

CEMENT.^a

INTRODUCTION.

The total production of hydraulic cement in the United States for 1902 was 25,753,504 barrels, an increase of 5,684,767 barrels over the quantity produced during the preceding year. The value of this production was \$25,366,380.

Of the entire quantity, 17,230,644 barrels were Portland, valued at \$20,864,078; 8,044,305 barrels were natural-rock, valued at \$4,076,630, and 478,555 barrels were Pozzuolana or slag cement, valued at \$425,672.

The growth of the cement industry is indicated by the fact that, although the increase in production for 1901 over 1900 reached the large number of 2,837,587 barrels, the increase in production for 1902 over 1901 was 5,684,767 barrels. It is of interest here to note that in 1892, just ten years ago, the entire production of cement in the United States was but 8,758,621 barrels, of which 8,211,181 barrels were natural-rock and 547,440 barrels were Portland.

PORTLAND CEMENT.

PRODUCTION.

There was an increase in the production of Portland cement in 1902 of 4,519,419 barrels. During the summer and autumn of the year there was a marked decline in the price of Portland cement in the Eastern States owing to a variety of reasons. This fact did not greatly affect the western production, however, nor was it a very lasting depression. The building of new factories, the enlargement and remodeling of old ones, and the steady and increasing demand for domestic Portland cement indicate a bright outlook for the future of the industry in this country.

^aThe entire statistical canvass and compilation of this report has been conducted by L. L. Kimball, of the United States Geological Survey.—D. T. D.

Following is a table showing the quantity and value of Portland cement produced in each State in 1900, 1901, and 1902:

Production of Portland cement in the United States in 1900, 1901, and 1902.

State.	1900.			1901.			1902. ^a		
	Num- ber of works.	Quantity.	Value, not in- cluding packages.	Num- ber of works.	Quantity.	Value, not in- cluding packages.	Num- ber of works.	Quantity.	Value, not in- cluding packages.
		<i>Barrels.</i>			<i>Barrels.</i>			<i>Barrels.</i>	
Alabama							1		
Arkansas	1	40,000	\$70,000	1			1		
California	1	44,565	89,130	^b 1	146,848	\$513,968	2	294,156	\$431,910
Colorado	1	35,708	71,416	^c 1	585,000	643,500	2	82,044	105,016
Georgia							1		
Illinois	3	240,442	300,552	4	528,925	581,818	4	767,781	977,541
Indiana	1	30,000	37,500	2	218,402	240,242	3	536,706	628,244
Kansas	1	80,000	100,000	1			1	830,050	1,017,824
Michigan	6	664,750	830,940	10	1,025,718	1,128,290	10	1,577,006	2,134,396
Missouri							1		
New Jersey	2	1,169,212	1,169,212	3	1,612,000	1,450,800	2	2,152,158	2,563,355
New York	8	465,832	582,290	7	617,228	617,228	10	1,156,807	1,521,553
North Dakota ..	1	400	1,200	1					
Ohio	6	534,215	667,769	^d 7	689,852	758,837	7	563,113	685,571
Pennsylvania ..	14	4,984,417	4,984,417	13	7,091,500	6,382,350	15	8,770,454	10,130,432
South Dakota ..	1	38,000	76,000	1			1		
Texas	2	26,000	52,000	^e 2	195,752	215,327	2	165,500	234,950
Utah	1	70,000	175,000	1			1		
Virginia	1	58,479	73,099	1			1	334,869	433,286
Total	50	8,482,020	9,280,525	56	12,711,225	12,532,360	65	17,230,644	20,864,078

^aThe States combined for 1902 are mentioned in the text.

^bIncludes product of the single plant in Utah.

^cIncludes product of the only Portland-cement plant in Kansas.

^dIncludes product of the only Portland-cement plant in Virginia.

^eIncludes product of the single plant in South Dakota.

In this table the output in 1902 of the single Portland-cement plant in Alabama is combined with the production of Georgia and Virginia to avoid disclosing individual figures; for like reasons the output of the only Portland-cement plant in Missouri (which in 1902 made simply an experimental run) is included with Kansas and South Dakota, and the output of the single plant in Utah is combined with California. In each case the total figures are placed against the name of that State contributing the largest proportion of the entire amount. The three new States to enter this table for 1902 as producers of Portland cement are Alabama, Georgia, and Missouri. New Mexico is dropped, owing to the fact that the plant in this Territory is definitely abandoned, so far as the cement industry is concerned.

Following is a table which shows the growth of the Portland-cement industry since 1890:

Development of the Portland-cement industry in the United States since 1890.

Section.	1890.			1899.			1900.		
	Number of works.	Quantity.	Per cent.	Number of works.	Quantity.	Per cent.	Number of works.	Quantity.	Per cent.
		<i>Barrels.</i>			<i>Barrels.</i>			<i>Barrels.</i>	
New York.....	4	65,000	19.4	7	472,386	8.4	8	465,832	5.5
Lehigh and Northampton counties, Pa., and Warren County, N. J.....	5	201,000	60.0	11	4,110,132	72.7	15	6,153,629	72.6
Ohio.....	2	22,000	6.5	6	480,982	8.5	6	534,215	6.3
Michigan.....				4	342,566	6.1	6	664,750	7.8
All other sections.....	5	47,500	14.1	8	246,200	4.3	15	663,594	7.8
Total.....	16	335,500	100.0	36	5,652,266	100.0	50	8,482,020	100.0

Section.	1901.			1902.		
	Number of works.	Quantity.	Per cent.	Number of works.	Quantity.	Per cent.
		<i>Barrels.</i>			<i>Barrels.</i>	
New York.....	7	617,228	4.8	10	1,156,807	6.8
Lehigh and Northampton counties, Pa., and Warren County, N. J.....	16	8,595,340	67.7	17	10,829,922	62.8
Ohio.....	7	689,852	5.4	7	563,113	3.3
Michigan.....	10	1,025,718	8.0	10	1,577,006	9.1
All other sections.....	16	1,783,087	14.1	21	3,103,796	18.0
Total.....	56	12,711,225	100.0	65	17,230,644	100.0

Pennsylvania continues to hold leading place as a producer of Portland cement, while New Jersey follows in second place. The counties of Lehigh and Northampton, Pa., formerly included all the factories producing Portland cement in the State; now, although they are still the center of that industry, there are 5 plants in other counties, none of them, however, ranking at present among the very large producers. Under all other sections is included the production of Alabama, California, Colorado, Georgia, Illinois, Indiana, Kansas, Missouri, South Dakota, Texas, Utah, and Virginia.

RELATION OF DOMESTIC PRODUCTION AND CONSUMPTION TO IMPORTS.

The increase, both in the use and in the production of Portland cement in the United States within the last thirteen years, as compared with natural-rock cement and with imported cement, is shown in the following table:

Comparative production of Portland and of natural-rock cement in the United States and of imports of hydraulic cement, 1890-1902.

Year.	Natural cement.	Portland cement.	Total of natural and Portland cement.	Imports.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>
1890.....	7,082,204	335,500	7,417,704	1,940,186
1893.....	7,411,815	590,652	8,002,467	2,674,149
1895.....	7,741,077	990,324	8,731,401	2,997,395
1897.....	8,311,688	2,677,775	10,989,463	2,090,924
1899.....	9,868,179	5,652,266	15,520,445	2,108,388
1900.....	8,383,519	8,482,020	16,865,539	2,386,683
1901.....	7,084,823	12,711,225	19,796,048	939,330
1902.....	8,044,305	17,230,644	25,274,949	1,961,013

This table does not include the production of Pozzuolana or slag cement reported by this Bureau for the last three years, which is as follows: 1900, 365,611 barrels; 1901, 272,689 barrels; 1902, 478,555 barrels.

Following is a diagram showing the growth of the domestic production of Portland cement, the increase of total consumption of Portland cement, and the decline of the imports of foreign hydraulic cements during the last thirteen years:

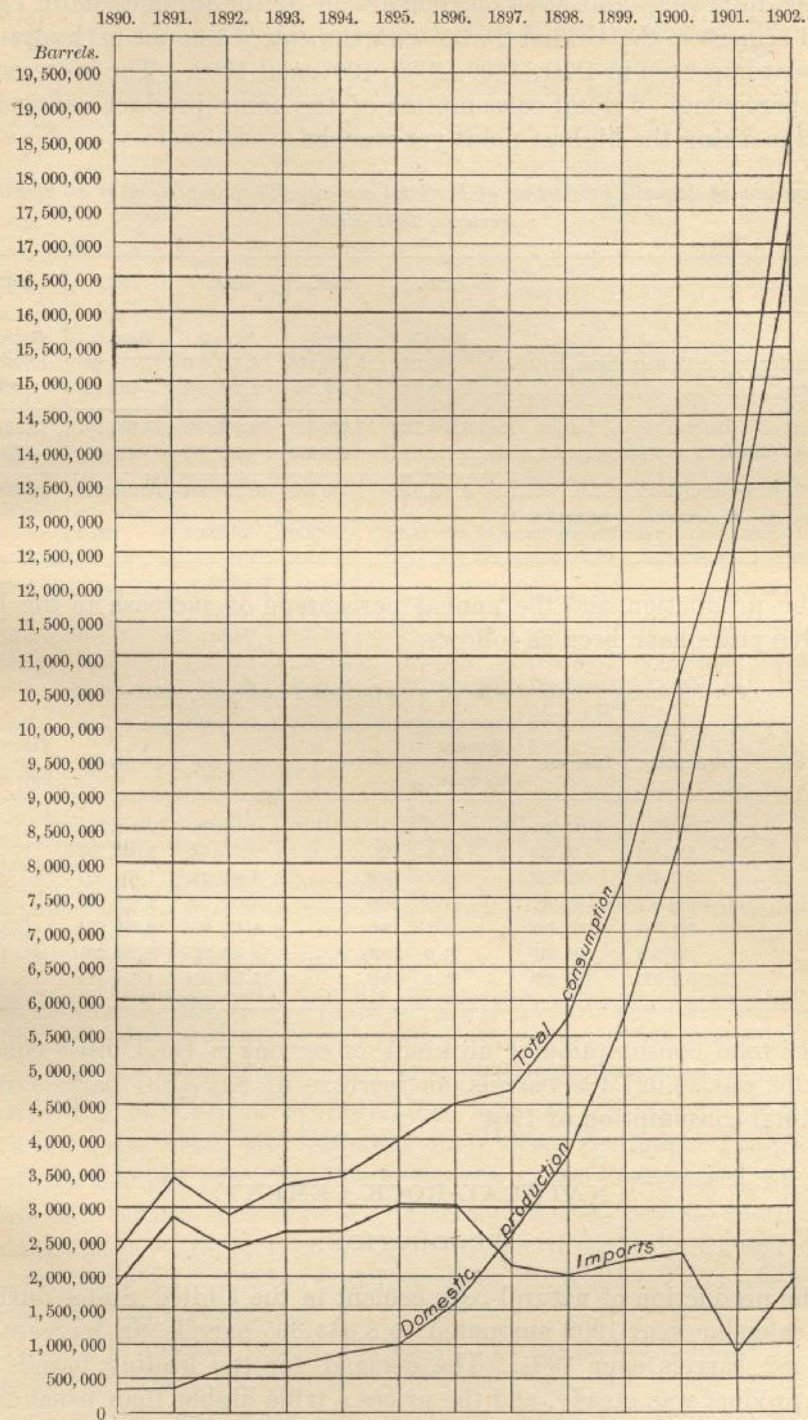


FIG. 1.—Diagram showing relation of domestic production of Portland cement to imports and to total consumption of Portland cement in the United States, by years and by barrels, from 1890 to 1902, inclusive.

The following table shows a comparison of the production of Portland cement in the United States with the entire amount of hydraulic cement imported in 1891, 1899, 1900, 1901, and 1902. The increase in the percentage of total consumption of the home product continues, 1902 marking the highest point yet reached.

Comparison of domestic production of Portland cement with consumption of all hydraulic cements, 1891-1902.

	1891.	1899.	1900.	1901.	1902.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>
Production in the United States.....	454,813	5,652,266	8,482,020	12,711,225	17,230,644
Imports	2,988,313	2,108,388	2,386,683	922,426	1,961,013
Total	3,443,126	7,760,654	10,868,703	13,633,651	19,191,657
Exports (domestic and foreign).....		110,272	139,939	417,625	373,414
Total consumption	3,443,126	7,760,382	10,728,764	13,216,026	18,818,243
Percentage of domestic production to total consumption in the United States.	13.2	73.9	79.1	96.2	91.6

The production and the annual percentage of increase in the last twelve years have been as follows:

Production of Portland cement, with increases each year, 1891-1902.

Year.	Quantity.	Increase.	Percent- age of increase.	Year.	Quantity.	Increase.	Percent- age of increase.
	<i>Barrels.</i>	<i>Barrels.</i>			<i>Barrels.</i>	<i>Barrels.</i>	
1891	454,813	119,313	35.6	1897.....	2,677,775	1,134,752	73.5
1892	547,440	92,627	20.4	1898.....	3,692,284	1,014,509	37.9
1893	590,652	43,212	7.9	1899.....	5,652,266	1,959,982	53.1
1894	798,757	208,105	35.2	1900.....	8,482,020	2,829,754	50.1
1895	990,324	191,567	24.0	1901.....	12,711,225	4,229,205	50.0
1896	1,543,023	552,699	55.8	1902.....	17,230,644	4,519,419	35.6

The total consumption of all kinds of cement in the United States in 1902 was 28,627,429 barrels, an increase of 8,053,891 barrels over the total consumption of 1901.

NATURAL-ROCK CEMENT.

PRODUCTION.

The production of natural-rock cement in the United States during the calendar year 1902 amounted to 8,044,305 barrels, an increase of 959,482 barrels over 1901. The demand for the leading brands of this product was steady, and the prices a trifle higher than usual during the greater part of the year.

The following table shows the quantity and value of the natural-rock cement produced in the United States in 1900, 1901, and 1902:

Production of natural-rock cement in 1900, 1901, and 1902.

State.	1900.			1901.			1902.		
	Number of works.	Quantity.	Value.	Number of works.	Quantity.	Value.	Number of works.	Quantity.	Value.
		<i>Barrels.</i>			<i>Barrels.</i>			<i>Barrels.</i>	
Georgia	1	28,000	\$21,000	2	50,577	\$40,967	2	55,535	\$31,444
Illinois	3	369,276	129,446	2	469,842	187,936	3	607,820	156,855
Indiana and Kentucky.....	19	2,750,000	687,500	15	2,150,000	752,500	15	1,727,146	869,163
Kansas	2	146,000	58,400	<i>a</i> 2	175,560	97,002	2	160,000	80,000
Maryland	4	335,070	134,028	4	351,329	175,665	4	409,200	150,680
Minnesota	2	109,403	54,701	<i>b</i> 2	126,000	63,000	2	150,000	67,500
Nebraska	1	500	400	1					
New York	17	3,409,085	2,045,451	<i>c</i> 18	2,234,131	1,117,066	19	3,577,340	2,135,036
North Dakota.....				1			1		
Ohio.....	3	35,029	17,514	<i>d</i> 1	104,000	62,400	2		
Pennsylvania	5	687,838	343,919	7	942,364	376,954	6	796,876	340,669
Tennessee	1	10,000	8,000						
Texas	1	17,000	28,900	1			1		
Virginia	3	25,313	15,187	1			2	34,000	20,000
West Virginia	1			1			1	88,475	62,655
Wisconsin	1	461,005	184,402	2	481,020	182,788	2	437,913	162,628
Total	64	8,383,519	3,728,848	<i>e</i> 60	7,084,823	3,056,278	<i>f</i> 62	8,044,305	4,076,630

a Includes product of Nebraska and Texas.

b Includes product of North Dakota.

c The number of companies producing natural cement only, is given, and the number given for 1899 and 1900 has been changed accordingly, as in those years the *total* number of companies in the State was given.

d Includes product of Virginia and West Virginia.

e This total includes one plant in North Dakota, which for this year is reported as having a natural cement product.

f The States combined for 1902 are noted in the text.

The product of the single plant in North Dakota for 1902 has been combined with that of the only plants producing natural-rock cement in the States of Ohio, Texas, and West Virginia for the purpose of avoiding the publication of individual figures; otherwise the table shows the State totals and values in their exact relation. The product of the cement plant in North Dakota is still designated by its owners as a natural-rock cement. Although it tests beyond the usual standard and is stronger than the general run of natural-rock cement, it does not reach a condition which permits the company to class it as high-grade Portland cement.

As stated in another report, the number of plants given in the above tables includes only the active producers of cement. Such plants as throughout the year were idle, or were closed for remodeling or repairs, or were destroyed by fire and in process of rebuilding, are not taken into account here, but are noted in the report by States.

It should also be said that where one company has several different plants in the same State the product of all of them is classed as one product and the works as one plant; that is to say, the companies rather than the plants are counted. Of course, plants owned by one company but located in different States are credited, with their products, to the States in which they are built.

New York still ranks all other States as a producer of natural-rock cement, and the combined output of Kentucky and Indiana—known as the Louisville cement—holds second place.

POZZUOLANA OR SLAG CEMENT.

PRODUCTION.

The States reporting production of Pozzuolana or slag cement in 1902 were Alabama, which has two plants, Illinois, Maryland, New Jersey, and Ohio, each of which has but one slag cement plant. The total production amounted to 478,555 barrels, valued at \$425,672, an increase of 205,866 barrels in quantity and of \$227,521 in value over the production in 1901. The two plants in Alabama were run under the same management in 1902, one company having leased the plant owned by the other company in that State. The production of the Illinois Company was many thousands of barrels in excess of their 1901 production, and the mills of the Maryland company nearly doubled their production in 1902, though they were idle for about two months. The New Jersey plant ran slightly ahead of its 1901 production, and the Ohio plant was within a few thousand barrels of twice its production for 1901.

A large plant for the manufacture of slag cement, which will have a capacity of 500 barrels per day, is in process of erection by the Stewart Iron Company, of Sharon, Pa.

The best slag cement now ranks with American Portland cement and is used for the same purposes, except in sidewalk work. This is a matter of deep interest to iron-furnace men, to whom hitherto the slag has been a troublesome and expensive waste product.

SLAG CEMENT IN EUROPE.

A recent paper quoted in *Le Génie Civil* states that the manufacture of cement from blast-furnace slag has made great progress. In France there are now ten factories making this cement, one of which produces 80 tons a day. Belgium has five slag-cement factories; Luxembourg two, and Switzerland one. In Germany there are twelve plants, turning out about 150,000 tons per year, and in Austria two plants make 100,000 annually. This paper recommends the granulation of slag by running it into cold water as it is drawn from the furnace.

PRODUCTION OF CEMENT IN CANADA.

For the calendar year 1902 the production of cement in Canada was as follows: Portland, 594,594 barrels, valued at \$1,028,618; natural rock, 124,400 barrels, valued at \$91,870—an increase in Portland cement of 297,528 barrels, or over 100 per cent, and a decrease in natural-rock cement of 8,928 barrels, or about 6.5 per cent, as compared with 1901.

IMPORTS.

The table showing the imports of cement into the United States by countries is as follows:

Imports of hydraulic cement into the United States in 1898, 1899, 1900, 1901, and 1902, by countries.^a

Country.	1898.	1899.	1900.	1901.	1902.
	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>	<i>Barrels.</i>
United Kingdom.....	241,198	199,633	267,921	37,390	79,087
Belgium.....	651,204	624,149	826,289	303,180	615,793
France.....	17,294	15,649	32,710	11,771	14,922
Germany.....	1,032,429	1,193,822	1,155,550	555,038	1,259,265
Other European countries.....	51,582	68,348	75,827	19,077	17,956
British North America.....	4,635	4,398	4,517	6,066	3,611
Other countries.....	15,476	2,389	23,869	6,808	4,153
Total.....	2,013,818	2,108,388	2,386,683	939,330	1,994,787

KILN REPORT IN 1902.

