tile Co.....	Morenci.....	Morenci.
Comfort, Albert A.....	R. D., Tecumseh.....	Tecumseh.
<i>Macon County:</i>		
Hartsig, Jacob.....	Warren.....	Centerline.
Hacker, Frank G.....	Mt. Clemens.....	Clinton.
Gass, East.....	R. D. No. 2, Washington.....	Davis.
Mt. Clemens Brick & Tile Co.....	Mt. Clemens.....	Mt. Clemens.
Warren Brick & Tile Works.....	Warren.....	Warren.
<i>Manistee County:</i>		
Kujawske, Joseph.....	Oakhill.....	Oakhill.
<i>Mecosta County:</i>		
Nehmer, Wm. F.....	Big Rapids.....	Big Rapids.
<i>Midland County:</i>		
Rilett & Herwig, J. W.....	R. D. No. 3, Coleman.....	Coleman.
Midland Tile Works.....	Midland.....	Midland.
<i>Monroe County:</i>		
Meyer Bros.....	Azalia.....	Azalia.
Linenfelter Brick & Tile Co.....	Maybee.....	Maybee.
Angerer Clay Products Co.....	Scofield.....	Scofield.
Strong & Son, John.....	South Rockwood.....	South Rockwood.
Huiel, John.....	Azalia.....	Azalia.
<i>Muskegon County:</i>		
Holton Brick Co.....	Muskegon.....	Holton.
<i>Newaygo County:</i>		
Stevens & Sons, Wm.....	R. D., Grant.....	Grant.
<i>Ottawa County:</i>		
Zeeland Brick Co.....	Zeeland.....	Zeeland.
<i>Saginaw County:</i>		
Parker-Lohmann Brick & Tile Co.....	R. D. No. 10, Saginaw, W. S.....	Saginaw, W. S.
Robie, Mrs. Peter.....	R. D. No. 10, Saginaw, W. S.....	Paines.
Sperry Bros.....	Paines.....	Paines.
Day, James.....	R. D. No. 8, Saginaw.....	Saginaw.
Day, Thomas.....	R. D. No. 3, Saginaw.....	Saginaw.
Saginaw Paving Brick Co.....	1850 S. Jefferson Ave., Saginaw.....	Saginaw.
<i>St. Clair County:</i>		
Belknap & Phillips.....	Bell River Road, St. Clair.....	St. Clair.
Beard, Fred'k. A.....	Atkins, R. D. 2.....	Ruby.
<i>Sanilac County:</i>		
Croswell Brick Co.....	Croswell.....	Croswell.
Minden City Brick & Tile Works.....	Minden City.....	Minden City.
Sandusky Brick & Tile Co.....	Sandusky.....	Sandusky.

BRICK AND TILE MANUFACTURERS, 1914.—Concluded.

Operators.	Office.	Works.
<i>Shiawassee County:</i>		
Detroit Vitrified Brick Co.....	Box 289, Corunna.....	Corunna.
<i>Tuscola County:</i>		
Thompson & Son, John.....	Tuscola.....	Tuscola.
Hall, Chas.....	Cass City.....	Cass City.
<i>Van Buren County:</i>		
Stewart, James.....	R. D. No. 2, Bangor.....	Bangor.
<i>Wayne County:</i>		
Daniel & Bro. Brick Co., Jacob.....	291 Clippert Ave., Detroit.....	Detroit.
Haggerty, John S.....	1815 Dime Sav. Bk. Bldg., Detroit.....	Detroit.
Lonyo, Harsha Brick Co.....	644 Humboldt Ave., Detroit.....	Detroit.
McDonald & Son, John C.....	707 Hammond Bldg., Detroit.....	Springwells.
Ajax Brick Co.....	66 Buhl Block, Detroit.....	Detroit.
Bunte Bros. Tile Co.....	Flat Rock.....	Flat Rock.
Clippert & Bro. Brick Co., Geo. H.....	1960 Michigan Ave., Detroit.....	Springwells.
Clippert, Wm.....	1960 Michigan Ave., Detroit.....	Springwells.
Detroit Roofing Tile Co.....	308 Hammond Bldg., Detroit.....	Springwells.
Mercier, Bryan, Larkins Brick Co.....	Michigan Ave. and Lonyo Road, Detroit.....	Springwells.
Lonyo Bros.....	613 Campbell Ave., Detroit.....	Springwells.
Porath Bros.....	306 Free Press Bldg., Detroit.....	Springwells.
Sass Bros. & Stuve.....	463 Lumley Ave., Detroit.....	Springwells.
Springwells Brick Co.....	1009 Hammond Bldg., Detroit.....	Springwells.
Wolf Brick Co., F. H.....	1467 Central Ave., Detroit.....	Detroit.
Pewabic Pottery & Tile Co.....	2161 Jefferson Ave., Detroit.....	Detroit.

SAND-LIME BRICK PRODUCERS, 1914.

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

CEMENT PRODUCERS, 1914.

