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HENRY B. KÜMMEL, STATE GEOLOGIST

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THE MINERAL INDUSTRY OF NEW JERSEY FOR 1911

BY

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Letter of Transmittal.

TRENTON, June 7th, 1912.

The State Printing Board, Trenton, N. J.:

GENTLEMEN—I hereby request that the State Printing Board order the publication of 3,000 copies of a Bulletin on the Mineral Industry of New Jersey for 1911, the manuscript of which is transmitted herewith. The publication of this report has been approved by the Board of Managers of the Geological Survey, and favorable action by the State Printing Board is requested, as provided by Chapter 46, Laws of 1910. The printing contract for 1911–1912 provides for the publication of such Bulletins of the Geological Survey as shall be ordered by your Board.

The Bulletin shows that the Mineral Industry of New Jersey during 1911 had a value of over $35,000,000—a greater value per square mile of territory than any other State except Pennsylvania.

Very respectfully,

HENRY B. KÜMMEL,

State Geologist.

The Mineral Industry of New Jersey.

By Henry B. Kümmel.

The collection of statistics of the mineral production of New Jersey was made in co-operation with the United States Geological Survey in order that producers might not be troubled by requests for information from two bureaus.

As compared to 1910, the returns indicate increases along some lines, notably zinc, the clay industry, Portland cement, and mineral waters, and decreases in iron mining, stone, sand and gravel, lime and sand-lime brick.

The total value of the mineral industry in 1911 amounted to $37,716,411, distributed as follows:

VALUE OF THE MINERAL INDUSTRY IN 1911.

	Value.	*Per Cent. of Whole.*	*Increase or Decrease Compared to 1910.*
Iron Mining,	$1,158,271	3.7	$423,942 D
Zinc Mining,	8,828,781*a*.	23.4	....
Clay and Clay-working Industries,	18,837,103	49.9	345,001 I
Stone,	1,623,884	4.3	80,228 D
Sand and Gravel,	1,058,926	2.8	80,349 D
Portland Cement,	3,259,528	8.6	192,363 I
Lime,	113,784	....	15,180 D
Mineral Water,	210,123	....	76,384 I
Sand-lime Brick,	17,710	....	6,101 D
Mineral Paints, Coke and by-products,	2,607,270*b*	5.7	....
Greensand Marl,	1,031	....	....

a. Value of recoverable output figured as metallic zinc. Since some of this zinc was used in the manufacture of mineral paint in New Jersey, there is a slight duplication of values in these totals. This does not exceed $425,000, and has been allowed for in making up the State total.

b. Combined in order to conceal individual production of coke and mineral paints.

IRON MINING.

The iron-mining industry in 1911 showed a marked decrease both in production and values as compared to 1910, but as the average value per ton was $3.22 as against $3.03 for the previous year, the decrease in value was not so great as in quantity. The production was 359,721 gross tons, about 66 per cent. of the previous year, and the value $1,158,271, or 73 per cent. For 1910 the figures were $521,832 gross tons valued at $1,582,213. At the beginning of the year the stock on hand at the mines was 17,567 long tons, while at its close this had increased to 115,581 tons. A decrease in production of 66 per cent., and the addition to the stock piles of 98,014 tons or 27 per cent. of the amount mined, indicates the extent of the depression in this industry. In fact, the production was less than for any year since 1900, when it was 342,390 tons. Of the ore mined, 233,824 tons were produced in Morris County and 125,897 in Warren and Passaic.

Of the Hibernia group of mines only the Wharton mine was a producer, all the other openings on this property being idle. At Wharton the Hurd mine was operated, but the Irondale and Orchard were shut down. The Richard mine was actively worked, and its production far exceeded that of any other; indeed, its production was approximately equal to that of its most successful year.

Some of the Mount Hope openings were worked, and at Oxford the Washington and Ahles mines were producers. The Peters mine at Ringwood increased its output and so did the Hoff mine near Dover. The Shoemaker mine near Belvidere was worked a portion of the year, but was shut down in October, and the High Ledge mine was a small producer for a portion of the year.

SINTERING OF MAGNETITE CONCENTRATES.

There are in northern New Jersey vast deposits of magnetic iron ores that are too low in iron for use at the present time, but which by concentration can be transformed into high-grade ore. In many cases the fineness of crushing necessary to secure proper concentration has prevented their use except in very limited degree. There has recently been described[1] a simple and effective method of sintering by which the fine magnetic concentrates can be transformed into a coherent mass, so open and cellular in structure that it is admirably adapted for blast furnace use.

The apparatus and process as described by Mr. Gayley is as follows:

"* * * The machine consists essentially of a frame of structural steel supporting a sheet-iron suction-box, open at the top, over which may be pushed a train of conveyor-elements called 'pallets,' each of which has a floor composed of ordinary herring-bone grates, and which slides on its planed bottom, making an air-tight joint with the horizontal top edges of the suction-box on which it rests. The vertical surfaces of contact of the pallets with each other are also accurately planed, so that all joints are closed air-tight when the train of pallets is being pushed along.

"An exhaust fan, connected with the suction-box by suitable piping, induces air-currents to travel downward through the openings in the pallet-grates and through the permeable material resting upon them. To trap the air properly, a smooth-surfaced dead-plate, somewhat longer than one pallet-length, is bolted to each end of the suction-box.

"The movement of the train of pallets is accomplished by a pair of cast-steel sprocket-wheels, which serve the double purpose of lifting the pallets from the lower level and pushing them horizontally across the suction-box. Each pallet is provided with four small roller-wheels which hang idle while the pallet is traveling over the suction-box, but serve to carry the pallet on its return trip to the point of beginning. The return of the pallets is provided for by a pair of semi-circular discharge-guides, terminating in a lower track-way sloping downward to the base of the main sprocket-wheels, and continuing as semi-circular guides around their peripheries. The pallets when they complete their journey across the suction-box to the point of discharge have their wheels engaged by the curved guides, and when pushed still further, beyond the crest of the curve, break away from the train that is pushing them, and one by one, drop with a sharp blow on the upturned edge of the pallet just preceding. This shock serves to dislodge the cake of sinter from the surface of the grates, which now stand more or less vertical. The train of discharged pallets, in the guides and on the inclined lower track-way, crowds down by its own weight to the foot of the main sprocket-wheel. During this period of their travel, the pallets are upside down, which automatically tends to clean out the grate-slots. The sprocket-wheel lifts the train of pallets to the upper level and the cycle is completed.'

"We thus have a practically endless conveyor, any individual element of which can be removed for repairs and a new one substituted without stopping. The circuit may, if desired, be made a closed one, and this arrangement has been used under special conditions; but, in general, it is customary to leave an interval in the train of about one and a half pallet-lengths, which gives just about the right amount of shock.

"The speed of horizontal travel of the pallets is adjustable to meet varying requirements, with the usual range from 7 to 30 in. of linear travel per minute.

"The ore-charge is automatically fed to the pallets in a thin layer (from 4 to 6 in. thick) from a simple funnel-shaped hopper of the same width as the pallets, hung directly over them at a point between the main sprocket-wheels and the suction-box. There being no bottom to the hopper, the material rests directly on the pallets and is dragged out by their movement,

[1] James Gayley, Trans. Amer. Inst. Mining Engrs., Vol. XLII, 631.

the front edge of the hopper acting as a scraper to form a uniform layer of the proper thickness.

"The stream of ore emerging from the hopper passes under an igniting-device which kindles the combustible elements in the charge on its top surface, and the combustion thus started is carried downward through the mass by the air-currents while the material is passing over the suction-box. This ignition can be accomplished by almost any kind of flame that will give a quick, intense heat. The amount of heat required at this point of the operation is exceedingly small and the cost of ignition correspondingly low. The wide variety of suitable means makes it possible to meet almost any local requirements.