The approximate number of kilns of each kind that were reported to this office as in existence during the year is shown in the following table, although the number of kilns in idle plants was not always reported. It should perhaps be said that although Portland cement is burned in both the rotary and the dome or vertical kilns, natural cement is burned only in the latter kind, and never in the rotaries.

Number, kind, and condition of cement kilns in 1902.

Kind.	Active.	Idle.	Building.
Vertical.....	611	76	6
Rotary.....	456	9	46
Total.....	1,067	85	52

Of these kilns, many that were building have already been completed and put into operation, although others will not be ready for use for a year or more. The several companies producing only Port-

^a This table shows total imports as contrasted with imports withdrawn for consumption used elsewhere in this report.

land cement and using nothing but vertical kilns for that production reported a combined output of nearly 400,000 barrels. This does not include any of the product of companies producing both kinds of cement. A rough estimate of all the Portland cement made in vertical kilns would place that output at something below 1,500,000 barrels, leaving the great bulk of the Portland cement manufactured in the United States to be credited to the rotary kilns.

PROCESSES OF MANUFACTURE.

Natural-rock, Portland, and slag cement are all hydraulic cements; that is, they possess the power of hardening under water.

Natural-rock cement is produced by burning an impure limestone at a comparatively low temperature. The stone best suited to the production of this cement is an argillaceous or clayey limestone, containing a certain percentage of lime, silica, and alumina. After the burning is accomplished the resulting clinker is ground to powder and packed in barrels or bags, and it is then ready to be put on the market. Of the natural-rock cements, the principal brands are Rosendale, from the region of the lower Hudson River; Louisville, from the Ohio valley, and Utica, Akron, and Milwaukee, from the localities indicated by those names.

Portland or artificial cement is made by grinding some form of carbonate of lime and clay to a coarse grit, mixing the required ingredients in exact proportions, and then burning the mixture at a high temperature to a point just short of vitrification. The clinker which results is ground to a fine powder and stored in bins, whence it is packed ready for shipment. In the dry process the ingredients are crushed, mixed, and then ground to a powder, which is fed directly into the rotary kiln, traversing it lengthwise, and passing out through a flame as clinker. In the wet or semiwet process the materials are mixed in exact proportions and made into a slurry, which is fed directly into a rotary kiln. Where Portland cement is burned in vertical or dome kilns, this slurry has to be dried and cut into blocks or bricks, which are packed in the kilns between layers of fuel. In all cases the burning for Portland must be under high temperature and the resulting clinker ground to powder. Of the Portland cements the Lehigh brands are from southeastern Pennsylvania, and those from New Jersey, Ohio, Michigan, and Texas are usually known by local or State names.

Pozzuolana, or slag cement, is made in this country of the slag from blast furnaces. Limestone is used as a flux for iron and other ores; its action is to flux the impurities, which pass off as slag. Upon issuing from the furnace this slag is granulated by a jet of cold water, as, if allowed to cool slowly from a state of fusion it loses some of its

hydraulic property. It is then dried, mixed with crushed slacked lime, and ground to a fine powder, when it is ready for use. Like many of the Portlands, the slag cements are frequently named from the States or from the immediate localities in which they are made. It should perhaps be said that when slag is used in the production of a true Portland cement it must be dried, analyzed, and ground before it can be mixed with the crushed limestone in such a manner as to give proper proportions for the manufacture of Portland cement. The mixture of slag and limestone is then ground and fed into the rotary kilns for burning. The clinker that results is reduced to powder, which is the finished product, and is in every way equal to Portland cement made of other ingredients, provided the slag has been of the right quality and properly proportioned.

The materials suitable for the production of artificial cements cover a wide range.

In France, marls, chalks, and clays are used for the manufacture of Portland cements. In England, the Portland cement is made of white and gray chalks, mixed wet with the blue clay or mud from English rivers. In Germany, where the Portland cement industry is developed in the northern part of the country chiefly, marls and limestones are both used in combination with clays. In Belgium, lime or clay is added to the natural cement rock; chalk and clay are also used.

REVIEW OF THE CEMENT INDUSTRY IN THE UNITED STATES BY STATES.

By L. L. KIMBALL.

ALABAMA.

The manufacture of cement in Alabama is of very recent date, though an attempt to utilize the slag in the State was made in 1889. In 1899 the Birmingham Cement Company first succeeded in making slag cement from the waste material at the iron furnaces in Ensley, near Birmingham. In 1900 their plant was destroyed by fire; but it was at once rebuilt, as the production of cement had proved to be successful, and during the year a second plant for the manufacture of slag cement was projected by the Southern Cement Company. In 1901 the new company produced cement satisfactorily, and the Alabama Portland Cement Company began to make a first-class Portland cement at Demopolis, in Marengo County, using for the purpose clay and the limestone which is plentifully deposited in this State. At the present time these three are the only Alabama companies.

CALIFORNIA.

In 1860 a bed of hydraulic limestone was opened about a mile south of Vallejo, in Solano County, Cal., and a small cement mill was erected near Benicia, having a capacity of 100 barrels of natural-rock cement daily. This mill was operated, though not always to its full capacity, for about twenty-five years, its largest output being in 1872, when the plant turned out 25,500 barrels of excellent cement. About 1875 limestone suitable for use in producing natural-rock cement was exploited at Santa Cruz, in Santa Cruz County, and a plant for its production was erected there. Business complications and litigation prevented the factory from running, however, for more than a very short time.^a In 1886 no cement was made in California, though the imports at San Francisco for that year amounted to 159,000 barrels, which were used largely in San Francisco and vicinity. A deposit of cement rock was opened at Niles, in Alameda County, about 1884, and

^aThe production of cement: Mineral Resources U. S. for 1883-84; U. S. Geol. Survey, 1885, p. 675.

the cement made there was reputed to equal the best brands of natural-rock cement. Its manufacture was, however, discontinued.^a In 1890 an important discovery was made of large deposits of cement rock in the Coast Range of mountains near Sierra Peak, nearly 4 miles southwest of South Riverside, in southern California, and in 1891 this rock was analyzed and tested for use in producing Portland cement. It was found that a first-class quality of Portland could be produced from it without the admixture of any extraneous material. It was of the following composition:

Analysis of cement rock near South Riverside, Cal.^b

Constituent.	Per cent.
Silica	24.34
Alumina.....	8.56
Lime	63.62
Magnesia.....	.40
Oxide of iron.....	2.08
Alkalies	1.00
Total	100.00

Reference to the ideal composition of a perfect Portland cement, given elsewhere in this report, will show how nearly the analysis of this rock approaches perfection. A plant was projected in this locality, but did not develop, though there has been talk of it at intervals since the discovery of this deposit.

In 1891 an unsuccessful attempt was made to reestablish works at Santa Cruz, and a small output of Portland cement was made by a new plant at Jamul, in San Diego County. The cheap price of foreign cements in 1891 had, however, a bad effect on this plant, and work there was discontinued for a time.^c In 1894 a cement plant began operations at Colton, and this company has had a steadily increasing output since that time. They use the white coralline limestone, which is nearly a pure carbonate of lime and clay.^d In 1897 a company was formed for the purpose of establishing a plant at Arroyo Grande, but the venture did not materialize, and in 1900 a plant was attempted at Benicia. This also was discontinued. In August, 1902, the Pacific Portland Cement Company began operations at Cement, in Solano County, and made a good record for the half year. It is quite possible that the plant projected in Riverside County may yet materialize, as the rock there offers exceptional advantages in its exposure, extent, and quality. It is nearly a hundred feet thick and has about 350 acres

^a The production of cement: Mineral Resources U. S. for 1885, U. S. Geol. Survey, 1886, p. 409.

^b The production of cement: Mineral Resources U. S. for 1889-90, U. S. Geol. Survey, 1891, p. 463.

^c The production of cement: Mineral Resources U. S. for 1892, U. S. Geol. Survey, 1893, p. 743.

^d The production of cement: Mineral Resources U. S. for 1894, U. S. Geol. Survey, 1895, p. 584.

surface area; it runs into the adjoining counties of San Bernardino and Orange and is underlain by a good bed of bituminous coal, which is mined on both sides of the mountain range adjacent to the cement-rock deposits. The fact that this location is directly within the great orange belt of southern California, where cement is largely used in constructing dams for irrigation and canals and also in building pipe lines, and the further fact that the railroad is near by are both greatly in favor of the undertaking.^a

COLORADO.

In 1882 this Bureau reported the accidental discovery during the year 1881 of the hydraulic quality of the lime burned from one of the limestone beds near Canyon, Colo. Experiments made by Mr. Megrue were at first but slightly successful in producing a good cement. Later, however, a satisfactory result was attained. In 1882 a plant was erected at Denver and about 100 barrels of excellent cement were made, which, when tested, proved entirely equal to the tests. In 1883 the first entire kiln of cement was turned out, and for the first six months of that year the output of the Denver Cement Company was 385 barrels, which retailed at \$4 per barrel. This company, with the Canyon City Iron, Paint and Cement Company, produced cement from the limestone of the Upper Silurian in the Hogback near Canyon.^b The small demand during the winter months led to the closing down of these plants at the close of 1884. In 1885 the works of the Denver Cement Company were run part of the year, but the production was not large. In 1886 the plant was enlarged and an attempt was made to extend the sale of its product. In the report for 1886 made by this Bureau it is noted that a small production of cement was made at Canyon.^c No further mention is made of this company until 1891, when the fact is noted that their capacity had been largely increased.^d In 1894 the plant was destroyed by fire and not rebuilt. In June, 1900, the Colorado Portland Cement Company started their factory for the production of Portland cement at Portland, in Fremont County. The mills ran throughout the rest of 1900 and through 1901. In 1902 this company was consolidated with the Portland Cement Company, which had just located at Portland, and in 1903 these plants will be under one management. A company has been incorporated at Canyon, and, if it is successful, will produce both Portland and natural-rock cement. There is a large supply of material in Colorado from which an excellent cement, either natural or artificial, may be made. Limestones, calcareous marls, chalks, slags, and clays are all plentiful and can be had in favorable locations.