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

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

Name of mine.	County.	Manager.	Address.	Superintendent.	Address.
Robert Gage Coal Co. No. 6.	Bay	Chas. Coryell.	Bay City.	H. C. Lewis.	Bay City.
Robert Gage Coal Co. No. 7.	Bay	Chas. Coryell.	Bay City.	John Coryell.	Bay City.
Monitor Mine.	Bay	Chas. Handy.	Bay City.	Jas. Love.	Bay City.
Beaver Coal Company.	Bay	Chas. Coryell.	Bay City.	John Coryell.	Bay City.
Wolverine Coal Mining Company No. 3.	Bay	R. M. Randall.	Saginaw.	Alex Liddle.	Bay City.
Wolverine Coal Mining Company No. 2.	Bay	R. M. Randall.	Saginaw.	Alex Liddle.	Bay City.
What Cheer Coal Mining Company No. 1.	Bay	E. B. Foss.	Bay City.	Alex Jeffreys.	Bay City.
Michigan Vitriol Brick Company.	Bay	Fred L. Twining.	Bay City.	John Harris.	Bay City.
Eben Wright Mine.	Eaton	Eben Wright.	Grand Ledge.	Eben Wright.	Grand Ledge.
What Cheer Coal Mining Company No. 2.	Genesee	E. B. Foss.	Bay City.	Alex Jeffreys.	Bay City.
Cedar River Coal Mining Company.	Ingham	Thos. M. Jenkins.	Williamston.	Thos. M. Jenkins.	Williamston.
Jenkins Coal Company.	Jackson	Irving Jenkins.	Jackson.	Irving Jenkins.	Jackson.
Robert Gage Coal Company No. 2.	Saginaw	Chas. Coryell.	Bay City.	Richard Jenkins.	St. Charles.
Robert Gage Coal Company No. 3.	Saginaw	Chas. Coryell.	Bay City.	Henry Dause.	St. Charles.
Bliss Coal Mining Company.	Saginaw	John T. Phillips.	Saginaw.	John E. Evans.	Saginaw.
Banner Coal Mining Company.	Saginaw	Win. B. Carmichael.	Saginaw.		Swan Creek.
Shiawassee Coal Mining Company.	Saginaw	R. M. Randall.	Swan Creek.	Jos. Skillcorn.	Saginaw.
Pere Marquette Coal Company No. 3.	Saginaw	R. M. Randall.	Saginaw.	Thos. Westwood.	Swan Creek.
Chappell and Fordney No. 2.	Saginaw	R. M. Randall.	Saginaw.	R. Johnston.	Saginaw.
Caledonia Coal Mining Company.	Saginaw	John Degan.	Saginaw.	Tim Hollis.	Saginaw.
Savage Coal Mining Company.	Saginaw	Ed. Savage.	Saginaw.	Geo. Theily.	Saginaw.
Detroit Vitriol Brick Company.	Shiawassee	J. W. DeBaubien.	Detroit.	Fred Johnston.	Saginaw.
Akron Coal Mining Company.	Tuscola	Chas. Handy.	Bay City (W. S.).	H. Sarazin.	Cornum.
				John Morris.	Akron.

Hon. Thomas Canary, State Coal Mine Inspector, Saginaw, Michigan.

CLAY MINERS, 1914.

Operators.	Office.	Mine.
<i>Bay County:</i>		
Valley Land Co.	Bay City	Bay City.
<i>Ontonagon County:</i>		
Emmond, Wm. F.	Rockland	Rockland.
Robinson Clay Products Co.	1010 E. Market St., Akron, Ohio	Rockland.
Vogtlin, W. P.	Rockland	Rockland.
Jeffs, F. A.	Rockland	Rockland.
Jeffs Land Co., Ltd.	Rockland	Rockland.
<i>Wexford County:</i>		
Stanley & Son, J. Z.	Harriette	Harriette.

COKE PRODUCERS, 1914.

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

NATURAL GAS PRODUCERS, 1914.

Operator.	Address.
<i>Benzie County:</i>	
Gordon & Conklin	Beulah.
<i>Hillsdale County:</i>	
DeWitt, C. M.	Osseo.
<i>Macomb County:</i>	
Hanekow, Mrs. Wm. H.	Warren, R. F. D. No. 2.
Hartsig, Wm. L.	Warren, R. F. D. No. 2.
Jacobs, Edward and Otto	Warren, R. F. D. No. 2.
Mielke, August	Warren, R. F. D. No. 2.
Smith, Alex.	Warren, R. F. D. No. 2.
Wolgast, Max.	Warren, R. F. D. No. 2.
Elwart, Franz	Warren, R. F. D. No. 2.
<i>Oakland County:</i>	
Landau, Ed.	Royal Oak, R. D.
Langer, Henry	Royal Oak.
McClelland, James	Redford.
<i>St. Clair County:</i>	
Haas, H. G.	Port Huron, 1615 Griswold St.
Michigan Central Oil, Gas and Mineral Co.	Port Huron.
Michigan Development Co.	Port Huron.
Stevens, H. Leroy	Port Huron.
Stock Co., G. B., Xylite Grease and Oil Co.	Port Huron.
Mason, F. H.	Port Huron, 2478 Military St.
Howe, Geo. W.	Port Huron, 4008 Military St.
<i>Washtenaw County:</i>	
Harmon, H. E.	Willis.
<i>Wayne County:</i>	
Becker, Irving	Redford.

GRAPHITE PRODUCERS, 1914.

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

GRINDSTONE AND SCYTHESTONE PRODUCERS, 1914.

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

PRODUCERS OF GYPSUM PRODUCTS, 1914.

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

LIMESTONE AND LIME PRODUCERS, 1914.