"The complete cycle of operations is as follows: A pallet being pushed outward tangentially from the top of the sprocket-wheels, passes under the feed-hopper, where it takes its load of ore in the form of a continuous, even layer of charge, say 4 in. thick. It next passes under the ignition, where the top surface is ignited, and at the same time the charge comes within the influence of the down-draft induced by the exhaust-fan through the suction-box. The air-currents promote rapid internal combustion of the fuel ingredients in the charge, and carry the action progressively downward from the top surface until it reaches the grates. This internally-developed heat and the chemical reactions consequent thereto serve to bind the mass together until it becomes a coherent cake of cellular material, much resembling coke. The speed of the machine should be regulated so that the combustion- and sintering-operation is complete when a given pallet has reached the far end of the suction-box, where the cake is discharged by the pallet dropping into the discharge-guides and striking the one just preceding it. The empty pallets then gradually crowd back to the face of the sprocket-wheels, are slowly raised to the upper track, take their load, and make a new trip. * * *

"In sintering materials which do not contain any heat-producing substances, recourse can be had to the practice of the ancient Catalan or Corsican process, where carbon fuel was mixed with the ore, and which, in its first stage, was an agglutinizing process. In order to test the machine on this class of work, some magnetic concentrates were treated, after being mixed with 7 per cent. of coal, and the product was found to be satisfactory in every particular. The material was sintered into a coherent mass, but so open and cellular in structure that the mass, in discharging from the pallets, broke into very convenient sizes for the furnace, and without any fines. As the mixture contained less carbon than the flue-dust, it was sintered much more quickly. While in the test on flue-dust, a travel of 12 ft. in the grate-movement was required to complete the sintering, the concentrates were completed in a travel of 6 ft. This represents, in the treatment of magnetic concentrates, a greatly-increased capacity for the machine."

The following is the analysis of the concentrates tested:

	Magnetic Concentrates Per cent.	*Sintered Product Per cent.*
Iron,	57.52	59.65
Phosphorus,	0.09	0.11
Manganese,	0.56	0.60
Silica (SiO_2),	9.70	10.60
Alumina (Al_2O_3),	3.43	4.00
Lime (CaO),	0.35	0.30
Magnesia (MgO),	0.10	0.10

SULPHUR.

	Per cent.
Magnetic concentrates with 7 per cent. of coal,	1.17
Sintered product,	0.006

SIEVE TEST OF MAGNETIC CONCENTRATES.

On 10-mesh,	28 per cent.
On 20-mesh,	44 "
On 40-mesh,	15 "
On 60-mesh,	7 "
On 80-mesh,	2 "
On 100-mesh,	1 "
Through 100-mesh,	3 "

Mr. Gayley emphasized the advantages of this process as follows:

"1. The feeding of materials to and discharge from the machine, without interfering with the continuity of the process.

"2. The down-draft of air exerts pressure in the direction of the gravity of the mass, and prevents the displacement of particles.

"3. The down-draft of air intensifies the combustion at the beginning of the sintering, and towards the end of it operates efficiently to cool the mass.

"4. The sintering-operation is under constant observation during the whole period, and permits of rapid changes in adjustment.

"5. The process can be stopped at any time to make any changes without interfering with or clogging any part of the apparatus.

"6. The duration and activity of treatment are subject to ready control.

"7. The adjustability of the process makes it adaptable to treating any class of fine material, without modifying the construction.

"8. The withdrawing of the gases by a fan provides a heating medium for drying ores carrying a surplus of moisture.

"9. There is no nodulizing of the sintered material, and the cellular structure, which is so important, is preserved.

"10. The product is ideal in structure for use in the blast-furnace, on account of the large 'area of contact' provided, and its adaptability in size for distribution in and passage through the furnace."

ZINC.

The Franklin Furnace mine of the New Jersey Zinc Company was steadily operated in 1911. The company reports that 341,543 tons of ore were hoisted during the year, a small increase over 1910. According to statistics obtained from the U. S. Geological Survey, 306,168 short tons of ore were sent to the concentrating mills, from which 252,166 short tons of concentrates were obtained. This is a decrease of 2,185 tons of ore and a decrease of 11,440 tons of concentrates. In addition, 67,896 tons of crude ore (an increase of 572 tons) were sent to the smelters.

Figured as metallic zinc, the total recoverable output was 154,890,000 lbs. of smelter, an increase of 17,534,781 lbs. over that of 1910. On the basis of the average price of 5.7 cents per pound, its value was $8,828,781.

ORE MINED SINCE 1880.

Previously reported,	4,504,784	tons.
Mined in 1911,	341,543	"

CLAY AND CLAY-WORKING INDUSTRY.

The clay and clay-working industry in New Jersey during 1911 showed a slight increase in value of products as compared to the previous year. The total value of all clay products, exclusive of raw clay, was $18,178,228; including the raw clay mined and sold by the miner (to a considerable extent to manufacturers in other States) it was $18,837,103. The corresponding figures for 1910 were $17,834,297 and $18,492,102, the increase in value of manufactured products being $344,951, and of total value, $345,001.

In 1910, New Jersey ranked third of all States in the value of clay products, manufacturing 10.48 per cent. of the total for the whole country. It was exceeded by Ohio and Pennsylvania, which produced 18.53 per cent. and 12.99 per cent. respectively. In Ohio, 683 operating firms reported; in Pennsylvania, 451; in New Jersey, 167. In Ohio the average individual production was $46,159; in Pennsylvania, $48,989; in New Jersey, $106,792; that is, in New Jersey the individual product was more than twice that of either the other States, or of Illinois and New York, the two States next after New Jersey.

In 1910 New Jersey was first of the States in fireproofing, second in architectural terra cotta, second in tile (not drain), third in front brick, fourth in fire brick, and fourth in common brick. It was second in total value of all pottery, third in white ware, first in china, first in sanitary ware, and third in porcelain electrical supplies. It produced 25.4 per cent. of all the pottery made in the United States. 73 per cent. of the sanitary ware, and 57 per cent. of the china. It was also first in the value of raw clay mined and sold.

The above comparisons are made for 1910, because at this writing the statistics for 1911 from other States are not available for comparison. It is probable, however, that the ranking for 1911 will be the same as in 1910, unless possibly in the sale of raw clay.

CLAY.

Only a small part of the clay mined in New Jersey is included under this head. All that used by the miner in the manufacture of brick, tile, etc., is reported as the finished product, and only that sold by the miner is here included. The raw clay dug and sold in 1911 amounted to 405,912 short tons, valued at $658,875, with an average value of $1.10 per ton. This was an increase of 321 tons and $1,070 in value.

The various kinds of clay mined, the number of producers, the tonnage and the value are shown in the following table.

CLAY MINED AND SOLD RAW.

	No. of producers.	*Amt. in short tons.*	*Value.*	*Average per ton.*	*Value in 1910.*
Ball clay,	3	1,249	$6,433	$5.15	$17,376
Fire clay, including sagger clay,	37	282,777	471,695	1.67	468,890
Stoneware clay,	6	29,392	64,068	2.18	45,171
Brick clay,	8	32,040	20,326	0.63	28,683
Miscellaneous,	9	60,454	96,353	1.61	97,685
	42	405,912	$658,875	$1.62	$657,805

The above table shows decreases in value in ball clay, brick clay and miscellaneous clays as compared to 1910, and increases in fire clay, and stoneware clay. The total increases exceeded the decrease by $1,070.