^a The production of cement: Mineral Resources U. S. for 1890, U. S. Geol. Survey, 1891, p. 463.

^b The production of cement: Mineral Resources U. S. for 1881, U. S. Geol. Survey, 1882, p. 462.

^c The production of cement: Mineral Resources U. S. for 1886, U. S. Geol. Survey, 1887, p. 564.

^d The production of cement: Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1892, p. 536.

ILLINOIS.

The construction of the Illinois and Michigan Canal led to the discovery of a very fine quality of magnesian limestone at Utica, Ill., in 1838. Experiments showed that the cement made from this rock was of unusual excellence, and in the same year Messrs. Norton and Steele erected a factory for the production of natural-rock cement, after having secured a contract to furnish this product for use in the construction of the canal. By the time this work was finished the Utica cement had an established reputation, and its annual production was continuous and uninterrupted. In 1845 the plant was purchased by Mr. James Clark, who operated it with great success for over thirty years. Improvements were made from time to time in the methods of manufacture and in the machinery used. When the kilns were first built they were located on the edge of the bluff near the river and the raw rock was brought to them by a horse-car railway, but later, as the business increased, patent processes for grinding and burning were used, and the rock was burned at the beds whence it came. In 1888 the plant was incorporated as the Utica Hydraulic Cement Company, and its capacity was largely increased. It is still successfully operated under this name.^a The same formation of cement rock used at Utica is also available at Lasalle, and in 1869 the manufacture of natural rock cement was begun there, since which time it has been continuously carried on.^b The production of Portland cement was begun in Illinois at Oglesby in 1894,^c and a year later slag and limestone were utilized by the Illinois Steel Company at Chicago to make Portland as well as slag cement. At Oglesby limestone and shaley clays are used; this factory was burned in 1898 and rebuilt on a larger scale. Meantime, two plants had been built at Lasalle for the production of Portland cement, and another plant had become a successful producer of natural-rock cement at Utica. In 1886 the State production was 226,000 barrels of natural-rock cement; in 1890 it was 400,000 barrels. Five years later the Portland cement output amounted to 750 barrels, and the natural-rock cement output was 491,012. In 1900 there were 240,442 barrels of Portland produced and 369,276 barrels of natural-rock cement. The figures for 1902 are given elsewhere.

KANSAS.

Natural-rock cement has been made in Kansas since 1868, when mills for that purpose were erected at Fort Scott. During the previous year it was discovered that rock suitable for this manufacture existed in large quantities in the locality, and a specimen was analyzed by

^a Cummings, U., *American Cements*, 1898, p. 20.

^b *Ibid.*, p. 22.

^c The production of cement: *Mineral Resources U. S. for 1894*, U. S. Geol. Survey, 1895, p. 581.

Prof. Louis Agassiz, who pronounced it to be "of superior value if properly calcined." The plant erected was a small one, and its first output was only 10 barrels per day. But the demand at that time was rather limited, and as it grew larger the company increased their production, making their first large shipment in 1870.^a The mills have been running continuously since that time and in 1888 reported a production of 40,000 barrels of cement as their output for the season. The plant has been remodeled, having had new machinery and improvements added, and is now a large producer annually.

In 1889 a second plant for the production of natural-rock cement was started at Fort Scott, and these two are still the only ones in the State. The plant at Iola produces only Portland cement. The company owns a large area of land which is underlain by limestone having 95 per cent of carbonate of lime and shale having 75 per cent of silica and alumina. They have been in successful operation since 1900.

A description of the geological formation of eastern Kansas bearing upon the manufacture of cement may be found in the reports of the University Geological Survey of Kansas.

KENTUCKY AND INDIANA.

The discovery of a natural cement rock in Kentucky and Indiana was due, as in so many other cases, to the construction of a canal. In 1829, while the Louisville and Portland Canal was being built, in order to facilitate navigation around the falls of the Ohio, an excellent natural cement rock was discovered,^b and Jno. Hulme & Co. began the manufacture of the now well-known Louisville cement in that year, at a small suburb of Louisville called Shippingport. This product, which was the first cement made in the West, was used in constructing the canal locks, and proved so satisfactory that the State of Kentucky continued to use it in making improvements on the Green, the Barren, and the Kentucky rivers. The value of this first Louisville natural-rock cement was shown by the fact that when in 1860, the enlargement of the Louisville and Portland Canal was begun the cement binding the stones together was found to be more firm and substantial than the stone itself. In 1832, at Clarksville, Mr. Vesey built a flour mill, which was shortly utilized to manufacture cement, and, after passing through many hands, was finally sold to Mr. W. F. Beach, who in 1873 had in operation four vertical kilns, with a total capacity of 400 barrels per diem.

For some years following the discovery of cement rock at Louisville the industry showed little growth, the census of 1850 recording for Kentucky but one cement factory, with four employees and a product

^aHazelrigg, C. H., *A New History of Kansas*, p. 156.

^bLesley, R. W., *Jour. Assoc. Eng. Soc.*, vol. 15, 1895, p. 198.

valued at \$10,000. The census of 1860 reported one cement establishment, but gave \$52,000 as the value of its product, and stated that 50 men were employed, showing a growth in the business of the plant if not in the number of factories. The census records for 1870 are not exact, but it is stated that 320,150 barrels of Louisville cement were sold during the year. The census of 1880 recorded no production of cement for Indiana, and gave Kentucky only two plants with a production said to be valued at \$145,000. In 1883 this Bureau reported^a 10 factories in the Louisville district, and in 1886^b gave the output as 925,210 barrels. In 1890^c the production amounted to 1,533,579 barrels, with a value of \$1,150,184, and in 1899 there were 19 factories, with an output of 2,922,000 barrels, valued at \$1,022,858.^d The records showing the detail of growth in the production of cement in the Louisville district are meager and incomplete, but the product has long been known as a most trustworthy cement. In 1848 it was said by Colonel Long, of the Corps of Topographical Engineers, to be—

a cement which, when used in the formation of subterranean and submarine foundations, and other structures in similar situations, is unsurpassed by any material of the kind hitherto employed for such purposes in this or any other country.^e

Among the natural-rock cements it ranks second to Rosendale only.

The production of Portland cement in Indiana is confined to the northern portion of the State, where the vast deposits of marl in the lakes and marshes furnish a material suited to this industry. In 1877 the first factory for the manufacture of Portland cement was erected by Mr. Millen, at South Bend. The materials used were marl and clay, and although the slurry had to be dried in bricks in order to admit of burning in the old-style dome or vertical kilns used at that time, the process was eventually successful, and the firm produced a well-known brand of Portland cement for a decade or more.^f In 1886 Mr. Millen commenced the manufacture of Portland cement in New York State, leaving the original factory in other hands, and within a few years thereafter the plant at South Bend began to deteriorate. In 1893 it was shut down, and has not been a successful producer since that time.^g That fact, however, is in no wise due to the lack of good materials in this locality, as is shown by the production during 1902 of over half a million barrels of cement by the three companies now operating there. In 1900 the Wabash Portland Cement Company commenced to make Portland cement at Stroh, in Lagrange County, and has been an

^a The production of cement: Mineral Resources U. S. for 1883, U. S. Geol. Survey, 1884, p. 672.

^b The production of cement: Mineral Resources U. S. for 1886, U. S. Geol. Survey, 1887, p. 556.

^c The production of cement: Mineral Resources U. S. for 1890, U. S. Geol. Survey, 1891, p. 461.

^d The production of cement: Mineral Resources U. S. for 1899, U. S. Geol. Survey, 1900, p. 407.

^e Gillmore, Q. A., Practical treatise on limes, hydraulic cements, and mortars, 11th edition, 1896, New York, pp. 59-60.

^f Twenty-fifth Ann. Rept. Geol. and Nat. Resources of Indiana, 1900, p. 24.

^g Ibid., p. 27.

increasingly successful producer since that time.^a In 1901 the plant erected at Syracuse, Kosciusko County, by the Sandusky Portland Cement Company, of Ohio, reported a large production,^b and in 1902 the plant of the Lehigh Portland Cement Company, of Pennsylvania, erected at Mitchell, Lawrence County, contributed a fair part of the entire output.

The success which has been so marked in the State of Michigan, where similar materials for the manufacture of Portland cement are in use, should be repeated in northern Indiana as the demand for and uses of Portland cement increase.

MARYLAND.

Up to the present writing there has been no attempt to manufacture Portland cement in Maryland, notwithstanding the fact that limestones, clays, shales, and marls, well situated relatively and suitable for the purpose, are distributed liberally through the State. The manufacture of natural-rock cement is, however, an industry of long standing. Rock suitable for use in this capacity was first discovered in Maryland in 1836, during the building of the Chesapeake and Ohio Canal, at a place called Round Top, which is about three miles southwest of Hancock. A cement plant was established here, which is still in existence. It was operated by Mr. George Shafer until 1862, when it was sold to Messrs. Bridges and Henderson, who now own and manage it. The plant averages more than 60,000 barrels per annum.^c The Cumberland Hydraulic Cement and Manufacturing Company, whose plant was started in the same year, has been a successful producer of an excellent brand of natural-rock cement ever since that time. Their quarries are on the south bank of Wills Creek, where the Helderberg rocks are finely exposed and where a series of natural folds in the beds admit of the convenient working of them. The product of this plant is more than 100,000 barrels yearly. The Antietam Cement Company, near Sharpsburg, formerly produced a good grade of cement from the Trenton limestone of the same formation that farther north is used in Pennsylvania and farther west is worked near Shepherdstown, W. Va. The works were started in 1888; they are now successfully operated by another company. There were also works at Lansdowne a number of years ago, but they have been idle since 1892. Besides the companies already noted are the Potomac Hydraulic Cement Company and the Cumberland and Potomac Cement Company, each of which has been under successful management for a number of years.^d In addition to these plants there is

^a Twenty-fifth Ann. Rept. Geol. and Nat. Resources of Indiana, 1900, p. 27.

^b *Ibid.*, p. 28.