Operators.	Office.	Quarry.
<i>Alpena County:</i> Collins, R. (also lime)	151 Water St., Alpena	Alpena.
Michigan Alkali Co.	Wyandotte	Wyandotte.
Great Lakes Stone and Lime Co.	Alpena	Rockport.
<i>Arenac County:</i> McDonnell, Jas. (lime)	Twining	Omer.
<i>Charlevoix County:</i> Northern Lime Co. (lime)	Petoskey	Bay Shore.
Charlevoix Rock Products Co. (also lime)	Charlevoix	Charlevoix.
<i>Cheboygan County:</i> Campbell Stone Co. (also lime)	Indian River	Afton.
Cheboygan Limestone Products Co	22 Pickering Bldg., Cincinnati, O.	Cheboygan.
<i>Delta County:</i> Delta Contracting Co.	Escanaba	Escanaba (Hyde).
Bichler, John	Groos	Groos.
<i>Dickinson County:</i> Metronite Co., The	Milwaukee, Wis.	Felch.
<i>Emmet County:</i> Antrim Lime Co. (lime)	912 Mich. Trust Bldg., Grand Rapids	Petoskey.
Northern Lime Co. (also lime)	Petoskey	Petoskey.
Petoskey Crushed Stone Co	Petoskey	Petoskey.
<i>Mackinac County:</i> Ozark Stone Quarry	Ozark	Ozark.
Union Carbide Co.	42nd St. Bldg., New York, N. Y.	Hendrick's Quarry.
Fiborn Limestone Co.	Sault Ste. Marie, Ontario, Can	Fiborn Quarry.
<i>Marquette County:</i> City of Negaunee	Negaunee	Negaunee.
<i>Menominee County:</i> Menominee Stone Crusher	Menominee	Menominee.
<i>Monroe County:</i> Shore Line Stone Co.	Monroe	Frenchtown.
The France Stone Co.	1800 Second Nat'l Bank Bldg., Toledo, O	Monroe.
Morris, Sam W.	Monroe	Monroe.
Wynocker, W.	Samaria	Samaria.
<i>Presque Isle County:</i> Michigan Limestone & Chemical Co.	55 Liberty St., New York, or Rogers City, Mich.	Calcite.
<i>Schoolcraft County:</i> The White Marble Lime Co.	Manistique	Blaney, Manistique and Marblehead.
Delta Contracting Co.	Escanaba	Manistique.
<i>Wayne County:</i> Solvay Process Co.	Syracuse, N. Y.	Trenton and Sibley.
Dunbar Stone Co.	Detroit or River Rouge	Mouth of Detroit River.

MINERAL PAINT PRODUCERS, 1914.

Operator.	Pigment.	Office.	Location of plant.
Acme White Lead & Color Works	White lead, red lead, litharge, orange mineral	Detroit	Detroit.
Pickands, Mather & Co.	Met. Point	Cleveland, Ohio.	Iron County.

MINERAL AND SPRING WATER PRODUCERS, 1914.

Operators.	Office.	Spring.
Arctic Spring Water Co.	412 Ottawa Ave., Grand Rapids	Arctic.
Bailey Marvel Springs Co.	Bellaire	Beaver.
Willis, J. L.	Bangor	Bromo-Hygeia.
Bromo-Hygeia Mineral Water Co.	Coldwater	Charlevoix.
Charlevoix Mineral Water Co.	Charlevoix	Cooper Farm Spring.
Walker Gordon Farm & Laboratory Co.	Birmingham	
Crystal Spring Water, Fuel & Ice Co.	35 No. Division St., Grand Rapids	Crystal Spring.
Eastman Springs Co.	Benton Harbor	Eastman.
Detroit Mineral Water Co.	584 Michigan Ave., Detroit	Giant Spring.
Harrison Spring Water Co.	360 W. Bridge St., Grand Rapids	Harrison.
Polaris Water Co.	Marquette	Lake Superior Mineral Spring.
Mt. Clemens Crystal Springs Water Co.	Mt. Clemens	Mt. Clemens Crystal Spring.
Ogemaw Spring Water Co.	Bay City	Ogemaw.
Dewitt, C. M.	Osseo	Osseo.
Ponce de Leon Co.	Grand Rapids	Ponce de Leon.
Pike, Lute H.	Topinabee	Sanitas.
Shorkey, Chas.	Mt. Clemens	Victory.
Coca-Cola Bottling Co.	Battle Creek	White Oak.
Ypsilanti Mineral Water & Bath Co.	Ypsilanti	Moorman Well.
Magnetic Spring Water Co.	Saginaw, W. S.	Andrew's Magnetic Mineral.
Beard Hills Mineral Spring Co.	105 E. Bancroft St., Toledo, Ohio	Avoca.
Charbeneau, Jno. H.	Mt. Clemens	Maple Leaf Springs.
Preussel, Frank W.	47 Crocker Ave., Mt. Clemens	Panacea.
Salutaris Water Co.	Detroit	Salutaris.
Oliver Co.	Pontiac	Welcome Island.
Wall, W. J.	South Haven	Crystal.
Jackson, Roger	Crystal Falls	Sterling.
Sutton, Geo.	Hartford	Sultana.

PETROLEUM PRODUCERS, 1914.

Operators.	Address.
Michigan Central Oil & Mineral Co.	807 Pine St., Port Huron.
Michigan Development Co.	103 Huron Ave., Port Huron.
Stock Xylite Grease & Oil Co., G. B.	Port Huron.

PIG IRON PRODUCERS, 1914.

Operator.	Office.	Name of furnace.	Location of furnace.
Lake Superior Iron & Chemical Co.	Detroit	Boyne City	Boyne City.
Lake Superior Iron & Chemical Co.	Detroit	Chocoley	Chocoley.
Lake Superior Iron & Chemical Co.	Detroit	Elk Rapids	Elk Rapids.
Lake Superior Iron & Chemical Co.	Detroit	Manistique	Manistique.
Lake Superior Iron & Chemical Co.	Detroit	Newberry	Newberry.
Mitchell-Diggins Iron Co.	Cadillac	Cadillac	Cadillac.
Detroit Furnace Co.	1069 Jefferson Ave., Detroit	Detroit	Detroit.
Detroit Iron & Steel Co.	149 Jefferson Ave., Detroit	A & B	Detroit.
East Jordan Furnace Co.	East Jordan	Pioneer No. 1	East Jordan.
Cleveland Cliffs Iron Co.	Cleveland, Ohio		Gladstone.
Antrim Iron Co.	Antrim	Antrim	Antrim.
Pioneer Iron Co.	Marquette	Carp	Near Marquette.
Pioneer Iron Co.	Marquette	Pioneer No. 2	Near Marquette.
Stevenson Charcoal Iron Co.		Stevenson	Wells.

POTTERY PRODUCERS, 1914.