Fire clay far exceeded all other kinds combined, both in quantity and value. This does not mean, of course, that more fire clay was dug than brick clay; as an actual fact the reverse was true, but most of the brick clay and other cheaper grades were used by the miner and not sold raw. In addition to the fire clay sold, as reported above, a large amount was dug and manufactured into fire brick directly. The value of this clay is included in the returns for fire brick as given elsewhere.

Seven out of the twenty-one counties reported clay dug and sold. Middlesex was first with a production of 371,020 tons, valued at $593,640; Mercer second, 10,939 tons, value $30,040;

Burlington third, 8,853 tons, value $12,493, and Camden, Ocean and Cumberland in the order named, their total production being 15,100 tons, valued at $22,702.

During the past year a deposit of clay heretofore unrecognized has come to the attention of the Survey. It is located on the property of J. A. Vannatta, a mile or two east of Martins Creek, in Warren County. A pit opened by the owner is said to show clay to a depth of 24 feet, with the bottom not exposed. At the time of my visit, the wall of the pit could be inspected to a depth of 10 to 12 feet, and showed the following section:

2 feet	of stony clay soil and subsoil,	0–2 feet
4–5 "	light colored mottled clay,	2–6½ "
½ "	sand somewhat clayey,	6½–7 "
3+ "	yellowish clay,	7–10 "

The yellowish clay is very tough and compact. Careful search revealed the occurrence of a very few small pebbles under ½ an inch in diameter and some minute bits of shale. These are so few, however, that at first sight the clay seems to be free from all stones.

A fire test of the clay has been made at the State School of Ceramics. It burns a good red and makes an excellent hard brick. At temperatures used for firing enameled brick it vitrifies and overburns. It would probably vitrify at about Seger cones 8 to 10.

The areal extent of the clay is not definitely known, but judging by the topography and its probable origin, there is good reason for believing that it occupies a considerable area. The presence of pebbles of foreign origin and the occurrence in this vicinity of a mantle of very old glacial drift indicates that the clay is probably one phase of these ancient deposits.

POTTERY.

The total value of all pottery manufactured during 1911 was $8,401,941, a slight decrease of $186,514 from the figures for 1910. Returns were received from 57 producers, two less than last year. Two plants were reported as idle, two out of business and one as "not yet operating."

The following table gives a summary of the different classes of ware manufactured and sold, together with figures for 1910, for the sake of comparison.

	No. of producers reporting.	1910.	1911.
Red earthenware,	7	$26,529	$38,910
Stoneware and yellow or Rockingham ware,	3	55,734	75,915
White ware, including C. C. ware, white granite, semi-porcelain ware and semi-vitreous porcelain ware,	9	1,345,156	1,148,904
China, Bone China, Delft and Belleek ware,	8	1,131,412	1,105,278
Sanitary ware,	19	4,955,066	4,898,588
Porcelain electrical supplies,	14	874,013	913,921
Miscellaneous,[1]	11	200,545	220,425
		$8,588,455	$8,401,941

From the above table it appears that there were increases in the value of red earthenware, stoneware and yellow ware, in porcelain electrical supplies and miscellaneous products, and decreases in the white ware, china and sanitary ware.

Pottery is manufactured in eleven of the twenty-one counties of the State, but the industry centers chiefly in Trenton, Mercer County. The values by counties is as follows:

Rank.	Counties.	No. of Producers Reporting.	Value.	Per Cent.
1	Mercer,	36	$7,713,599	91.8
2	Camden,	3	224,136	2.6
3	Middlesex,	3	199,688	2.4
4	Hunterdon,	3	133,391	1.6
5	Union,	2	*	..
6	Essex,	4	35,764	0.4
7	Burlington,	2	*	..
8	Hudson,	1	*	..
9	Monmouth,	1	*	..
10	Cumberland,	1	*	..
11	Atlantic,	1	*	..
	Total of counties each with less than three producers,	..	95,363	1.1
		57	$8,401,941	

The above table brings out the pre-eminent position of Trenton in the pottery industry, since the entire value for Mercer County is made there. It makes no red earthenware or yellow ware,

[1] Includes chemical ware, art pottery, clay tobacco pipes, doorknobs, porcelain hardware trimmings, druggists' earthenware, porcelain stilts, spurs and pins.

* Less than three producers each, hence figures cannot be published separately.

but, with these exceptions, it is first in all the listed classes of pottery. It produces *all* the white ware and china, all the sanitary ware except to the value of $418,989, and all the porcelain electrical supplies except to the value of $31,859.

Essex County leads in the manufacture of red earthenware and Hunterdon in stoneware and yellow ware; Camden is second in sanitary ware, Middlesex is third; Hunterdon is second in porcelain electrical supplies.

Among the miscellaneous products chemical ware is made in Middlesex and Camden counties, clay tobacco pipes in Hudson and Essex, art pottery in Essex and Middlesex and door knobs in Mercer.

BRICK AND TILE.

The statistics regarding the manufacture of brick and tile in 1911 are summarized in the following table:

	Counties.	*No. of Producers.*	*Production in Thousands.*	*Value.*	*Per M.*	*Increase or Decrease.*
Common brick, ..	19	67	429,367	$2,401,962	$5.59	$186,334 I
Front brick,[1]	6	10	47,764	531,024	11.12	78,821 D
Fancy brick, .. }	..	2	......	....	....	....
	2	..	......	432,118	....	185,861 I
Enameled brick, }	..	2	......	....	....	....
Fire brick, ...	3	12	58,470	1,344,884	23.03	343,821 I
Total brick, ...				$4,709,988		$637,195
Drain tile, ...	6	9	......	26,502	....	3,355 I
Sewer pipe, ...	2	4	......	103,137	....	........[3]
Architectural terra cotta, ...	3	6	......	1,669,973	....	330,066 D
Fireproofing and hollow blocks,..	4	11	......	1,728,811	....	146,710 I
Tile (not drain), .	3	14	......	1,197,330	....	1,783 D
Miscellaneous,[2] ...	5	9	......	340,546	....	....
Total all products, ...				$9,776,287		$530,433

The total value of all products is $9,776,287, an increase of over half a million dollars compared in 1910. The detailed figures show increases in the value of common brick, fancy and enameled brick and fire brick, and a considerable decrease in the value of front brick, although the quantity showed an increase

[1] A few vitrified brick made by one producer are included here.
[2] Includes glass-melting pots, gas-furnace linings, underground conduits, retorts and muffles, chimney brick, wall coping and stove lining.
[3] Included last year in miscellaneous.

of 113,000, the explanation being found in the much lower prices per thousand. The average price for common brick per thousand was 4 cents higher than in 1910, while for front brick it was $1.68 lower and for fire brick $2.93 lower. Drain, tile, fireproofing and hollow blocks show increases in value while architectural terra cotta and tile (not drain) show slight decreases.

By counties the production is as follows:

Rank.	*Counties.*	*Value.*	*Per Cent.*
1	Middlesex,	$7,077,988	72.3
2	Mercer,	758,319	7.7
3	Bergen,	340,097	3.4
4	Camden,	320,533	3.2
5	Monmouth,	318,139	3.2
6	Somerset,	227,792	2.3
7	Atlantic,	186,760	1.9
8	Burlington,	153,203	1.5
9	Hudson,*	......	..
10	Passaic,	77,650	0.8
11	Morris,*	......	..
12	Warren,*	......	..
13	Cumberland,	31,600	0.3
14	Salem,*	......	..
15	Union,*	......	..
16	Gloucester,*	......	..
17	Ocean,*	......	..
18	Hunterdon,*	......	..
19	Cape May,*	......	..
All counties marked *,		281,216	2.9

Common brick were manufactured in all counties of the State except Essex and Sussex. Middlesex was first, 218,299 M., value $1,099,014; Bergen second, 60,562 M., value $340,097; Mercer third, 27,810 M., value $190,360, then Atlantic, Camden, Burlington, Monmouth and Passaic. The value for the other counties was less than $60,000 each, and for most of them less than $25,000. Sixty-seven producers reported making common brick.