^c Maryland, its resources, industries, and institutions, 1893, Baltimore, p. 139.

^d *Ibid.*, p. 139.

at Sparrows Point a plant where slag cement of good quality is produced. This plant has been in successful operation for more than five years. The production of natural-rock cement in Maryland in 1890 was 223,209 barrels,^a in 1900 it was 335,070 barrels, and in 1902 it was 409,200 barrels.

The slag used for the manufacture of cement in Maryland is produced by the blast furnaces at Sparrows Point, where limestone and marble are used as a flux. Much of this stone comes from Texas, in Baltimore County, where there is a large quarry whence an average of 400 tons daily is shipped to Sparrows Point. There are also extensive limestone quarries at Cavetown, in Washington County. Besides the use of this limestone as a flux for blast furnaces, large quantities of the stone from the numerous quarries at Texas are used for burning lime; the limestone from Lochraven is also used for this purpose, as is that from Westminster and New Windsor.^b

The slate belt in Maryland forms a narrow zone, which begins a short distance east of the Susquehanna River and passes in a southwest direction through the southeastern corner of York County, Pa., terminating near Pylesville, on the Baltimore and Lehigh Railroad, Maryland. At the present time nearly all the active quarries are in Harford County.^c

MINNESOTA.

Minnesota has produced natural-rock cement for many years, the older of the two plants in that State having been active for nearly twenty-five years. It is situated just south of Mankato, and fronts on the Blue Earth River, where the rock formation yields a very superior quality of cement. This rock is a compact, finely grained, siliceous limestone, actively hydraulic, and the cement produced from it sets quickly and is very durable. The superficial area of the quarry is about 90 acres, and clay deposits are found abundantly in the neighborhood. This plant has been steady in its output and yields a successful annual production.^d Until 1895 it was the only plant in Minnesota, but during that year a factory in Austin, Mower County, was opened,^e and since then the two have produced all the cement made in the State. No production of Portland cement has as yet been attempted here.

NEW JERSEY.

The cement industry in New Jersey is an old one, though the earlier product was a natural-rock cement, and the present output is entirely Portland cement. The State Geological Survey made a very complete

^a Production of cement: Mineral Resources U. S. for 1890, U. S. Geol. Survey, 1891, p. 532.

^b Maryland, its resources, industries, and institutions, 1893, Baltimore, p. 133.

^c Ibid., p. 133.

^d The State of Minnesota, by State Board of Immigration, 1885, St. Paul, p. 146.

^e Production of cement: Mineral Resources U. S. for 1895, U. S. Geol. Survey, 1896, p. 891.

and valuable report on the geology of New Jersey in 1868, and on page 525 of that volume the statement is made that limestones had been used at a few places in the State for cement manufacture, though none was then being made; that when wood was used as a fuel in lime burning the magnesian limestones yielded a product having hydraulic properties, but that since coal had been introduced the additional heat, or burning at higher temperature, caused the product to lose its hydraulic property, and that the so-called cement layers of rock were no longer used for the manufacture of cement. This report further states that at Johnsons Ferry, in Hunterdon County, opposite Durham, Pa., there is an old quarry, near the Presbyterian Church, which was worked for rock to make the cement used in building the "locks on the feeder," but that the quarry was not worked at that time (1868). It mentions that along the Delaware River the Corniferous limestone had been used at Dingmans Ferry as a source of cement. In 1890 the erection of a plant for the manufacture of Portland cement was begun at Alpha by Mr. T. D. Whitaker, who turned out his first product in 1891. In 1895 this plant, which had been in constant operation since its establishment, was sold to the present owners, the Alpha Portland Cement Company, and is one of the largest producers in the country. In 1894 the Vulcanite Portland Cement Company, which also produces annually a very large output, built a plant at Vulcanite, near Alpha. The raw material used by these plants is closely similar; in each case the land is underlain by the cement rock, which has a depth of more than 160 feet.^a

Following these plants, mills were erected at Clinton and at Stewartsville. The Alpha Company also have an additional mill at Phillipsburg. At Perth Amboy the plant making cement produces a slag or Pozzuolona cement. Two companies have been incorporated in this locality which have not materialized. The Edison plant, which is located at Stewartsville, will probably have an output in 1903. The company owns about 600 acres of land a few miles northeast of the Alpha and the Vulcanite properties, and if the process used proves to be successful it is designed to so enlarge the plant as to have an output of 10,000 barrels per day. The present capacity is about 2,500 barrels per day.

For an extended description of the deposits in New Jersey of materials suitable for the manufacture of cement, reference may be made to the annual reports of the geological survey of New Jersey for 1899-1900.

NEW YORK.

History begins, in so far as the cement industry in New York State is concerned, with the discovery of a natural cement rock about 1818 by Mr. Canvass White at or near Chittenango, Madison County.

^a Production of cement: Mineral Resources U. S. for 1894, U. S. Geol. Survey, 1895, p. 584.

After some experimenting, a process for producing good cement from this rock was found by Mr. White, who then applied to the State for an exclusive right to manufacture the product for twenty years. Such a right was refused, but instead he was presented by the State with \$20,000 in recognition of his valuable discovery.^a His cement was first used in building the Erie Canal, as shown by the following extract from a letter written June 24, 1820, by Mr. Benjamin Wright, chief engineer of the canal, touching the subject of the lime used in the subaqueous construction of the canal:^b

The specimen of argillo-ferruginous limestone herewith presented is found in great abundance in the counties of Madison, Onondaga, and Cayuga, State of New York. When found in place, it is always under the blue lime, which is uniformly overlain by gray lime. * * * The whole is 6 or 8 feet in thickness. Under the blue lies the first described, which is found to be a superior water cement and is used very successfully in the stonework of the Erie Canal and believed to be equal to any of the kind found in any other country. * * * I do not know that it is found in the counties west of Cayuga, but presume from the geological character in that county it may be found in all the country west to Niagara, and probably farther west. It is pulverized (as it will not slack) and then used by mixing two parts lime and one part sand. It hardens best under water. * * * Mr. Canvass White, a friend of mine, has obtained a patent for it when used for hydraulic purposes. * * * For cisterns it will be much used, no doubt, and for all the principal erections of stonework for canals it is indispensable.

The price of this lime—pulverized, burnt, and delivered at Utica—was 20 cents per bushel, and the analysis of it, made in 1821 by Doctor Hadley, is as follows:

Analysis of Madison County (N. Y.) hydraulic lime, 1821.

Constituent.	Per cent.
Carbonic acid	35.05
Lime	25
Silex	15.05
Alumine.....	16.05
Water	5.03
Oxide of iron.....	2.02
Total	98.20

Mr. Myron Holley, one of the Erie Canal commissioners, wrote from Albany, in January, 1821, as follows:

Mr. White, one of our engineers on the Erie Canal, and a man of good character and useful attainments, discovered in the course of the season before last material for making an excellent waterproof cement, existing in great abundance in the western district of this State, and we have made extensive and profitable use of this discovery in the locks and other mason work of the Erie Canal. It is probably superior to Parker's Roman cement in quality, and may be afforded at less than half the expense of that. It will therefore probably soon come into general use throughout our country wherever such a cement is required.

^aSylvester, N. B., History of Ulster County, N. Y., 1880, p. 240.

^bAm. Jour. Sci., vol. 3, 1821, p. 230.

A few years after this, when the Delaware and Hudson Canal was being constructed, it was assumed that the cement used would, of necessity, be brought from Madison County, but during the summer of 1825 a cement rock similar to that at Chittenango was found at High Falls, in Ulster County, which, under test, proved to be of excellent quality, and for that reason the purchases from Chittenango ceased.^a The first specimen of the rock at High Falls was burned in a blacksmith's forge and reduced to powder by pounding. In 1826 the first cement mill was built below High Falls, and, this proving insufficient for the necessary grinding, others were soon erected. In 1828 a mill was erected at Rosendale, in Ulster County. This locality quickly became a leading center for the production of natural-rock cement, and it has remained so ever since. Extensive works were also erected by Mr. Hugh White at Whiteport, and others soon appeared in the vicinity. The kilns for these pioneer mills were built small, and wood was the fuel used for burning. At the bottom of the kiln an arch was formed to contain the wood; the kiln was filled with cement rock; a fire was lighted and kept burning for six days and nights, and at the end of this time the stone was supposed to be sufficiently well cooked. Frequently unfavorable weather or inexperienced burning caused the whole kilnful to come out either worthless cinders or raw stones. At best the entire product of a kiln for the week was not more than 25 barrels. After the Delaware and Hudson Canal had been in operation for a short time kilns were so constructed as to admit of daily drawing. These were called "draw kilns," and coal was used in them instead of wood. So great was the improvement that an output of 550 or 600 barrels was the result of a burning that under the old method would have yielded but 25 barrels. At this time water power was used for grinding, and a production of 4,000 or 5,000 barrels of cement was regarded as a good season's business.^b

With the completion of the Delaware and Hudson Canal the manufacture of cement ceased to a great extent, but it began to revive when Louis Elmendorf reopened the old Snyder mill and commenced the manufacture of natural-rock cement for the general market. Cement rock had been discovered at Williamsburg, Erie County, and a mill was erected there. In 1839 cement rock of an exceptionally high grade was found at Akron, also in Erie County, and since then the output of cement from there has been continuous.^c

In 1840 beds of limestone yielding hydraulic cement were extensively worked in the vicinity of Kingston, Rosendale, Lawrenceville, and High Falls, and there were 60 kilns burning natural-rock cement,

^a Sylvester, N. B., *History of Ulster County, N. Y.*, 1880, p. 240.

^b *Ibid.*, p. 244.

^c Cummings, U., *American Cements*, 1888, p. 20.

the season's output being about 600,000 barrels. Mr. Mather states^a that—

White's quarries and kilns are the most numerous, and turn off about 600 barrels of cement per diem. Mr. White contracts with the quarrymen to quarry and burn the stone for 25 cents per barrel, while he furnishes the fuel (dust anthracite from screened coal), delivered at the kilns, removes the cement to the mills, grinds, and barrels it.