Operator.	Office.	Works.
<i>Ionia County:</i>		
Ionia Pottery Co.	Ionia	Ionia.
<i>Wayne County:</i>		
Detroit Flower Pot Co.	490 Howard St., Detroit	Detroit.
Jeffery-Dewitt Co.	Detroit	Detroit.
Hupprich, Anton	2161 Michigan Ave., Detroit	Detroit.
Mt. Clemens Pottery Co.	Mt. Clemens	Mt. Clemens.
Pewabic Pottery & Tile Co.	2161 Jefferson St., Detroit	Detroit.

QUARTZ PRODUCERS, 1914.

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

SALT PRODUCERS, 1914.

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

SANDSTONE PRODUCERS, 1914.

Operator.	Office.	Quarry.
<i>Houghton County:</i>		
Portage Entry Redstone Co.	Jacobsville	Jacobsville.
<i>Huron County:</i>		
Cleveland Stone Co.	Cleveland, Ohio	Grindstone.
<i>Monroe County:</i>		
Strouse, J. D.	Ottawa Lake	Ottawa Lake.

SAND AND GRAVEL PRODUCERS, 1914.

Operator.	Office.	Pit.
<i>Allegan County:</i>		
Sutler, Fred W.	Byron Center	Burnips Corners.
Wiest, Peter	Dorr, R. F. D. 2	Dorr.
Terpsira, Geo.	Dunningville, R. F. D. 1.	Dunningville.
Wheeler, Mrs. J. C.	Martin	Martin.
Kool, Henry	New Richmond	New Richmond.
Pierce, Myron	Otsego	Otsego.
Powell, J. C.	Plainwell	Plainwell.
Craim, W. C.	Douglass	Douglass.
<i>Alpena County:</i>		
Riley & Monkman	501 State St., Alpena	Alpena.
<i>Antrim County:</i>		
Hilton, Robert	Bellaire, R. F. D. 1	Bellaire.
Sissons, F. E.	Central Lake, R. F. D. 1	Central Lake.
McPherson, Guy	Eastport	Eastport.
Campbell, W.	Mancelona	Mancelona.
Swan, Guy	Mancelona	Mancelona.
<i>Arenac County:</i>		
Wells, A. H.	Standish, R. D. 2	Standish.
Daniels, Wm.	Sterling, R. F. D.	Sterling.
Pettit, Frank	Twining, R. F. D. 1	Twining.
Rogers, Sidney	Twining	Twining.
Mayer of Omer City	Omer	Omer.
<i>Barry County:</i>		
Woolston, Chas	Hastings	Hastings.
Hitt, Geo.	Woodland	Woodland.
Renkes, Fred	Hastings	Hastings.
Dunham, P. O.	Nashville	Grove Center.
<i>Bay County:</i>		
Hayward, R.	Bay City, R. F. D. 3	Bay City.
<i>Benzie County:</i>		
Huddleston, Wm	Bendon, R. F. D. 1	Bendon.
Rice, J. R.	Benzonia, R. F. D. 1	Benzonia.
Wilson Bros.	Lake Ann	Lake Ann.
Betsey River Orchards, Ben Newhall & Co.	840 Ohio Bldg, Chicago, or Thompsonville, Mich	Thompsonville.
<i>Berrien County:</i>		
Edgecombe, Geo. W.	439 Main St., Benton Harbor	Benton Harbor.
Warren, Paul Co	Lakeside	Lakeside.
Benton Harbor Sand Co.	Benton Harbor	Benton Harbor.
American Sand & Gravel Co.	Benton Harbor	Benton Harbor.
Garden City Sand Co.	Riverside	Riverside.
Kerlikowske Bros.	St. Joseph	St. Joseph.
Brown, H. C.	Berrien Springs	Baroda.
Brewer, Frank	Galien	Galien.
<i>Branch County:</i>		
Werner, Jake	Bronson	Bronson.
Hoyt, Moses	Coldwater	Coldwater.
Barnes, Mrs. J. M.	Montgomery	Rinderhook.
<i>Calhoun County:</i>		
March, Andrew	Union City, R. F. D. 5	Union City.
Ringler, A.	Albion, R. F. D. 2	Albion.
Young, Willard A.	Albion	Albion.
Blowers, N. A.	Athens	Athens.
Marrow, D. G.	Battle Creek	Athens.
Ellis, Bert	Battle Creek	Battle Creek.
Funk, F. J.	Battle Creek, R. F. D. 2	Battle Creek.
Hiscock, Seth	Battle Creek	Battle Creek.
Webb, Mrs. N. E.	Battle Creek, R. F. D. 11	Battle Creek.
Grosbeck, Fred	Burlington	Burlington.
Adrian, John	323 Hamblin Ave.	Battle Creek.
Crystal Sand & Gravel Co.	12 E. Main St., Battle Creek	Battle Creek.
Brownlee Park & Material Co.	Battle Creek	Brownlee Park.
Michigan United Traction Co.	Jackson	Marshall.
Prince, Wm. A.	Ceresco	Ceresco.

SAND AND GRAVEL PRODUCERS, 1914.—Continued.