Front brick were made in Middlesex, Camden, Atlantic, Mercer, Morris and Monmouth counties, in the order named, but separate figures for the counties cannot be given, because in each case there were less than three producers. Ten producers reported.

Fancy brick and enameled brick were made in Middlesex and

* Less than three producers in each county, values cannot be given separately. Combined value for all these counties is $281,216.

Camden counties, the former being the chief producer. Four firms reported.

Fire brick were produced in Middlesex, Hudson and Mercer counties, but the two latter counties produced only 15 per cent. of the total, Middlesex showing a value of $1,154,692.

Small amounts of drain tile were made in Middlesex, Monmouth, Salem, Burlington, Camden and Atlantic counties by nine producers, but the entire production for the State was valued at only $26,502.

Sewer pipes were made in Middlesex and Atlantic counties, chiefly in the former, and as there were four producers reporting it is possible to give the value, which is $103,137. Last year, with less than three producers, it was included in "Miscellaneous Products."

Architectural terra-cotta, produced in Middlesex, Somerset and Burlington counties, was valued at $1,669,973, of which 87 per cent. was manufactured in the first-named county.

Fire-proofing and hollow blocks were manufactured in Middlesex, Monmouth, Burlington and Warren counties. Their total value was $1,728,811, of which Middlesex produced $1,608,265, or about 94 per cent. Eight of the eleven plants reporting are located in that county, the other three counties having one each.

Tile (not drain) were manufactured at fourteen plants in Middlesex, Mercer and Monmouth counties, the value being $603,506, $472,166 and $121,658, respectively.

Glass-melting pots, gas-furnace linings, underground conduits, retorts and muffles, chimney brick, wall coping and stove linings have been grouped under the head of miscellaneous products, the total value of which was $340,546. They were manufactured at nineteen plants in Middlesex, Cumberland, Mercer, Atlantic and Burlington counties, but 97 per cent are made in the first-named county.

STONE.

The stone industry of New Jersey is chiefly the quarrying and crushing large amounts of stone for road metal, railroad ballast and concrete. Building stone forms a much smaller proportion of the whole, although the State does not lack excellent stone of this character, both granite and sandstone.

The total production of all classes of stone in 1911 was $1,623,884, a decrease of $80,228 as compared to 1910. Of this 70 per cent. was trap rock, 10.3 per cent. granite, 9.5 per cent. sandstone, 8.5 per cent. limestone and 1.7 per cent. slate, talc and soapstone.

The table below shows the value of the stone used for various important purposes, and in each case the percentage of the whole:

USES OF STONE AND VALUES, 1911.

Building stone and monuments,	......	$133,013	8.2
Rough,	$82,771	....	....
Dressed,	50,242	....	....
Paving,	......	26,441	1.6
Crushed stone,	......	1,317,053	81.1
Road metal,	760,736	....	....
Railroad ballast,	240,308	....	....
Concrete,	316,009	....	....
Blast furnace flux,,	......	91,781	5.6
Other uses,	......	55,596	3.4
		$1,623,884	

TRAP ROCK.

The trap rock quarried in 1911 constituted 69 per cent. of the value of the stone production in New Jersey. Of this, over 96 per cent. in value was crushed stone for roads, ballast and concrete. Road metal constituted 57 per cent. of the total, concrete stone 24 per cent., and railroad ballast 15 per cent. The total value was $1,136,385; there were 1,394,795 tons of crushed stone, 913,678 paving blocks and small amounts of rubble, riprap and building stone. Compared with 1910, there was a decrease in values in building stone, in road metal, railroad ballast and "other uses," and an increase in rubble and concrete stone, the net decrease in value being $121,427. Reports were received from 76 producers, of which 54 were active.

The following table gives the chief facts regarding the production of trap rock.

PRODUCTION OF TRAP ROCK, 1911.

	No. of Producers.	Amount Short Tons.	Value.	Average Price Per Unit.	Increase or Decrease.
Building stone, rough and dressed, ...	6	......	$6,154	.....	$1,835 D.
Paving blocks, ...	6	(913.678M)	26,441	$28.95	......
Rubble, ...	3	......	5,079	.....	2,006 D.
Crushed stone—					
Road metal, ...	51	791,043	646,209	0.82	75,552 D.
R. R. ballast, ...	13	242,008	177,019	0.73	46,798 D.
Concrete, ...	39	361,744	271,203	0.74	41,297 I.
Other values, includ-in riprap, ...	2	......	4,280	.....	5,910 D.
		1,394,795[1]	$1,136,385		$121,427 D.

Considered by counties, we find that nine were producers, in the following order: Somerset, Hunterdon, Passaic, Essex, Hudson, Morris, Bergen, Union, Mercer, the individual production ranging from $268,959 for Somerset, to $30,793 for Mercer.

PROPERTIES OF TRAP ROCK FOR ROAD METAL.

Since so large a proportion of the trap rock quarried is used in road work, it may not be amiss to repeat a portion of an article by J. Volney Lewis[2] regarding the properties of trap rocks for road construction.

"The merits of this stone for the building of macadam roads have become generally known throughout the country, but it is not all equally adapted for all roads, as abundantly demonstrated by both experience and laboratory tests of the stone from the various quarries. Hence it was deemed advisable, in connection with the study of the geology and petrography of the trap rocks, to collect specimens from the more accessible localities and submit these to the Office of Public Roads, Department of Agriculture, Washington, D. C., for systematic examination of their properties for road construction.

"The accompanying table and diagram represent the results of these tests, including some half a dozen samples that had been

[1] Weight of crushed stone only.
[2] Annual Report of the State Geologist for 1906, p. 165.

previously submitted by others. In the column designated 'French coefficient of wear,' the higher the number the more durable the rock; higher values also indicate superior 'Hardness' and 'Toughness' in the next two columns. Under 'Cementing value' the higher numbers show greater binding power of the finely powdered material. In further explanation of these properties as affecting the adaptability of a stone for road building, the following is quoted from Mr. L. W. Page, Director of the Office of Public Roads:[1]

"'By hardness is meant the power possessed by a rock to resist the wearing action caused by the abrasion of wheels and horses' feet. Toughness, as understood by road builders, is the adhesion between the crystals and fine particles of a rock, which gives it power to resist fracture when subjected to the blows of traffic. This important property, while distinct from hardness, is yet intimately associated with it, and can, in a measure, make up for a deficiency in hardness. Hardness, for instance, would be the resistance offered by a rock to the grinding of an emery wheel; toughness the resistance to fracture when struck with a hammer.

"'Cementing or binding power is the property possessed by the dust of a rock to act after wetting as a cement to the coarser fragments composing the road, binding them together and forming a smooth, impervious shell over the surface. Such a shell, formed by a rock of high cementing value, protects the underlying material from wear and acts as a cushion to the blows from horses' feet, and at the same time resists the waste of material caused by wind and rain, and preserves the foundation by shedding the surface water. Binding power is thus probably the most important property to be sought for in a road-building rock, as its presence is always necessary for the best results.

"'The hardness and toughness of the binder surface more than of the rock itself represents the hardness and toughness of the road, for if the weight of traffic is sufficient to destroy the bond of cementation of the surface, the stones below are soon loosened and forced out of place. When there is an absence of binding material, which often occurs when the rock is too hard for the traffic to which it is subjected, the road soon loosens or ravels.