In 1847 Mr. White's property passed into the hands of the present Newark and Rosendale Lime and Cement Company. The growth of the cement industry from this time on was gradual, but steady. A letter from Messrs. Newman & Bro., written in March, 1859, says:^b "We are now burning 100 barrels on account of the dullness of the market; we can burn 130 barrels every twenty-four hours with three cords of wood." Mr. Newman further speaks of the great improvement made in the cement from his factory by the introduction of the newly patented "flame" kiln, made to replace the "draw" kiln. This new patent had a vertical division wall, extending a little above the level of the furnaces, which prevented a horizontal draft through the kiln. It was so constructed that either coal or wood could be used for fuel. In order to test the advantages claimed for this new kiln, the Newark and Rosendale Company erected one in the fall of 1859 with very satisfactory results. Since that time the plants and methods for burning natural-rock cement have undergone no radical changes, the business having been carried on along the lines which experience proved to be trustworthy with entire success.

From time to time, as new outcrops of the stone, which is now known to be abundant in the State, were found, new plants for the making of natural-rock cement were established. In 1870 a plant was erected at Howe Cave, Schoharie County. In 1874 the Buffalo Cement Company began manufacturing cement at Buffalo, Erie County. In 1877 they rebuilt their factory on a larger scale to increase its capacity. Both these localities continue to yield a uniformly good quality of cement.^c

It was about this time that efforts were made to produce a good Portland cement in this State. Experiments were tried in Ulster County, but the cost of production was found to be prohibitive, and the supply of Portland continued to come from abroad, chiefly from England, whence it had been imported since 1865, being first used but sparingly for the more difficult kinds of engineering work. In those years the imports were small and the prices large, but as work could be done with it which could not be done with natural-rock cement, the imports increased, and the manufacture of a good American Portland cement became a demand which, at last, created the supply. Mr. Lesley

^aMather, W. W., N. Y. Nat. Hist. Survey, Geology 1st Dist., 1843, p. 329.

^bGillmore, Q. A., Limes and hydraulic cements and mortars, 1896, p. 133.

^cCummings, U., American Cements, 1898, p. 22.

states^a that the Buffalo Portland cement, of which small quantities were manufactured from 1878 to 1885, was due to the discoveries and patents of Uriah Cummings and L. J. Bennett, who found out that by selecting overburned material from the natural-rock-cement kilns of the Buffalo Cement Company and using it for the manufacture of Portland cement a material closely resembling the imported Portland could be made. In 1881 Portland cement of good quality was made by the Wallkill Portland Cement Company, and in 1884 prices of American Portland were quoted as far west as California.

In 1885 nothing new developed, the product of New York consisting chiefly of natural-rock cement. In 1886 the Empire Portland cement plant was erected at Warners, Onondaga County, by Messrs. Thomas and Duane Millen, for the production of Portland cement from the marl and clay found in abundant quantities in that vicinity. These gentlemen had been successful in producing a first-class Portland cement from similar material in northern Indiana for a number of years, and were no less successful in New York, though the entire amount of Portland cement made in the State in 1886 was considerably less than 50,000 barrels, while the natural-rock production amounted to 2,620,856 barrels, or more than half the entire production of natural-rock cement in the United States. The growth of the Portland cement industry was steady, however, and the demand for American Portland continued to increase. In 1890 the supply had increased to meet this demand, and the output of the single plant at Warners was over 60,000 barrels.

Other plants in the State producing Portland cement had met with varying success. In 1889 the one at South Rondout was burned down and not immediately rebuilt. Within the next five years, however, the progress of the industry in this State was rapid. In 1893 a large plant for the manufacture of Portland cement was erected at Glens Falls, Warren County, which has since been a successful and continuous producer. In the same year a factory, which had been erected at Montezuma on an old site, was burned. It had produced Portland cement successfully for a year, but was not rebuilt. In 1892 Millen & Son began making Portland cement at Wayland, Steuben County, and they, too, had a disastrous fire in 1893. Their plant was rebuilt, however, and has been prosperous since that time.

In 1890 the production of natural-rock cement was about 3,500,000 barrels in New York State, and the progress of this industry during the next few years was steady, though not so rapid as that of the Portland-cement industry. Prices for natural-rock cement were slightly depressed in 1893, but the enormous production made it possible to obtain a profitable percentage on the capital invested, and within a

^a Lesley, R. W., *Journal Assoc. Eng. Soc.*, vol. 15, 1895, p. 200.

short time prices again advanced. There was also a falling off in the prices of American Portland cement in 1893, but in spite of this fact the total production of the State increased to 159,320 barrels, the production of natural-rock cement for that year being 3,939,727 barrels. From this time until 1901 the growth of the Portland-cement production was as marked as it had been during the years immediately preceding. New York has never been so prominent in the production of Portland as of natural-rock cement, possibly because the latter industry so greatly antedates the former. But in 1901 the number of factories in the State making Portland cement had increased from four (in 1895) to seven, of which five were devoted exclusively to its production, the other two making both kinds of cement. The output of natural-rock cement, always increasing until 1900, decreased in that year and in 1901. In 1902 it again increased.

The total State production for 1897 was 394,398 barrels of Portland and 4,259,186 barrels of natural-rock cement; for 1899 it was 472,386 barrels of Portland and 4,689,167 barrels of natural-rock; for 1901 it was 617,228 barrels of Portland and 2,234,131 barrels of natural-rock cement, and for 1902 it was 1,156,807 barrels of Portland and 3,577,340 barrels of natural-rock cement.

NORTH AND SOUTH DAKOTA.

The cement industry in South Dakota is of earlier date than that in North Dakota. The plant at Yankton, S. Dak., was built in 1889, and had its first production of Portland cement in 1890.^a It has been in successful operation since that time and is now in process of enlargement. The materials used are chalkstone of the Colorado Cretaceous and a dark, fat clay overlying it, commonly known as the clay of the Pierre epoch. The clay is also found below, and in the chalk. This formation covers many hundred square miles northward from the southern boundary of the State, and at Yankton has a thickness of 150 feet.^b The plant is built on the north side of the Missouri River, about four miles west of Yankton, with which it is connected by rail.

In North Dakota the only cement factory is that at Pembina, on the Tongue River. It was erected about five years ago, and was originally planned to produce a high grade of Portland cement. The tests did not reach a sufficiently high standard to admit of this, however, and the company now puts out its product as a natural-rock cement, though it is far stronger than the usual requirements of such a product.^c A soft, chalky clay is the material used for making the cement; it outcrops from a hillside, and is more than 50 feet in thickness. The factory was built with great regard to economy of labor and material,

^a Production of cement: Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1892, p. 536.

^b South Dakota Geol. Survey Bull. No. 3, 1902, p. 100.

^c Production of cement: Mineral Resources U. S. for 1901, U. S. Geol. Survey, 1902, p. 722.

and has been a successful though not a very large producer since it started. The scarcity and high cost of fuel in this section of the country is a factor which enters largely into the success or failure of cement making here.

OHIO.

Numerous cement plants are scattered throughout the entire State of Ohio. Among the first to be established was a small plant at Sandusky, which was abandoned after a short time. The next venture in cement manufacturing was made by Mr. Gleason, at Defiance. He succeeded in producing an excellent article, which he called the Auglaize cement, and which was made from the lowest and most calcareous layers of the Huron shale.^a This plant was established in 1846, and has been operated, though not continuously, ever since. It is now managed by Messrs. Wilhelm and Gorman. In 1858 the firm of Messrs. Parker & Sons began to manufacture cement at Barnesville, in Belmont County, from the limestone there. At the outbreak of the war their establishment was closed, as the demand for cement ceased. In 1868 it was reopened, and in 1869 their product was tested by the Atlantic and Great Western Railway Company, in competition with eleven other brands, the result being that Parker's cement was adopted. Eleven thousand barrels were used in the construction of the railroad bridge at Bellaire. These works are not operated at the present time, but until quite recently there were cement works just below Bellaire where cement was made from this same stone.^b

In 1884 a small plant was erected at Columbus, which ran successfully for a number of years, but is now closed down. In 1889 the Buckeye Portland Cement Company established a plant at Harper, in Logan County, which has been successfully operated since that time. The materials used here are marl and clay, and the plant has been twice enlarged to meet the demand for its output. In 1891 cement was being manufactured at Bellaire, and at New Lisbon, Columbiana County, but none was produced in Sandusky.^c In 1892 a plant was erected at Middle Branch to produce Portland cement from limestone and clay, and it is still a successful producer. In 1893 the Sandusky Portland Cement Company began operations at Bay Ridge, near Sandusky.^d In 1898 works were built at Castalia, and have been running continuously since that time. In the same year a plant was established at Ransomes for the production of a fine, white cement for use in art work and other special purposes.^e This venture was not entirely successful, and the works were later closed, so far as producing cement was concerned. The Alma Portland Cement Company

^a Rept. Geological Survey of Ohio, vol. 2, 1875, p. 438.

^b Rept. Geological Survey of Ohio, vol. 3, 1878, p. 269.

^c Production of cement: Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1892, p. 532.

^d Production of cement: Mineral Resources U. S. for 1893, U. S. Geol. Survey, 1894, pp. 621-622.

^e Production of cement: Mineral Resources U. S. for 1895, U. S. Geol. Survey, 1896, p. 886.

was established at Wellston in 1898, and has been producing cement for the last five years.^a Another plant erected at Wellston three years later was sold in 1902 to a large cement company in Pennsylvania. There are other companies, all of more or less recent date, in the State, and they are successful in their operations. The Sandusky Portland Cement Company, whose plant at Bay Ridge has a large annual output of cement, in 1901 built a factory in Syracuse, Ind.

The growth of the cement industry in Ohio has been steady, though it has not been so marked as in some other States. In 1890 the entire production amounted to only 57,000 barrels of Portland cement, which was manufactured by two plants. In 1902 twelve plants reported, and the seven factories engaged in producing Portland cement had an output of 563,113 barrels.

PENNSYLVANIA.