Operator.	Office.	Pit.
<i>Cass County:</i>		
McNab, M.	Cassopolis	Cassopolis.
Thorp, Mrs. L. S.	Niles	Cassopolis.
<i>Charlevoix County:</i>		
Healy, Chas	East Jordan, R. F. D. 2	East Jordan.
<i>Cheboygan County:</i>		
Charpointiar, Jos	Cheboygan, R. F. D. 2	Cheboygan.
<i>Chippewa County:</i>		
Taylor, F. H.	Pickford	Pickford.
Belanger, Louis	Sault Ste. Marie	Sault Ste. Marie.
Rye, Jas.	409 Maple St., Sault Ste. Marie	Sault Ste. Marie.
<i>Clare County:</i>		
Littlefield, J. L.	Farwell	Farwell.
<i>Clinton County:</i>		
Parmenter, Geo.	Shepardsville	Shepardsville.
Gleason, S. B.	Ovid	Ovid.
Allen, Frank	Elsie	Elsie.
Keys, Hiram	St. Johns	St. Johns.
Wilhelm, Noah	Bath, R. D.	Bath.
Lerg, John A.	DeWitt, R. F. D. 26	DeWitt.
Mich. United Traction Co.	Jackson	DeWitt.
Stowell, Elmer	Ovid	Ovid.
Ott, Geo.	DeWitt	DeWitt.
Coats, Lewey	Ovid	Ovid.
<i>Crawford County:</i>		
Latham, Nathan J.	Grayling	Grayling.
<i>Delta County:</i>		
Putvin, Louis	Garden	Garden.
Chicago & N. W. R. R.	Chicago	Escanaba.
Escanaba Stone & Gravel Co.	Escanaba	Escanaba, Flat Rock.
Jorgensen, Adolph	Escanaba	Escanaba.
<i>Dickinson County:</i>		
Chicago & N. W. R. R.	Chicago	Iron Mountain and Loretto.
Vulcan Brick Works	Vulcan	Vulcan.
<i>Eaton County:</i>		
Palmiter, S. J.	Bellevue, R. F. D. 4	Bellevue.
Hull Bros.	Dimondale	Dimondale.
Johnson, C.	Eaton Rapids	Eaton Rapids.
Divine & Co., Wm	Grand Ledge	Grand Ledge.
Frost, C. A.	Grand Ledge	Grand Ledge.
Kent, V. M.	Grand Ledge	Grand Ledge.
Saier, H. E.	Lansing, R. F. D. 6	Millet.
Cheal, J. E.	Sunfield	Sunfield.
Wells, C. E.	Vermontville	Vermontville.
<i>Genesee County:</i>		
Bird, Jos	Davison	Davison.
Burns, Ed	Duffield	Duffield.
Farnham, Henry	Farnham, R. F. D. 3	Fenton.
Flint Sandstone Brick Co.	Flint	Flint.
Reid, Alfred	Flint	Flint.
Scott, F. D.	Genesee	Genesee.
Boston, H. W.	Goodrich, R. F. D. 1	Goodrich.
Brock, August	Goodrich	Goodrich.
Stine, Martin	Goodrich	Goodrich.
Bowles, E.	Linden	Linden.
Hogan, Daniel	Linden	Linden.
Fletcher, Seward	Linden	Linden.
Sansan, Geo	Linden	Linden.
Brown, D.	Swartz Creek	Swartz Creek.
Johnson, Ernie	Swartz Creek	Swartz Creek.
<i>Gladwin County:</i>		
Wenzel, John	Beaverton, R. F. D. 1	Beaverton.

SAND AND GRAVEL PRODUCERS, 1914.—Continued.

Operator.	Office.	Pit.
<i>Gogebic County:</i>		
Chicago & N. W. R. R.	Chicago	Blemers.
<i>Grand Traverse County:</i>		
Koch, John	Mayfield	Mayfield.
<i>Gratiot County:</i>		
Church, J. H.	Alma	Alma.
Sawvel, Robert	Breckenridge	Breckenridge.
Lippert, Jacob	Elwell	Elwell.
Curtis, C.	Ithaca, R. F. D. 6	Ithaca.
Haas Bros.	Northstar, R. F. D. 3	Northstar.
Tomlin, A.	Sumner	Sumner.
Wiles, Wm.	Sumner, R. F. D. 2	Sumner.
<i>Hillsdale County:</i>		
Crowl, A.	Camden	Camden.
Morgan, H. C.	Camden, R. F. D. 37	Camden.
Sholfield, H. C.	Pittsford	Pittsford.
Thompson, L. W.	Waldron	Waldron.
Wolcott, C. Nelson E.	Hillsdale	Hillsdale.
<i>Houghton County:</i>		
Winona Copper Co.	Winona	Winona.
<i>Huron County:</i>		
Conkey, Sam	Caseville	Caseville.
Merrick Gravel Co.	Pigeon	Pigeon.
Wallace Co., The	Port Austin	Port Austin.
Haskell, Miss Eliz. A.	Port Austin	Port Austin.
<i>Ingham County:</i>		
Artz, Joe	Leslie	Sec. 23, Bunker Hill Twp.
Atkinson, Mr.	Mason	S. W. Cor. Sec. 16, Vevay Twp.
Bell, O. E.	Mason or Lansing	Sec. 36, Delhi Twp.
Breitenwischer, Lewis	Lansing	Lansing.
Bunker, Chas.	Leslie or Stockbridge	Sec. 35, Bunker Hill Twp.
Corwin, W. L.	Williamston	Sec. 2, Wheatfield Twp.
Couch, Chas.	Mason	Sec. 25, Aurelius Twp.
Curtiss, Bert	Williamston	N. E. Cor. Sec. 21, Wheatfield Twp.
Potts, W. S.	Mason, R. F. D. 1	Mason.
Dubois, D. D.	Leslie	Sec. 28, Bunker Hill Twp.
Frost, A. J.	Williamston	Sec. 22, Wheatfield Twp.
Frost, J. F.	Williamston	Sec. 26, Wheatfield Twp.
Holbrook, John	Lansing	Lansing (Holt).
Linn, Lew	Williamston	Sec. 15, Wheatfield Twp.
Saier, H. E.	Lansing, R. F. D. 6	Lansing.
Stockman, F. M.	Lansing	Lansing.
Shortwell, E.	Leslie (or Stockbridge)	Sec. 35, Bunker Hill Twp.
Campbell, Hugh	1516 6th St., Bay City	Mason.
Nice, Geo.	Mason	Sec. 6, Vevay Twp.
Okobock, Dennis	Mason	Sec. 5, Vevay Twp.
Potts, Walter F.	Mason, R. F. D. 1	Mason.
Rappe, A.	Lansing or E. Lansing	Sec. 16, Meridian Twp.
Roark, J. C.	Williamston	Sec. 34, Williamston Twp.
Sheltraw, A. E.	Saginaw	Mason.
Smith, Geo.	Mason	Sec. 10, Vevay Twp.
Stevens, F. B.	Mason	Sec. 5, Vevay Twp.
Victory, Ward	Leslie or Stockbridge	Sec. 36, Bunker Hill Twp.
Michigan United Traction Co.	Jackson	Sec. 25, Delhi Twp., Mason and Haslett.
Warner, Mr.	Mason	N. W. Cor. Sec. 36, Aurelius Twp.
Williams, C. W.	Williamston	Sec. 35, Williamston Twp.
Winters, J. P.	Leslie or Stockbridge	Sec. 25, Bunker Hill Twp.
Graves, Frank	Williamston	Williamston.
<i>Ionia County:</i>		
Crawford, Geo. W.	Ionia, R. F. D. 3	Ionia.
Ionia Cement Products Co.	Ionia	Ionia.
Larsen, Geo.	Greenville, R. F. D. 3	Greenville.
Miller, Henry	East Main St., Ionia	Ionia.
Normington, Frank	Ionia, R. F. D. 1	Ionia.