"'Experience shows that a rock possessing all three of the properties mentioned in a high degree does not under all conditions make a good road material; on the contrary, under certain conditions, it may be altogether unsuitable. As an illustration of this, if a country road or a city parkway, where only a light traffic prevails, were built of a very hard and tough rock with a high cementing value, neither the best, nor, if a softer rock were available, would the cheapest results be obtained. Such a rock would so effectively resist the wear of a light traffic that the amount of fine dust worn off would be carried away by wind and rain faster than it would be supplied by wear. Consequently, the binder supplied by wear would be insufficient, and if not supplied from some other source the road would soon go to pieces. The first cost of such a rock would, in most instances, be greater than that of a softer one, and the necessary repairs resulting from its use would also be very expensive. * * *

"'The degree to which a rock absorbs water may also be important, for in cold climates this to some extent determines the liability of a rock to fracture by freezing. It is not so important, however, as the absorptive power of the

[1] Yearbook of the U. S. Department of Agriculture for 1900, p. 351.

road itself, for if the road holds much water the destruction wrought by frost is very great. This trouble is generally due to faulty construction rather than to material. The density or weight of a rock is also considered of importance, as the heavier the rock the better it stays in place and the better it resists the action of wind and rain.'

THE SELECTION OF A STONE FOR MACADAM ROADS.

"As stated above, a stone of the greatest hardness, toughness, and cementing power does not make the best road under all circumstances; in fact such material would give the best results only under the most severe conditions of heavy traffic. It is equally true that a stone of the same general kind or class does not always possess these properties in the same degree. The trap rocks, for instance, vary greatly in their texture, chemical composition, and degree of alteration, and these variations affect to a marked degree the properties of the stone for road construction.

"The trap rock produced by the various quarries varies from exceedingly dense, fine-grained and even partly glassy condition to a coarse-grained, granitic texture, in which the individual minerals are developed in grains of one fourth of an inch or more in diameter. Under the microscops the 'habit' of the mineral particles is seen also to vary greatly; in some cases they are of about equal dimensions in every direction, tending toward a rounded form, in others they are greatly elongated, lath-shaped and rod-shaped forms. Other things being equal, fine-grained varieties and those composed of interlocking, elongated minerals possess a higher degree of toughness.

"Variations in chemical composition are accompanied chiefly by corresponding variations in the proportions of the minerals pyroxene and feldspar (labradorite), the two principal constituents of the trap rocks of this region. Of these the former possesses the greater toughness and the latter the greater hardness. In some of the more basic varieties olivine (chryolite) may constitute as much as 10 per cent. of the rock. This mineral is somewhat harder even than the feldspar, but it is usually more or less altered into serpentine, which is considerably softer. The pyroxene is also subject to extensive alteration into greenish chloritic minerals, which are also much softer than the original mineral. The feldspar is somewhat less subject to extensive alteration, but is often partly changed into a soft white powdery kaolin.

"Thus it will be readily understood that while some trap rocks are very hard and tough and suited only for heavy-traffic roads, there are others that are not suited to such severe conditions and are better adapted to suburban streets, parkways, and country roads. Too often, however, the selection of the material for road building is made solely with a view to convenience or cheapness of the stone, with the result that an inferior road is constructed and the economy in first cost is more than counterbalanced by the expense of maintenance. Such initial carelessness may result in the selection of a stone that is too hard and tough for the traffic to which it is subjected or one that is too soft and brittle.

"'If the surface of a macadam road continues to be too muddy or dusty after the necessary drainage precautions have been followed, then the rock of which it is constructed lacks sufficient hardness or toughness to meet the traffic to which it is subjected. If, on the contrary, the fine binding material of the surface is carried off by wind and rain and is not replaced by wear of the coarser fragments, the surface stones will soon loosen and allow water to make its way freely to the foundation and bring about the destruction of the road. Such conditions are brought about by an excess of hardness or toughness of the rock for the traffic. Under all conditions a rock of high cementing value is desirable; for, other things being equal, such a rock better resists the wear of traffic and the action of wind and rain.'

"The different classes of traffic have been divided into five groups according to volume and character, as follows:

"1. City traffic, such as exists on the business streets of large cities. The conditions are too severe for any macadam, and more resistant forms of pavement must be used.

"2. Urban traffic, that of the less severe city conditions, but subjected to heavy traffic and requiring the hardest and toughest macadam.

"3. Suburban traffic, that of suburbs of larger cities and main streets of country towns, requiring a macadam of high toughness but somewhat less hardness than the preceding.

"4. Highway traffic, such as exists on the principal country roads. A rock of medium hardness and toughness is best.

"5. Country-road traffic, that of the less frequented country roads. For this it is best to use a comparatively soft rock of medium toughness.

"In the diagram, Figure 1, the samples are arranged according to the French coefficient of wear, beginning with the greatest

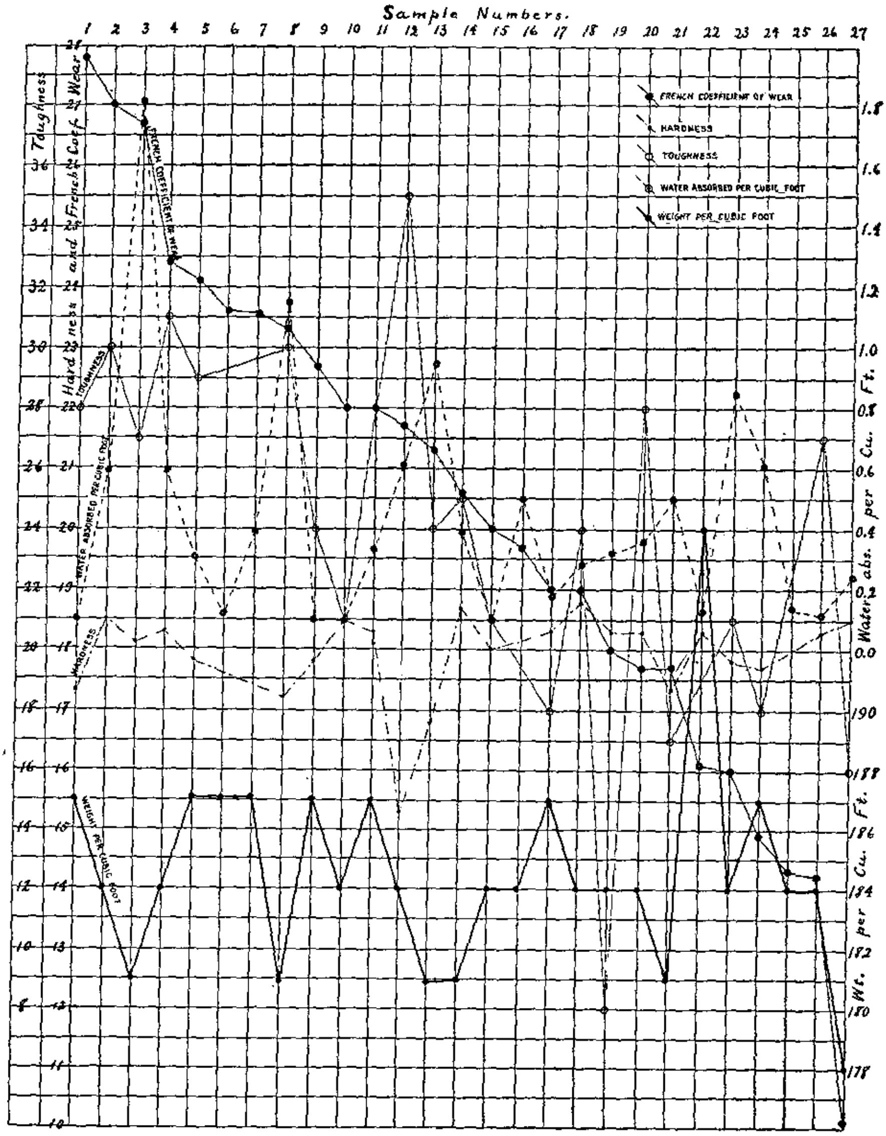

Fig. 1.