In 1831 excavations were made in the process of constructing a canal to connect Muncy, Lycoming County, with Lock Haven, Clinton County, which exposed a large mass of cement rock of first-class quality near Williamsport. On being tested it yielded such satisfactory results that a cement plant was at once erected for the production of such cement as should be necessary in the construction of the locks and dams of the new canal. For more than three years these kilns, built by Mr. Crane, continued to manufacture and to supply all the local trade as well as the canal with an excellent quality of cement. When the canal was finished, however, the local demand was not great enough to justify a large supply. The industry was kept up, but in a very small way, the production fluctuating as there was or was not a market.^b In the year 1850, when the Lehigh Canal, running from Easton, Northampton County, to Mauch Chunk, Carbon County, was under construction, the cement rock, which has since been used in such enormous quantities in this valley, was uncovered.

This discovery of hydraulic limestone or cement rock was of great economic importance to the entire State, as it obviated the necessity of importing cement from New York State or from abroad, besides proving a great source of wealth in itself. The manufacture of cement for the canal was begun at Siegfried, Northampton County, and the product proved to be of excellent quality. The methods of burning were somewhat primitive as compared with the present appliances to be seen at Siegfried, but the rock yielded a fine cement, and has been used more or less continuously since that time.^c In 1865 Mr. David Saylor established a large natural-rock cement plant at Coplay, in Lehigh County. The product of this plant was good, but the competition with Rosendale and other long-established brands of natural-

^a Production of cement: Mineral Resources U. S. for 1899, U. S. Geol. Survey, 1900, p. 402.

^b Cummings, U., *American Cements*, 1898, pp. 19-20.

^c *Ibid.*, p. 21.

rock cement led to experiments in the manufacture of an artificial or Portland cement, and in 1870 Mr. Saylor began to produce a small output of this important product. His was the first plant in the United States where Portland cement was successfully made, and the history of the experiments tried before a good result was obtained is most interesting.

In 1876 the plant, which is still a successful producer of Portland cement, was established, the materials used being limestone and clay. At the Centennial Exposition held at Philadelphia in that year, both the Wampum and the Saylor Portland cements were exhibited, and held their own with the foreign brands sent here for that occasion.^a In 1878 there were four cement plants on the Lehigh River, two on the west side worked by the Coplay Cement Company and the Lehigh Cement Company, and two on the east side, the Allen Cement Company and the old Lehigh Cement Works. The Coplay plant had at that time 11 kilns, 7 of which were burning Portland cement. Their success led to the growth of the industry, and this locality, which was the first in the United States where Portland cement was extensively manufactured, became the leading center of production for Portland, which position it still holds, producing more than one-half the entire output of the country. The Coplay Cement Company have had continued success, and have now 34 kilns, producing a large annual output of both natural-rock and Portland cement. In 1882 the production of Portland cement was well established in the Lehigh Valley, and the United States Geological Survey reported for that year that "both natural and artificial cements were manufactured to a considerable extent at Allentown, Pa."^b In 1883 the Pennsylvania State Geological Survey reported as follows:

Two companies have tried to utilize the hydraulic properties of the limestone in Northampton County, but neither of them has done a great deal for the last four or five years, and the quarries have been practically unworked. These companies are the Old Lehigh Cement Works and the Allen Cement Company. But it must not be supposed that because these companies have been apparently unsuccessful there is no future for this business in this part of the State; on the contrary, the success of the Coplay Cement Company shows what perseverance under difficulties can and does do. Of course, the composition of some of the cement beds is far more favorable to the manufacture of cement than that of others, but all may be more or less profitably utilized by careful intermixture.^c

It was during this same year that a plant for the manufacture of Portland cement was inaugurated at Egypt. For a time its output was rather small, but it increased slowly, and at the present time the outcome of this small beginning is the American Cement Company, one of the largest producers of both natural-rock and Portland cement in this country.

^a Lesley, R. W., Jour. Assoc. Eng. Soes., vol. 15, 1895, p. 200.

^b Production of cement: Mineral Resources U. S. 1882, U. S. Geol. Survey, 1883, p. 461.

^c Second Geol. Survey Pennsylvania, vol. 1, D. 3, 1883, p. 164.

In 1885 the small output of artificial cement was mostly from Pennsylvania, though a certain percentage of it was produced in New York. The imports increased, and the slow growth of the home production left them apparently unchecked. There were, however, three reasons for this in 1885 other than the natural demand. They were, a strong competition among the importers, very low ocean transportation, and the removal of duty on packages.^a In 1886 there were a number of improvements made in the machinery devised to save labor and reduce the cost of producing Portland cement, which gave an impetus to this industry. Referring to these improvements, Mr. R. W. Lesley, president of the American Cement Company, said, in a paper read before the Engineer's Club at Philadelphia:^b

The raw rock is crushed and ground dry. The powder thus formed is run into a mixer, when a small proportion of pitch and water is added. The moistened powder is then passed through a pair of heavy rolls having matched, egg-shaped cavities, which mold it into small eggs and deliver these latter in front of the kilns, avoiding all handling. These eggs can be used the same day in the kilns, if necessary, whereas under the old process the same stage of manufacture required weeks—a manifest advantage, to say nothing of the immense saving in labor, land, and interest. The form of the material, its uniformity in density, porosity, and size, make it more easily burned, handled, crushed, and ground, and cause a saving at every stage of the process, while the addition of the pitch aids the uniform burning, and, moreover, by forming pores through which the moisture in the egg escapes prevents them from falling away in the kiln, which they would otherwise do, owing to the generation of steam within them and the formation of a crust on their outer surfaces. This is the point which in the old process prevented placing the wet paste in the kilns promptly, and which is here overcome by the use of a combustible. By this process the foreign brands are fairly met in point of price, and repeated tests by leading authorities here and in Europe show that the quality of the cement made is equal to the foreign Portland.

It was about this time that Ransome's improved revolving cylinder for the manufacture of Portland cement was introduced in England. It was first used in this country by a plant in Oregon,^c which has since been abandoned. After a number of failures and many experiments with a view to improvements on Mr. Ransome's invention, the rotary kiln was adopted here. The modifications and changes made in this country were very advantageous, and the first rotary kiln successfully established in the Lehigh district proved to be a great saver of time and labor. The expense of fuel was much increased, but the output of the plant was so much greater that this disadvantage was obviated in a degree. The recent use of powdered coal, which has superseded the use of oil as a fuel, has somewhat reduced the expense of rotary kilns. In 1891 the output of Portland cement in Lehigh County had reached 268,500 barrels, this being the production of six

^a Production of cement: Mineral Resources U. S. for 1885, U. S. Geol. Survey, 1886, p. 407.

^b Production of cement: Mineral Resources U. S. for 1886, U. S. Geol. Survey, 1887, p. 560.

^c Production of cement: Mineral Resources U. S. for 1887, U. S. Geol. Survey, 1888, p. 530.

plants.^a The production of natural-rock cement was 695,000 barrels. In 1895 two of the leading plants at Coplay enlarged their factories so as to nearly double their capacity for producing Portland cement. There were now seven plants in Pennsylvania producing Portland and five producing natural-rock cement.^b

In 1897 the State production of Portland cement was very much in excess of that of any previous year, while the production of natural-rock cement increased but slightly; and in 1898 the output of Portland again increased remarkably in this district, reaching upward of 2,000,000 barrels, while that of natural-rock cement decreased, the figures reported showing only about a quarter of a million barrels.^c In 1900 Pennsylvania had a record of fourteen plants for the production of Portland and five for the production of natural-rock cement. Of these several plants had an output of both kinds of cement. In 1901 there were seven plants devoted to the exclusive production of Portland cement, six that made both Portland and natural-rock, and one where only the natural-rock cement was manufactured; three plants were idle, two of them being closed for reconstruction, and four new ones were in process of building. The quantity of Portland cement produced in the State during the year was 7,091,500 barrels or more than half of the entire output of the United States. The figures for the production of natural-rock cement were 942,364 barrels. The materials used in this locality are argillaceous limestone or cement rock for the natural cement, and the same stone mixed with pure limestone for the Portland cement. The Lehigh Valley cement rock, which carries silica and alumina mixed with almost the requisite amount of lime, analyzes as follows:

Analysis of Lehigh Valley cement rock.

Constituent.	Per cent.
Silica	14.44
Iron oxide and alumina	5.91
Lime	42.10
Magnesia37
Carbon dioxide	33.48
Total	96.30

UTAH.

A discovery of cement rock, which proved on analysis to be of good quality, was made in 1888 in Utah, and noted in the report of this Bureau on cement for that year as being "at some point between

^a Production of cement: Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1892, p. 537.

^b Production of cement: Mineral Resources U. S. for 1895, U. S. Geol. Survey, 1896, p. 884.

^c Twentieth Ann. Rept. U. S. Geol. Survey, pt. 6 [cont.], 1899, p. 540.

Ogden and Provo City."^a In 1890 a company formed to exploit this discovery erected a plant for the production of Portland cement at Salt Lake City, and in 1891 the first production of cement from Utah was reported by this Bureau.^b In the fall of 1896 the present company began to manufacture Portland cement, and they have been very successful, in spite of the fact that in the spring of 1898 the plant was entirely destroyed by fire. During the summer following the factory was rebuilt, rotary kilns were installed, and steel buildings erected. The capacity was also enlarged. The original plant had a capacity of but 50 barrels per day. The present one produces 600 per day. The stone used is a hard, argillaceous limestone, very similar to the rock so extensively quarried for the manufacture of Portland cement in the Lehigh Valley of Pennsylvania. It is found in Parleys Canyon, about 10 miles east of the plant, where it is quarried from a ledge of rock 50 feet high and lying in strata which stand at an angle of about 75°. The rock is taken out by tunnel blasting in an open face, ordinary drills being used. The present plant is equipped with electric power, and powdered coal is the material used for fuel. As this is the only factory in the State of Utah and as the nearest plants are those in Colorado, it will be easily understood that there is generally a ready market for the entire production of cement manufactured in the State.

VIRGINIA AND WEST VIRGINIA.