SAND AND GRAVEL PRODUCERS, 1914.—Continued.

Operator.	Office.	Pit.
<i>Ionia County.—Con.</i>		
Fellows, Jas. M.	Lake Odessa	Lake Odessa.
Hauserman, Herman	Lake Odessa, R. F. D.	Lake Odessa.
Millard, Seymour	Palo	Palo.
Ronald Twp. Gravel Pit	Palo	Palo.
Grievess, Mrs.	Saranac, R. F. D. 12	Saranac.
Keyser, Chas.	Saranac, R. F. D. 10	Saranac.
<i>Iosco County:</i>		
Boomer & Son, Jno.	Tawas City	Tawas City.
Davison, Thos.	Tawas City	Tawas City.
Kimball, Ray	Crystal Falls	Crystal Falls.
Chicago, Milwaukee & St. Paul R. R.	Chicago	Crystal Falls.
<i>Isabella County:</i>		
Winans, Frank	Blanchard	Blanchard.
Himebaugh, Geo.	Mt. Pleasant	Mt. Pleasant.
Coughlin, Will.	Shepherd, R. F. D. 1	Shepherd.
Dexter, James	Shepherd	Shepherd.
<i>Jackson County:</i>		
Greenville Gravel Co.	Greenville	Ackerman Lake.
Cooper, Alfred	Horton	Horton.
Winters, J. P.	Jackson	Jackson.
Cavanaugh, Wm.	Horton	Horton.
Blackmar, Chas.	107 Stewart Ave., Jackson	Jackson.
Blake, Wm.	Jackson, R. F. D. 6	Jackson.
Emmons, Wm. P.	123 Clinton St., Jackson	Jackson.
Meyers, Albert	Jackson, R. F. D. 6	Jackson.
Watts, C. R.	Jackson, R. F. D. 2	Jackson.
Anderson, F. L.	Parma	Parma.
Bern, C. E.	Parma	Parma.
Mich. Central R. R. Co.	Detroit	Bloomerville.
Mich. United Traction Co.	Jackson	Michigan City.
Hunn, G. L.	Parma	Parma.
<i>Kalamazoo County:</i>		
Mich. United Traction Co.	Jackson	Augusta.
Miller, J. B.	Augusta	Augusta.
Balch, Wm. A.	Kalamazoo	Kalamazoo.
Balch, Uriel K.	Kalamazoo	Kalamazoo.
Buurma, Sam'l H.	Kalamazoo	Kalamazoo.
Haas & Son, A.	Kalamazoo	Kalamazoo.
Huff, Archie	Kalamazoo	Kalamazoo.
Klepper, Jacob	Kalamazoo	Kalamazoo.
Molhark, Peter	Kalamazoo	Kalamazoo.
Owens, Michael	Kalamazoo	Kalamazoo.
Russell, Jas. T.	Kalamazoo	Kalamazoo.
So. Mich. Brick Co.	Kalamazoo	Richland Twp.
Mich. United Traction Co.	Jackson	Kalamazoo.
Chadderton, Emery	Richland	Richland.
Gunn, J. W.	Watervliet	Williams.
<i>Kalkaska County:</i>		
Myers, Fred	Williams	Williams.
Anderson, Lind	Kalkaska	Kalkaska.
Hayward, W. F.	South Boardman	South Boardman.
<i>Kent County:</i>		
Holt, C. E.	Ada, R. F. D. 42	Ada.
Deiss, Jos.	Ada, R. F. D. 17	Alpine.
Reed, Percy	Alpine	Alpine.
Brewer, Earl	Byron Center, R. F. D.	Byron Center.
Battjes Fuel & Bldg. Mat. Co.	Grand Rapids	Grand Rapids.
Bunker Co., G. W.	Grand Rapids	Grand Rapids.
Harrison Land Co., Ltd.	Grand Rapids	Grand Rapids.
Carpenter & Anderson	Grand Rapids	Grand Rapids.
Pinyon, S. G.	Grand Rapids	Grand Rapids.
Valley City Stone & Gravel Co.	Grand Rapids	Grand Rapids.
Ide, D. K.	Grandville	Grandville.
Maloney, Pat.	Harvard, R. F. D. 40	Harvard.
Holmgren, E. A.	Kent City	Kent City.
Kruger, M.	Kent City	Kent City.
Ryno, M. J.	Ross, R. F. D.	Ross.
Farnam, Reuben	Sand Lake	Sand Lake.
Kilts, Henry	Sand Lake	Sand Lake.
Standard Builders Supply Co.	Grand Rapids	Grand Rapids.
General Builders Supply Co.	Grand Rapids	Grand Rapids.