Diagram showing tests on trap rock as road metal.

and decreasing toward the right, while hardness, toughness, and other properties vary irregularly. Therefore those stones that fall on the left-hand side and toward the middle of the diagram and show at the same time great hardness and toughness are best adapted to urban and other very heavy-traffic uses; while those in the middle of the diagram with moderate hardness and toughness, and toward the left with lower or toward the right with higher values of these properties, are suitable for suburban and heavy-traffic highway purposes. Those toward the right-hand side with medium and further to the left with low hardness and toughness are adapted to lighter suburban and ordinary highway traffic conditions. Even the softest and most brittle material in the list is too resistant for the best results on the less frequented country roads, unless combined with softer materials to furnish the necessary fine powder for cementing.

"It should be a matter of interest to all who are in any way responsible for road construction or maintenance, as well as to owners of quarries supplying road materials, to know that the U. S. Department of Agriculture has a fully equipped road-material laboratory, where any person residing in the United States may have tests made free of charge by applying for instructions to the Office of Public Roads, Dept. Agriculture, Washington, D. C."

RESULTS OF TESTS OF NEW JERSEY TRAP ROCKS.

Made by the Office of Public Roads, U. S. Dept. of Agriculture, Washington, D. C.

	Specific gravity.	Weight per cu. ft. (Lbs.).	Water absorbed per cu. ft.	Per cent. of wear.	French coefficient of wear.	Hardness.	Toughness.	Cementing value.	Designation on Fig. 1.	Dept. Agr. Lab. No.
BERGEN COUNTY.										
Shadyside Quarries,	3.0	184.0	0.50	2.0	19.7	......	.....	38 dry; 211 wet,	(16)	566
ESSEX COUNTY.										
Great Notch, Francisco Bros., Quarry No. 1,	2.9	180.9	0.95	1.9	21.3	16.8	24	12 dry; 125 wet,	(13)	986
Great Notch, Francisco Bros., Quarry No. 2,	2.9	184.0	0.61	1.8	21.7	15.3	35	51 dry; 283 wet,	(12)	987
Milburn, C. A. Lighthipe & Son,	2.95	184.0	0.10	2.0	20.0	18.0	21	Excellent,	(15)	1718
Upper Montclair, Osborne & Marsellis,	2.99	187.1	0.30	1.7	24.1	17.8	29	21 dry,	(5)	988
Verona, F. J. Marley,	2.90	181.0	0.50	2.3	17.7	17.3	17	Excellent,	(21)	1727
West Orange, John O'Rourke,	2.95	184.0	0.10	1.8	22.0	18.5	21	Excellent,	(10)	1721
West Orange, "black trap," Geo. Spottiswoode & Co.,	3.00	187.0	0.10	1.8	22.7	17.8	24	Excellent,	(9)	1753
West Orange, "gray trap," Geo. Spottiswoode & Co.,	3.00	187.0	0.10	1.4	27.8	17.3	28	Good,	(1)	1754
West Orange, "blue trap," Geo. Spottiswoode & Co.,	2.95	184.0	0.36	2.3	17.7	18.3	28	Excellent,	(20)	1755
HUDSON COUNTY.										
Jersey City, O'Neill & Hopkins,	3.15	196.0	0.13	2.5	16.1	18.3	19	Good,	(22)	1773
Snake Hill, Prison Quarry,	2.95	184.0	0.12	2.8	14.2	18.3	27	Excellent,	(26)	1751
Snake Hill, N. J. Trap Rock Co.,	3.00	187.0	0.18	2.1	19.0	18.3	18	Excellent,	(17)	1756
HUNTERDON COUNTY.										
Lambertville,	2.90	184.0	0.14	2.8	14.3	......	.....	131 wet,	(25)	387
MORRIS COUNTY.										
Millington, Morris Co. Crushed Stone Co.,	3.00	187.0	0.61	2.7	14.9	17.7	18	500 wet,	(24)	1708
Mountain View, Helmer Hosier,	2.95	184.0	0.85	2.5	16.0	17.8	21	Good,	(23)	1730
PASSAIC COUNTY.										
Albion Place, W. A. Ferguson,	2.95	184.0	0.59	1.5	27.0	18.5	30	Good,	(2)	1717
Montclair Heights, Wright & Lindsley,	2.95	184.0	0.28	2.1	19.0	18.8	24	Excellent,	(18)	1713
Paterson, Paterson Crushed Stone Co.,	2.90	181.0	0.39	1.9	20.6	18.7	25	Excellent,	(14)	1716
Paterson, McKiernan & Bergin,	2.95	184.0	0.59	1.6	24.4	18.3	31	Excellent,	(4)	1731

RESULTS OF TESTS OF NEW JERSEY TRAP ROCKS.—*Continued.*

	Specific gravity.	Weight per cu. ft. (Lbs.).	Water absorbed per cu. ft.	Per cent. of wear.	French coefficient of wear.	Hardness.	Toughness.	Cementing value.	Designation on Fig. 1.	Dept. Agr. Lab. No.
SOMERSET COUNTY.										
Bernardsville, Somerset Stone Crushing Co.,	2.85	178.0	0.24	4.0	10.1	18.5	16	Excellent,	(27)	1719
Bound Brook, Wm. Haelig,	2.98	187.1	0.12	1.69	23.61	.....	.....	72 dry,	(6)	357
Bound Brook, Bound Brook Crushed Stone Co.,	2.90	181.0	1.81	1.5	26.7	18.1	27	96 dry; 298 wet,	(3)	1619
Warrenville, E. E. Cooper,	3.00	187.0	0.33	1.8	22.0	18.3	28	70 dry,	(11)	1706
UNION COUNTY.										
New Providence, A. A. Potter,	2.98	187.1	0.39	1.7	23.58	.....	.....	19 dry,	(7)	350
Springfield, Stewart Hartshorn,	2.90	180.9	1.15	1.7	23.3	17.2	30	22 dry; 174 wet,	(8)	912
Summit, Commonwealth Quarry Co.,	2.95	184.0	0.32	2.2	18.0	18.3	8	225 wet,	(19)	1707
MAXIMUM AND MINIMUM RESULTS ON 103 SAMPLES OF TRAP (DIABASE).										
Minima,	2.60	162.0	0.03	1.2	6.4	13.0	4	2 dry; 7 wet,		
Maxima,	3.20	200.0	2.73	6.3	34.5	19.3	54	201 dry; 500 wet,		
Averages,	2.95	184.0	.....	.....	.....	.....	.....			

GRANITE.

Granite and granite-gneiss were quarried by fourteen producers located in Passaic, Morris and Sussex counties. The total value was $167,112, as against $80,105 for 1910, an increase of $87,007, or more than 100 per cent. Details are shown in the following table:

PRODUCTION OF GRANITE IN 1910.

	No. of Producers.	*Value 1911.*	*Value 1910.*
Sold rough—building,	6	$6,090	$6,772
Sold rough—monumental,	4	11,232	2,465
Sold rough—other uses,	2		
Dressed—building,	4	4,192	1,338
Rubble,	2	3,262	1,730
Riprap,	3		
Crushed stone—			
Road making,	1	139,195	66,924
Railroad ballast,	1		
Concrete,	3	2,803	....
Other uses,	..	338	876
Total,	14	$167,112	$80,105

Passaic County led in the production, its value being $89,723, although it had fewer producers than Morris, which was second, and not far behind. The production in Sussex was small.