An excellent quality of cement was made in Virginia as early as 1835 from natural rock obtained in Rockbridge County. The report of the State Geological Reconnaissance for that year alludes to it as a rock "that has been quarried and found highly valuable in the formation of water cement."^c Works were established at Balcony Falls, Rockbridge County, in 1848, which were known as the James River Cement Works.^d In 1898 the cement report issued by this Bureau stated that the plant of the James River Cement Works at Balcony Falls had been destroyed by flood, but was rebuilt in a most substantial manner at Locker, a short distance away.^e This is the present location of these works, which are the oldest in Virginia. Subsequently a mill was erected at Blue Ridge Springs, which was sold a few years ago, and is henceforth to be used for other purposes. The Ridgemont cement plant is of recent establishment, and it has been remodeled within a short time. In 1900 a plant for the manufacture of Portland cement was started up at Craigsville, and it has had marked success in producing a fine quality of cement.

^a Production of cement: Mineral Resources U. S. for 1888, U. S. Geol. Survey, 1889, p. 553.

^b Production of cement: Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1892, p. 532.

^c Rogers, Wm. B., Rept. Geol. Reconnaissance State of Virginia, 1835, p. 91.

^d Cummings, Uriah, American Cements, 1898, p. 21.

^e Twentieth Ann. Rept. U. S. Geol. Survey, pt. 6 [cont.], 1899, p. 550.

In West Virginia natural-rock cement was made near Shepherdstown, Jefferson County, at a very early date. In the State report of 1835 mention is made of the fact that this cement was of the very best quality. An analysis given is as follows: ^a

Analysis of cement, Shepherdstown, W. Va.

Constituent.	Per cent.
Carbonate of lime	32.17
Carbonate of magnesia	18.36
Silica	38.93
Oxide of iron and alumina	4.17
Total	93.63

A great diversity in the chemical constituents of the rock in this neighborhood occurs. The rock used for preparing cement to be used for the locks of the James River Canal had the following analysis: ^a

Analysis of rock used for cement for James River Canal locks.

Constituent.	Per cent.
Carbonate of lime	38.33
Carbonate of magnesia	16.30
Silica	36.60
Oxide of iron and alumina	6.33
Total	97.56

The industry was not kept up continuously in this locality, but about 1870 the Shepherdstown Hydraulic Cement Works were established by Mr. H. W. Blunt, who owned the vast deposits of limestone which outcrop about a mile south of Shepherdstown, along the Potomac River. For more than thirty years this plant produced a superior brand of natural-rock cement, but since the death of the proprietor the mill has been shut down. The situation at Shepherdstown is an exceptionally favorable one from an economic point of view, as the good water power, the adjacent canal, and the near-by railroads are all available. The deposit of limestone shows about 100 feet high above the river, and contains, besides the strata of natural cement rock, a great deal of stone which has all the elements necessary to a good Portland cement. This limestone shows through its thin covering of soil for hundreds of acres.

OTHER STATES.

Besides the more detailed account of various well-known sections in the United States where suitable materials exist from which cement can be profitably manufactured, mention should be made of other

^aRogers, W. B., *Geology of the Virginias*, 1835, p. 138.

localities containing similar deposits, some of which have never been developed.

Arkansas.—The cement industry in Arkansas is confined to a single plant, which is located at White Cliffs, and which, under the new management that took possession in 1901, began a production of cement in 1903. This plant is about seven years old and has been idle for the last two years. The factory and buildings have been thoroughly remodeled, and as the raw material owned by the company is practically unlimited, their future outlook is good. The materials used are chalk and clay. The company owns the chalk cliffs on the banks of Little River and 3,000 acres of woodland, including 600 acres of fine-grained clay.^a

Florida.—Of the material in Florida, Mr. Cummings reported in 1898 that what was perhaps the most remarkable natural hydraulic cement rock known occurs near River Junction. This deposit extends for several miles along the left bank of the Appalachicola River southerly to Aspalaga. It comprises over 2,000 acres and has a thickness of 80 feet above the river, containing sufficient raw material to produce over 2,000,000,000 barrels of cement. The material is usually soft enough to cut with a spade and shows a remarkable uniformity of proportions of the ingredients essential to the production of a good cement. The raw material is white, and the manufactured product is as white as marble. This rock has been successfully used, a mill having been operated at River Junction a number of years ago. Within the last four years it has been idle, waiting for capital to develop this field.^b

Georgia.—The hydraulic-cement rock in Bartow County has been used for the manufacture of cement since 1889, and has always yielded a satisfactory product. The plant is located at Cement. In 1900 a company was formed to develop the deposits at Clifford, but the plan was abandoned for lack of capital. In 1901 a plant was established at Rossville to produce natural-rock cement, and in 1902 this plant had also a small output of first-class Portland. The plant which is being erected at Rockmart will produce Portland cement in 1903. In the report on cement made by this Bureau in 1899, the deposit of cement rock at Rossville (near Chattanooga, Tenn.) is described as being a bed of natural Portland similar to that at Boulogne, France, but superior to the latter, in that the proper proportion of ingredients is more uniform.^c

Iowa.—The natural-rock deposits, the St. Louis marls and limestones, and the deposits of chalk in the northwestern portion of Iowa are all available for the manufacture of good cement, and are described in the Annual Report of the Iowa Geological Survey for 1899.^d

^a Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 5 [cont.], 1897, p. 1174.

^b Twentieth Ann. Rept. U. S. Geol. Survey, pt. 6 [cont.], 1899, p. 549.

^c Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 6 [cont.], 1900, p. 410.

^d Rept. Iowa Geol. Survey, vol. 10, 1899, p. 622.

Missouri.—Notwithstanding an abundance of good material, the cement industry had not been attempted in Missouri until the year 1902, when the St. Louis Portland Cement Company completed its plant at Prospect Hill Station.

Nebraska.—In 1880 the manufacture of hydraulic cement had been conducted for some time at Beatrice, but owing to inadequate appliances it was at first insufficiently pulverized. Later it was properly manufactured, and is said to have stood the test of time.^a In 1880 the business of producing cement was temporarily suspended, and was carried on only at times for the next fifteen years. The plant then became a fairly successful producer, though with only a small output. Since late in 1901 no cement has been manufactured in Nebraska.

New Mexico.—In 1899 this Bureau reported a small production of Portland cement from Springer, N. Mex. Since that time, however, the plant has been idle, and is now dismantled.

Oregon.—The report on cement made by this Bureau in 1882 states that in Oregon and also in Washington Territory a good quality of hydraulic limestone had been found, and that in Oregon works had been erected for making cement.^b The report for 1884 mentions that a deposit was opened in Oregon some years ago, but it was not of an extensive character.^c In 1887 this Bureau reported that the first attempt in the United States to use the Ransome process of burning and grinding cement—that is to say, the first use of the rotary kiln—had just been made by the Portland Cement Company, of Portland, Oreg.; that those works had just commenced operations, and were located at Oregon City, Clackamas County, and that the material used was a natural Portland cement rock, found in Douglas County. Gas was the fuel, and the abundant water power of the Willamette River was utilized. The works had a 30,000 barrel per annum capacity.^d In 1888 a new discovery of cement rock at Llewellyn, Lane County, Oreg., was noted by this Bureau, and it was stated that the material when burned gave satisfactory results and would probably be developed.^e The report for 1891 stated that the works at Portland had not been operated for some time, owing to litigation among the stockholders of the company, and that the cement had formerly been made of natural rock and burned in a rotary furnace.^f Since that time no cement production from Oregon has been reported.

Tennessee.—In Tennessee there are many deposits of hydraulic limestone, and cement of a fine quality was produced therefrom before 1860.

^a Aughey, S., *Physical Geography and Geology of Nebraska*; pt. 2, *Geology*, p. 314.

^b Production of cement: *Mineral Resources U. S. for 1882*, U. S. Geol. Survey, 1883, p. 463.

^c Production of cement: *Mineral Resources U. S. for 1884*, U. S. Geol. Survey, 1885, p. 675.

^d Production of cement: *Mineral Resources U. S. for 1887*, U. S. Geol. Survey, 1888, p. 530.

^e Production of cement: *Mineral Resources U. S. for 1888*, U. S. Geol. Survey, 1889, p. 553.

^f Production of cement: *Mineral Resources U. S. for 1891*, U. S. Geol. Survey, 1892, p. 536.

In 1886 cement rock of first-class quality was examined at Erin, in Houston County, and there was talk of a plant at that place. It did not develop, however.^a In 1887 the fact that the cement works at Erie, in Loudon County, were enlarged to give a capacity of 2,000 barrels per month, looked very encouraging. But in the report for 1891, made by this Bureau, it is stated that "no cement is now made in this State,"^b and since then no production is reported.

Texas.—Cement has been made in Texas for more than twenty years. The plant which first produced it had an output of natural rock cement, which, though small, was of good quality. About 1892 a plant for the manufacture of Portland cement was erected near Dallas, and has been in active operation since that time.^c The plant at San Antonio, Bexar County, makes both varieties of cement, and the one at Austin, Travis County, has been shut down for the last two years.

Washington.—Two companies have been formed in this State within the last few years for the purpose of manufacturing cement, but as yet no plant has been erected.

Wisconsin.—About 1874 a remarkably good quality of natural cement rock was discovered in this State by Dr. I. A. Lapham, who directed general attention to it in an article mentioning the geological relation existing between this rock and the water limestone of Louisville, Ky., and suggesting its possessing the same useful qualities. In 1875 a cement mill was established near White Fish Bay, and with scarcely a break it has been producing an excellent quality of cement since that time.^d In 1890 a second company was formed, and shortly thereafter a second plant was erected not a great distance from the first. These two plants produce all the cement made at the present time in the State. They use the same kind of rock, which is described in the second volume of the report of the State Geological Survey of Wisconsin, published in 1877.

^a Production of cement: Mineral Resources U. S. for 1886, U. S. Geol. Survey, 1887, p. 564.

^b Production of cement: Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1892, p. 532.

^c Production of cement: Mineral Resources U. S. for 1891, U. S. Geol. Survey, 1892, p. 530.

^d Geology of Wisconsin, vol. 2, 1873-1877, p. 400.