SAND AND GRAVEL PRODUCERS, 1914.—Continued.

Operator.	Office.	Pit.
<i>Lake County:</i> Saunders & Co., G. W.	Chase.	Chase.
<i>Lapeer County:</i> Hallock, Roy P. Miteen, Fred. Caley, M.	Almont. Goodrich. Metamora.	Almont. Goodrich. Hunters Creek.
<i>Leelanau County:</i> Bronson, Margaret	Maple City, R. F. D. 1.	Maple City.
<i>Lenawee County:</i> Shannon, F. J. Smith, Porter C. Fuller, Charlie. Lockwood, Sam. Lowe, Frank. Evans, Geo. Gillispie, R. P. Wilson, Ira. Tecumseh Gravel Co.	Adrian. Clinton. Hudson. Hudson. Hudson. N. Morenci. Tecumseh. Tecumseh, R. F. D. 3. Tecumseh.	Adrian. Clinton. Hudson. Hudson. Hudson. N. Morenci. Tecumseh. Tecumseh. Tecumseh.
<i>Livingston County:</i> Ohio & Michigan Sand & Gravel Co. Coles, Ben. Arnold, O. B. Butler, Dwight. Hosby, E. B. Thomas, Henry	1025 Nicholas Bldg., Toledo, Ohio. Fowlerville. Gregory. Hamburg. Howell. Oak Grove.	Chilson. Fowlerville. Gregory. Hamburg. Howell. Oak Grove.
<i>Macomb County:</i> Hornung Gravel Co. Pratt, Ben J. Ruff, Michael. Chapman, Jas. Lake Side Ice & Coal Co. Harder, Henry. Wacker, H. Jacob. Savadore, Jos. Detroit Sand & Gravel Co. Superior Sand & Gravel Co.	412 Weadock Bldg., Saginaw. Armada. Lenox, R. D. Memphis. Mt. Clemens. Richmond. Mt. Clemens. Utica, R. F. D. 2. 34 McGraw Bldg., Detroit. Detroit.	Armada. Armada. Lenox. Memphis. Mt. Clemens. Richmond. Mt. Clemens. Utica. Utica. Utica.
<i>Manistee County:</i> Hansen, Chris. Hubbell Sand Co. Miller Bros. & Co. Summerfield, Porter M. Farr, M. A. McMartin, Chas. Johnson, John.	Manistee. Manistee. Manistee. Manistee. Onokama. Chief, R. F. D. 2. Chief.	Manistee. Manistee. Manistee. Manistee. Onokama. Chief. Chief.
<i>Marquette County:</i> Cleveland Cliffs Iron Co. Chicago & N. W. R. R.	Ishpeming. Chicago.	Ishpeming. Michigamme.
<i>Mason County:</i> Hall, Ed. Szymanski, Geo. Wahr, John. Beaune, Oliver. Clark, Henry. Lorentz, Ferdinand. Dodge, C. C. Edmonson, James.	Custer, R. F. D. 2. Freesoil, R. F. D. 2. Freesoil, R. F. D. 2. Ludington, Box 68. Ludington. Ludington. Ludington. Tallman. Tallman.	Custer. Freesoil. Freesoil. Ludington. Ludington. Ludington. Tallman. Tallman.
<i>Meosta County:</i> Conklin, Wm. Riley, J. E.	Big Rapids, R. F. D. 5. Millbrook, R. F. D. 2.	Big Rapids. Millbrook.
<i>Menominee County:</i> Schoen, Jno. A. Chicago & N. W. R. R.	Wilson. Chicago.	Wilson. Paggett.

SAND AND GRAVEL PRODUCERS, 1914.—Continued.

Operator.	Office.	Pit.
<i>Midland County:</i> Troyer, D. J. Gehoski, Mike.	Brier. Midland, R. F. D. 1.	Brier. Midland.
<i>Missaukee County:</i> Pickering, O. L. Reeves, Rary D.	Lake City. McLean, Ill.	Lake City. McBain.
<i>Monroe County:</i> Falmstock, Emerson. Stoeckert, Wm. National Silica Co.	Carlton. Monroe. Steiner.	Carlton. Monroe. Steiner.
<i>Montcalm County:</i> Belknap Cement Products Co. Boezwinkle, Wm. Matz, Chas. Tissue, Legn. Sinkey, Mrs. L. M. Larsen, Geo. Williams, E. O.	Greenville. Pierson. Pierson. Stanton, R. F. D. 1. Carson City. Greenville, R. F. D. 3. Edmore.	Greenville. Pierson. Pierson. Stanton. Carson City. Greenville. Edmore.
<i>Muskegon County:</i> Bettis, Phil. Homer, Wm. Valley, Edw.	Ravenna, R. F. D. Ravenna, R. F. D. Twin Lakes.	Ravenna. Ravenna. Twin Lakes.
<i>Newaygo County:</i> Wentland, Mrs. Johanna. Hall, A. E. Nieboer, J. Raymond, R. J.	Woodville. Newaygo. Grant. Grant.	Woodville. Newaygo. Grant. Grant.
<i>Oakland County:</i> Heberson Bros. Park & Son, A. H. Mich. Portland Cement Paving Co. Ely, C. Rice, E. J. Campbell, John. Detroit-Oxford Gravel & Stone Co. Bartlett, C. S. Kemp, W. H. Rockwell, C. L. Slater Construction Co. Heal, Geo. Rochester Sand & Brick Co. Boomer Sand & Gravel Co.	Birmingham. Birmingham, R. F. D. 2. Griswold St., Detroit. Farmington. New Hudson. Ortonville, R. F. D. 2. Oxford. Pontiac. Pontiac. Pontiac. Pontiac. 669 Baker St., Detroit. Detroit. 520 Forest St. E., Detroit.	Birmingham. Birmingham. Clarkston. Farmington. New Hudson. Ortonville. Oxford. Pontiac. Pontiac. Pontiac. Pontiac. Rochester. Rochester. Rochester.
<i>Oceana County:</i> Aldrich, A. O. Golden Twp. Pit. Twp. Board of Newfield. Cartright, Thos. Wherle, Frank.	Crystal Valley. Mears. Hesperia. Rothbury, R. F. D. 1. Rothbury, R. F. D. 1.	Crystal Valley. Mears. Hesperia. Rothbury. Rothbury.
<i>Ogemaw County:</i> Edwards, John. Brooks, H. F. Harvey, D.	Prescott. Rose City. West Branch, R. F. D. 1.	Prescott. Rose City. West Branch.
<i>Osceola County:</i> Carmichael, Ed. White & Day. Stone, Chas. E. Woodward, Carl. Hoogerhide, Jno. Marvin, Seymour.	Evart, R. F. D. 1. Evart. Hersey, R. F. D. 1. Hersey, R. F. D. 1. Reed City, R. F. D. 6. Tustin, R. F. D. 1.	Evart. Evart. Hersey. Hersey. Reed City. Tustin.
<i>Ottawa County:</i> Holthrop, Jno. Graham, Mrs. T. Walsma & Co. Van Weelden & Co., J.	Ferrysburg. Grand Haven. Grand Haven. 609 Fulton St., Grand Haven.	Ferrysburg. Grand Haven. Grand Haven. Grand Haven.