It will be noted that only 10 per cent. was for building or monumental work, whereas 85 per cent. was crushed stone.

SANDSTONE.

Sandstone was reported from five counties, the total value being $155,765, a gain of $42,115 as compared with 1910.

The different uses, value of stone and number of producers is shown in the following table:

PRODUCTION OF SANDSTONE IN 1911.

	No of Producers.	*Value.*	*Per Cent.*	*Value 1910.*
Building stone, rough,	15	$60,716	39	$56,099
Building stone, dressed,	4	45,900	29.5	16,600
Road metal,	3	16,736	10.7	....
Concrete,	2	......	....	39,951
Flagging,	1	32,413	20.8	....
		$155,765	100.0	$112,650

Mercer County leads in the quarrying of sandstone, with value of $57,718; Bergen is second, value $54,235; Hunterdon, Somerset and Passaic counties follow in the order named with total value of $43,812. Most of the stone from Mercer County was rough building stone, although there were small amounts of railroad ballast and crushed stone for concrete. The chief quarries are along the canal at Wilburtha and at Princeton. In Bergen 80 per cent. of the product was dressed building stone, the balance chiefly rough building stone, although small amounts of flagging and crushed stone were quarried. Passaic County produced only rough stone, but in Somerset it was mostly cut or dressed.

All of the sandstone was from the Triassic formation.

LIMESTONE.

The limestone statistics do not include the amounts nor value of stone used in the manufacture of lime or of Portland cement, this portion of the production being included in the value of those manufactured products.

The total value of the limestone quarried for other uses was $138,148, a decrease of $86,559 or 38 per cent. compared to 1910. This decrease was chiefly in stone for flux, the value of which showed more than $100,000 decrease. On the other hand, the sales of limestone for agricultural purposes was very greatly increased.

PRODUCTION OF LIMESTONE IN 1911.

Uses.	*No. of Producers.*	*Short Tons.*	*Value.*	*Average Per Unit.*
Road making,	5	17,936	$11,616	0.65
Concrete,	5	16,612	10,340	0.62
Blast furnace flux,	10	183,267	91,781	0.50
Building stone,	3	......	341	...
Railroad ballast,	1	......	24,070	...
Other uses.	3			
Total,	13		$138,148	

By counties the production was—Sussex, $82,500; Warren, $34,196, and Hunterdon, $21,452. The chief centers in Sussex County were Franklin Furnace and Hamburg, in Warren

County, Oxford, and in Hunterdon County, Califon and German Valley.

The great bulk of the limestone sold for flux and agricultural purposes was the white crystalline variety.

SLATE, TALC AND SOAPSTONE.

The combined value of slate, talc and soapstone for 1911 was $26,474, a decrease of $2,464. As there were less than three active producers in each of these industries, the values are combined in order that the figures of individual producers may not appear.

The two active slate properties are at Lafayette and Newton, both in Sussex County, and both producing roofing slate. In 1908 tests of these slate in comparison with some of the best-known Pennsylvania slates were made and the results published.[1] The field examination and tests showed that the Newton slate is hard and bluish-black in color, not particularly strong, although not much below some of the widely-used Pennsylvania and Vermont slates in strength. It is also more brittle, but, on the other hand, is considerably less porous than others that were tested with it, and is more resistant to the corrosive action of acids than any slates in the country that up to that time had been tested. On account of these qualities it is particularly well adapted for use in cities and in manufacturing establishments, in fact wherever much coal is burned or corrosive fumes are produced by any means. This conclusion is further strengthened by the fact that in the acid tests fading or change of color was barely perceptible in a film less than $^1/_{100}$ of an inch (0.14-0.24 mm.) in thickness. In this respect it was equaled only by slate from Chapmans, Pa.

The tests of the Lafayette slate showed that it equaled in strength many of the best slates of Pennsylvania and Vermont, while in toughness it exceeded all slates tested up to that time, although it is nearly equaled by the products of the Chapmans, Old Bangor and Slateford quarries. It is also very low in porosity and near the average in corrodibility.

[1] Annual Report State Geologist of New Jersey for 1908, p. 102 *et seq.*

The acid test gave a distinct brownish tinge to the surface film about $^{1}/_{200}$ of an inch (0.14 mm.) in thickness.

One great source of expense in operating a slate quarry is the enormous proportion of waste, and a reduction in this deserves careful consideration, since it costs as much to remove the waste rock from the quarry as the marketable slate. Not only do the enormous piles of waste slate heaped up in the immediate vicinity of every opening mean the loss of the slate itself, but also an expenditure of about 40 cents per cubic yard or even more to remove it from the quarry to the dump pile. In some quarries the substitution of channelers for the old wasteful methods of blasting is said to have resulted in a great saving of slate.

The great hardness of most of the New Jersey slate adapts it to a variety of uses to which slate, like that of the softer slate of Pennsylvania, is unsuited, such as steps, floorings, railings and flagging, in which resistance to wear and weathering are prime requisites. On account of its hardness, however, it is not so easily sawed into slabs as the softer kinds.

Talc and soapstone, although occurring at a number of points in New Jersey, are quarried only in Warren County along the Delaware River just north of Phillipsburg. Other extensive openings occur on the Pennsylvania side of the river.[1] Most of the rock quarried in New Jersey is used in the manufacture of mineral pulp. As described by Peck, it is "rather hard, compact, massive to finely granular in texture, and very light-green or mottled-green and white in color. It consists of a very intimate mixture of two or three different mineral species, chief of which is serpentine, which gives the rock its greenish color. The colorless portion consists of a lime-magnesia silicate, having approximately the chemical composition of the colorless amphibole, tremolite. This mineral has undergone a partial alteration, by hydration and a loss of its lime, to talc, which shows as floury patches wherever the rock is struck with a hammer. The lime thus set free by the more or less complete decomposition of the tremolite remains, in part at least, in the rock as a third constitutent, though a small one, constituting usually not more than

[1] Annual Report of the State Geologist for 1904, p. 163 *et seq.*

2 or 3 per cent. of the entire rock mass. Occasionally this aggregate of minerals has been so thoroughly kneaded together as to result in a homogeneous mixture of its constituents, so that it assumes a uniform apple-green color, is tough and compact or very finely granular, has a splintery fracture and approaches very closely that variety of serpentine known as bowenite in all physical properties except that of hardness, which is only 3.5 instead of 5 to 6."

Some of the rock from this quarry is used for decorative purposes. According to Peck it is "essentially a serpentine, but is usually darker-green in color than the rock used for grinding, for only the lighter-colored rocks grind to a pulp of the desired whiteness. It is a mottled mixture of light and dark serpentine, occasionally sprinkled with grayish, pinkish or flesh-colored dolomite crystals and sometimes veined with streaks or seams of pure white, these streaks consisting of a compact to fibrous-looking calcite, in which are imbedded fibres of asbestos."

SAND AND GRAVEL.

The production of sand and gravel during 1911 amounted to 3,352,765 short tons, valued at $1,058,926, a decrease in value as compared to 1910 of $80,349. There were decreases in molding sand, $43,629; building sand, $97,629; furnace sand, $2,255; miscellaneous sand,[1] $43,910, and increases in glass sand, $7,471; fire sand, $34,941; engine sand, $2,644; filtration sand, $2,407; gravel, $59,602.

Sand and gravel are widely distributed in the State and returns were received from 17 out of the 21 counties, Essex, Hudson, Hunterdon and Somerset being the only non-producers.

In five of the counties there are only one or two producers, while Burlington had 28 and Middlesex 19. In order of production the counties ranked as follows: Burlington, $307,517; Middlesex, $216,475; Cumberland, $187,224; Cape May, $79-414; Morris, $61,776, and then Monmouth, Passaic, Gloucester,

[1] Including sand for grinding and polishing, paving, asphalt, grading and filling, and other miscellaneous uses.

Warren and Camden all between $50,000 and $10,000; and Atlantic, Union, Ocean, Mercer, Bergen, Salem and Sussex in the order named, all under $10,000.

Cumberland County leads in the production of glass sand, while Camden, Gloucester and Middlesex produce much smaller amounts. Middlesex, Cumberland and Burlington are the chief counties for molding sand, their product being valued at $114,-546, $102,061 and $82,285, respectively. In building sand, Burlington leads with 1,211,335 tons, valued at $151,950, and has no close competitor, Morris, 141,041 tons, value $43,473, being second. Fire sand comes chiefly from Middlesex, value $54,190, while Morris and Camden supply small amounts. Monmouth County leads in the production of gravel, but as there are less than three producers, its figures cannot be published. Passaic and Burlington are almost equal, with the former slightly ahead.

Inasmuch as a large number of the smaller miners keep very imperfect records of their production, many selling by wagon loads of varying load or by the cubic yard, it is not easy to determine the tonnage mined. In previous years no attempt was made to compile it except in the case of glass sand. This year, however, an estimate has been made, and, while it is probably not strictly accurate, it is a close approximation.

Building sand leads in the amount dug—1,501,951 tons—but the average price per ton was only 16 cents, so the total value, $242,659, was not so great as for the 715,654 tons of molding sand at 55 cents, value $392,840. Fire sand brought the highest price per ton, $1.04, furnace sand was next, $1.01, and a small amount of polishing and grinding sand was sold at prices approximating $1.00 per ton, while paving sand brought only 15 cents. The prices and amounts of all grades are shown in the table below.

PRODUCTION OF SAND AND GRAVEL IN 1911.

Classes.	No. of Producers.	Quantity Short Tons.	Value.	Value Per Ton.	Increase or Decrease.
Glass sand, ...	8	91,530	$68,549	$0.75	$7,471 I.
Molding sand, ...	49	715,654	392,840	0.55	43,629 D.
Building sand, ...	52	1,501,951	242,659	0.16	97,629 D.
Fire sand, ...	13	64,977	67,503	1.04	34,941 I.
Engine sand, ...	4	45,743	12,310	0.27	2,644 I.
Furnace sand, ...	6	6,895	6,991	1.01	2,255 D.
Paving, ...	6	89,177	13,438	0.15	......
Other sands, including grinding, polishing and filtration, ..	17	119,783	56,442	0.47	......
Gravel, ...	35	717,055	198,194	0.27	59,602 I.
Total, ...	118	3,352,765	$1,058,926		$80,349 D.

PORTLAND CEMENT.

There was a slight increase over 1910 in both production and value of the Portland cement manufactured during the year. The total output (sales) was 4,411,890 barrels, valued at $3,259,-528, or $0.738 per barrel in bulk, as against 4,184,698 barrels, valued at $3,067,265, an increase of 227,192 barrels (5 per cent.) and $192,263 (6 per cent.) in value. The average price for the year was slightly above that during 1910, although all producers reported much lower prices for the latter part of 1911 than earlier in the year. At the close of the year the stock on hand amounted to 481,097 barrels.

Three plants were active during the year and one idle. The combined daily capacity of the three active plants was 20,400 barrels, but none of the three ran to full capacity. If the daily capacity be taken at 20,400 barrels for 360 days in the year, the total production (sales) was not quite 60 per cent. of capacity; if the estimate be made on basis of 300 working days in the year, it was 72 per cent. Or, to put it somewhat differently, if the daily capacity be 20,400 barrels, the entire production for the year could have been made up in 216 working days. In these respects the past year did not differ greatly from preceding years, since for a long time the actual production has been far short of the total working capacity of the plants. The total number of kilns reported was 44, varying from 60 to 150 feet in length. Coal, slack and gas were used as fuel, the former chiefly. As in previous years, the active plants are all located in Warren County and the raw materials used were limestone and cement rock.

LIME.

The stone used in making lime is not included in the statistics of limestone in the stone industry, as to do so would result in a duplication of values.

The production of lime in 1911 amounted to 27,057 short tons, valued at $113,784, which is a decrease of 7,278 tons and $15,180 in value. The average value per ton in 1911 was $4.20 per ton as against $3.75 in 1910. There were 17 active producers, most of them burning the blue magnesian limestone. Four firms, however, use the white crystalline limestone and manufacture 50 per cent. of the total in quantity and 67 per cent. in value.

The chief facts regarding the industry are tabulated as follows:

PRODUCTION OF LIME IN 1911.

	No. of Producers.	*Amount short tons.*	*Value.*	*Value per ton.*
Building lime,	3	3,583	$20,492	$5.72
Chemical works,	4	4,445	18,096	4.07
Paper mills,	1			
Fertilizer,	15	13,013	36,694	2.82
Dealers,	3	6,016	38,502	6.40
Total,	17	27,057	$113,784	$4.20

Sussex County was first, 13,682 tons, $76,196 in value; Hunterdon, second, 6,019 tons, valued at $16,038; Warren, third, 4,516 tons, valued at $13,030, and Somerset and Morris following with less than three producers each.

SAND-LIME BRICK.

Sand-lime brick were manufactured in Camden and Morris counties, three plants being in operation, the same as in 1910.

The production was 1,988,000, valued at $17,710, a decrease of 836,000 in quantity and of $6,101 in value, as compared to the previous year.

	Number Thousands.	Value.	Value per Thousand.
Common Brick,	1,314	$8,716	$6.64
Front Brick,	674	8,994	13.34
Total,	1,988	$17,710	$8.90

MINERAL WATERS.

The use of bottled spring water for drinking purposes in preference to that of public supplies is steadily increasing. In 1908, 1,199,023 gallons were sold; in 1909, 1,419,100 gallons; in 1910, 1,583,050 gallons and in 1911, 2,233,627 gallons. In 1908 the value was $126,603; in 1911, $210,123. It appears, therefore, that since 1908 the quantity has nearly doubled and the value increased about 65 per cent. The average retail value per gallon at the spring was 9.4 cents.

In addition to the amount sold, chiefly for table use, the value of which has been given, nearly 50,000 gallons additional were used in the manufacture of soft drinks, the value of which is not included in these totals.

GREENSAND MARL.

Reports from seven producers in 1911 showed a total of 2,904 short tons of greensand marl, valued at $1,031. The great bulk of that produced was used by the owners of the pits, so that the value represents hardly more than the cost of digging.

The production, so far as reported, was limited to Burlington County.

MINERAL PAINTS.

The mineral paint industry includes natural pigments, pigments made directly from ores, and chemically manufactured pigments. Some shale is ground in Middlesex County, zinc oxide is made from the ore mined at Franklin Furnace, and lithophone and Venetian red are the chief chemically manufactured. The total value of all classes of mineral paints are included with coke and its by-products in order to conceal individual production.

COKE.

Coke, with its by-products, tar, liquid ammonia and gas (illuminating and fuel), was manufactured at Camden. Since there was only one producer, separate quantities and values cannot be given. It is interesting to note that the total value of the by-products exceeded the value of the coke by over 12 per cent. Tar amounted to 18 per cent., liquid ammonia 29 per cent. and gas 65 per cent. The value of the coke was 73 per cent. of the coal from which it was produced.

In order to conceal individual production, the value of mineral paint and of coke with its by-products are combined. In 1911 they amounted to $2,607,270.