SAND AND GRAVEL PRODUCERS, 1914.—Continued.

Operator.	Office.	Pit.
<i>Presque Isle County:</i>		
Kroll, Andrew	Posen	Posen.
<i>Roscommon County:</i>		
Campbell Gravel Co.	Roscommon	Roscommon.
Cresswell, Thos. B.	Saginaw	Riverbend (Saginaw).
Moiles, C. B.	Saginaw	Saginaw River.
<i>St. Clair County:</i>		
Armitage, Sidney	Atkins, R. F. D. 1	Atkins.
Chapman, Jas.	Memphis	
Kinney, Frank	Atkins, R. F. D. 1	Atkins.
Snyder, Wm.	Atkins, R. F. D. 1	Atkins.
Kitchen, Cyrenius	Smiths Creek	Smiths Creek.
McGennett, Jas.	Smiths Creek	Goodells.
Westrick & Son, C. A.	Marine City	Smiths Creek.
Caldwells Sand & Gravel Co.	Windsor, Ont.	Marine City.
Jaques & Sons, E.	Foot of 1st St., Duluth, Minn.	Port Huron.
Marine Contracting Co.	211 Quay St., Port Huron	Port Huron.
<i>St. Joseph County:</i>		
Hill, S.	Colon	Colon.
Wade, H. H.	White Pigeon	White Pigeon.
<i>Sanilac County:</i>		
David McKillen	Brown City	Brown City.
Swaffer, Chas.	Deckerville	Deckerville.
Buck, C. J.	Marlette	Marlette.
Gilbert, Geo.	Melvin, R. F. D. 6	Melvin.
Miller, Henry	Minden City	Minden City.
Dawson & Son	Sandusky	Sandusky.
<i>Shiawassee County:</i>		
Barnes, Olin	Byron	Byron.
Graham, John	Byron	Byron.
Shannon, A. E.	Byron	Byron.
Van Campen, C.	Henderson	Henderson.
Schultz, A. A.	Laingsburg	Laingsburg.
<i>Tuscola County:</i>		
Hill, Tom	Caro	Caro.
Consolidated Coal Co.	Saginaw	
Baker, Gilbert	Kingston	Kingston.
Whittaker, Benson	Kingston	Kingston.
Donigan, Joseph	Millington	Millington.
Scott, Wm.	Reese, R. F. D. 1	Reese.
Hill, Elmer A.	Unionville	Silverwood.
<i>Van Buren County:</i>		
Burger, F. A.	Bangor	Bangor.
Hoppin, A. D.	Bangor	Bangor.
Shine, John	Bangor	Bangor.
McKee, Jr., Darwin	Decatur	Decatur.
Orr, James	Decatur	Decatur.
Sherburn, John	Decatur	Decatur.
Otis, L. L.	Kibbie	Kibbie.
Hunt, Geo.	Lawrence	Lawrence.
Fry, W. G.	South Haven	South Haven.
<i>Washtenaw County:</i>		
City Concrete & Coal Co.	1015 Dime Bank Bldg., Detroit	Delhi.
Eddie, Geo.	Ann Arbor, R. F. D. 8	Ann Arbor.
Fiegel, Fred	Ann Arbor, R. F. D. 3	Ann Arbor.
Pease, Wm.	Saline, R. F. D.	Saline.
Youngs, Ed.	Saline, R. F. D.	Saline.
Crane, Mortimer R.	217 Mich. St., Ypsilanti	Ypsilanti.
Elsifer, S. A.	117 First St., Ann Arbor	Ann Arbor.
Lake Shore & Mich. So. R. R. Co.		Manchester.
Mich. Central R. R. Co.	Detroit	Osborne Pit.
Washed Clean Sand & Gravel Co.	Ann Arbor	Dexter.

SAND AND GRAVEL PRODUCERS, 1914.—Concluded.

Operator.	Office.	Pit.
<i>Wayne County:</i>		
Detroit United Fuel & Supply Co.	Detroit, Free Press Bldg.	Utica and Detroit.
Mich. Builders Supply Co.	Detroit	Detroit.
Wabash R. R. Co., American Silica Co.	Rockwood	Rockwood.
Thompson, W. R.	Detroit, 606 Kress Bldg.	Detroit.
<i>Washtenaw County:</i>		
Selma Twp. Pit	Cadillac	Cadillac.
Fewless, John	Manton, R. F. D. 3	Manton.

TRAP ROCK PRODUCERS, 1914.

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

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